Jan. 25, 1949. J. FINK 2,459,930

ELECTRIC BALANCE CLOCK

Filed July 10, 1944

Fig. 1

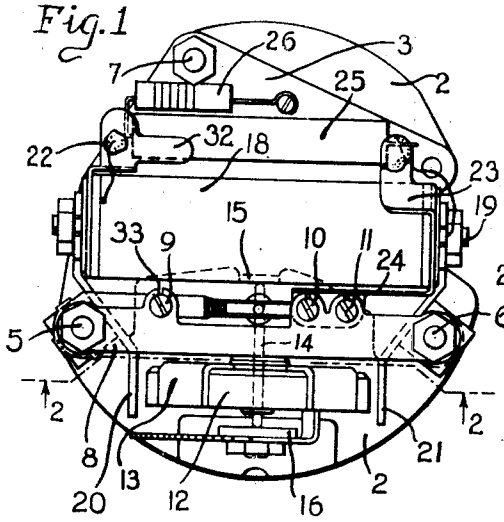


Fig. 2

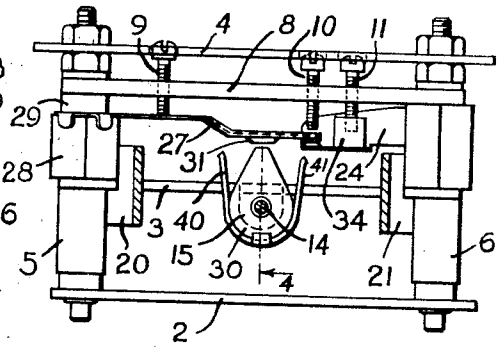


Fig. 3.

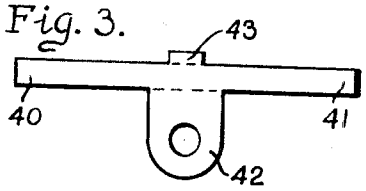


Fig. 4.

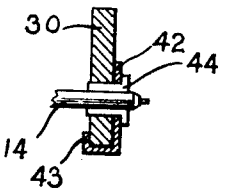


Fig. 5

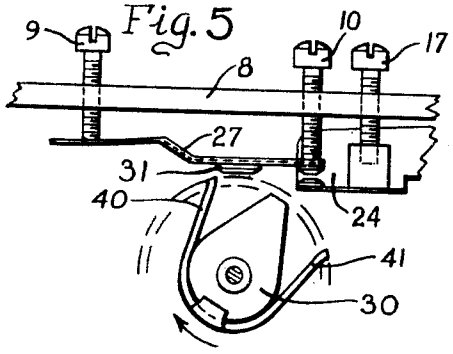


Fig. 6

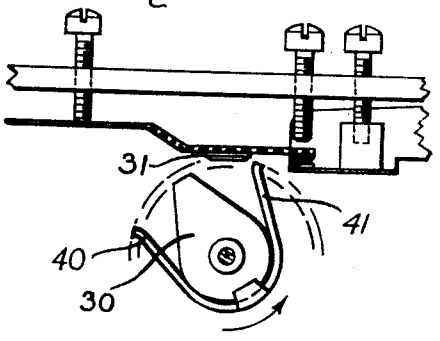
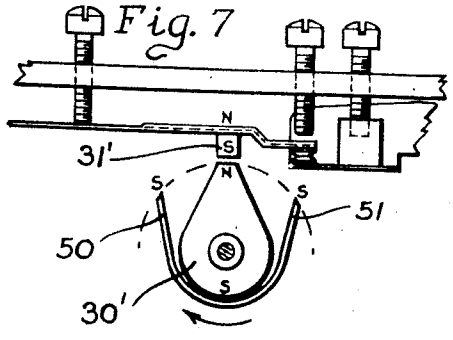


Fig. 7



INVENTOR.
Jean Fink
BY
R B Richardson
Atty.

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ELECTRIC BALANCE CLOCK

Jean Fink, Delavan, Wis., assignor to The George W. Borg Corporation, Chicago, Ill., a corporation of Delaware

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4 Claims. (Cl. 58—28)

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The present invention relates in general to clocks of the electromagnetically driven balance type, such as are used in automobiles, for example; and the object of the invention is to produce a new and improved clock of this character.

The invention is concerned more in particular with the arrangement for controlling the circuit of the electromagnet which drives the balance. This arrangement preferably includes a switch comprising a relatively fixed contact and a movable contact mounted on a flexible contact spring, together with means for periodically actuating the contact spring to close the circuit of the electromagnet. For actuating the contact spring a permanent magnet on the balance arbor may be employed, cooperating with an armature on the contact spring.

The arrangement described in the foregoing operates very satisfactorily, and is especially reliable as regards starting of the clock; but is nevertheless subject to a small amount of sporadic trouble due to the contacts "sticking" or failing to separate promptly when the actuating force is removed. The invention is directed specifically to the elimination of trouble from this source.

According to a feature of the invention means are provided for accurately adjusting the air gap between the permanent magnet and its armature, both in the operated and unoperated positions of the armature. This results in a more efficient magnetic structure which makes it possible to use a stiffer contact spring and thus greatly reduce the possibility of the contacts sticking together. Means is also provided for accurately adjusting the tension of the contact spring.

According to another feature of the invention means is provided for positively separating the contacts in the event that sticking should take place and for performing this function in timed relation to the release of the armature by the permanent magnet so that the motion of the balance is not interfered with. In one embodiment of the invention this means has the form of a device supported on the balance arbor which engages the armature, in the event of contact sticking, and mechanically separates the contacts. In a modified form of the invention a polarized armature is employed and the permanent magnet is provided with pole pieces which cooperate with the polarized armature to restore the contact spring by magnetic repulsion.

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

Fig. 1 is a rear view of an automobile clock embodying the invention, with the back frame plate removed to expose the electromagnet and other parts;

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Fig. 2 is a section on the line 2—2, Fig. 1, showing the permanent magnet and the contact separating attachment which is associated therewith;

Fig. 3 is a plan view of the sheet metal stamping from which the contact separating attachment is formed;

Fig. 4 is a section through the permanent magnet on the line 4, Fig. 2;

Figs. 5 and 6 and fragmentary views which will be used in explaining the operation of the contact separating attachment; and

Fig. 7 shows a modified form of the contact separating device, operating on the principle of magnetic repulsion.

The gear train, drive mechanism, and other parts not concerned with the invention have been omitted from the drawings. For a full disclosure of these details reference may be made to Patent No. 2,356,983, granted Aug. 29, 1944, and Patent No. 2,357,645, granted Sept. 5, 1944.

Referring to the drawings, the various parts of the clock are mounted on a frame which comprises the front plate 2, the center plate 3 and the back plate 4. These plates are held together in spaced relation by means of the posts or pillars 5, 6 and 7, of which only posts 5 and 6 are shown in Fig. 2. The back plate 4 is removable without disturbing any of the other parts and is not shown in Fig. 1. The frame is of known construction, except for the bridge member 8 which extends between the posts 5 and 6, as seen in Figs. 1 and 2. This bridge member is preferably made from rather heavy stock and serves to stiffen the frame, which is thus given ample strength and rigidity independent of the back plate 4.

The bridge member 4 also serves to support the adjusting screws 9, 10 and 11, the function of which will be explained more fully later on. Suffice it to say at this point that since the screws are carried on the bridge member 4, which is a rigid and substantial part of the frame, they can be given a final and complete adjustment during the assembly of the clock and before the back plate 4 is attached.

The clock includes a balance comprising the ring 12 which is supported on the four pole armature 13. The armature is in turn supported on the arbor 14, which is provided with suitable bearings in the frame plate 3, see down-turned part 15, and in the balance cock 16. The usual hairspring is provided, and is located inside the balance ring 12.

The balance is driven by an electromagnet which comprises the winding 18, core 19, and the pole pieces 20 and 21. The pole pieces are supported on the frame plate 3 as shown. The winding 18 is carried on a spool of insulating material which is clamped between the ends of the pole pieces by means of nuts threaded onto the opposite ends of the core 19. The terminal members 22 and 23 are inserted between the pole pieces and the spool heads and are insulated from the former by means of insulating washers. The ends of the winding 18 are connected to the terminal members 22 and 23, respectively. A condenser 25 and a resistor 26 are connected in series between the terminal 23 and the frame plate 3, as shown.

The details of the construction of the electromagnet spool and terminals are shown and described in Patent No. 2,357,645, previously referred to.

The switch for controlling the circuit of the electromagnet comprises a fixed contact member 24, formed integrally with the terminal 23, and a contact spring 27, which is assembled on the post 5 between the square spacer 28 and the washer 29. This arrangement is shown clearly in Fig. 2. For operating the contact spring 27 a small permanent magnet 30 is provided. This magnet 30 is mounted on the balance arbor 14 and cooperates with an armature 31 mounted on the contact spring.

In explanation of the circuit of the electromagnet, it should be mentioned that the back plate 4 carries a terminal (not shown) which engages the tongue 32 of terminal 22 when the back plate is assembled in the clock movement. This terminal on the back plate is the live terminal of the clock and is connected to the ungrounded pole of the battery when the clock is installed in an automobile. The electromagnet circuit is then completed over a path which includes the ungrounded pole of the battery, back plate terminal, terminal 22, winding 18, terminal 23, fixed contact member 24, contact spring 27, the clock frame, and the frame of the automobile, the latter being connected to the grounded pole of the battery. It will be noted that the condenser 25 and resistor 26 are connected in shunt of the switch 24—27.

When the electromagnet circuit is open, at the back plate terminal, for example, the oscillating parts are in the position in which they are shown in Figs. 1 and 2. This is due in part to the hairspring which is so adjusted that the balance is brought to rest in such a position that the permanent magnet 30 is opposite armature 31, or at least within operative range of the armature. The permanent magnet, therefore, orients the balance to the position in which it is shown and also attracts the armature 31, thus operating the contact spring 27 and closing the switch. The clock is thus maintained in readiness to start when the circuit is closed.

When the clock is connected up, current starts to flow over the circuit described above and the electromagnet is energized. An impulse is thus given to the balance, which rotates it is one direction or the other, causing the permanent magnet 30 to rotate also and release the armature 31, thus opening the circuit of the electromagnet. The rotation of the balance tensions the hairspring, which shortly stops the rotation and causes it to be resumed in the opposite direction, whereupon the permanent magnet, as it passes the armature 31, operates the switch momentarily to close the electromagnet circuit again and give another impulse to the balance. This action continues and after a few swings the balance will be oscillating with full amplitude, receiving an impulse from the electromagnet during each beat.

The general construction and operation of the clock having been described so far as necessary, attention may now be directed more in detail to the features of the invention.

The adjusting screws 9, 10 and 11 are threaded into tapped holes in the bridge member 8. Before the holes are tapped, slots such as 33, Fig. 1, are sawed in the bridge member to intersect the holes. Due to these slots the material is able to yield slightly when the holes are tapped, with the result that the tapped holes are slightly smaller than the screws. When the screws are inserted the material again yields, but grips the screws tightly so that they remain in any adjusted position. This construction enables lock nuts to be dispensed with.

The electromagnet assembly including the terminal 23 and the fixed contact 24 are so designed and constructed that when the parts are assembled in the clock the fixed contact member 24 is too high, that is, the armature 31 is too far away from the magnet 30 when the armature is in operated position. The screw 11 is provided so that the air gap between the armature 31 and magnet 30 can be accurately adjusted, and is turned down until the air gap is reduced to the desired length. The contact member 24 is quite stiff but is adapted to yield sufficiently to enable the adjustment to be made. A small block 34 of insulating material is inserted between screw 11 and the contact member 24 to avoid a short circuit between the contact member and the frame.

The screw 10 is a back stop for the spring 27 and serves to adjust the stroke of the armature 31. By adjusting the stroke as short as possible consistent with a satisfactory separation of the contacts the air gap between the permanent magnet and the armature in retracted position is reduced to a minimum and the contact spring 27 accordingly may have the maximum tension.

It has been found that a more close and accurate adjustment of the air gap can be made if the contact spring 27 is made substantially unflexible between the contact and the armature 31 and for some distance beyond the latter. This is accomplished by providing the contact spring with an upturned flange along each edge, as shown in the drawings.

The screw 9 is provided in order to enable the tension in spring 27 to be adjusted. The spring is tensioned upward and the end of the spring rests against the stop screw 10 when the armature 31 is not influenced by the magnet 30. More tension than can be used is put in the spring before it is assembled and then after assembly the tension is relieved to the desired extent by turning in the screw 9.

The adjusting arrangements described enable the permanent magnet 30 to operate at maximum efficiency and make it possible to have a fair amount of tension in the spring 27, sufficient to cause the contacts to separate reliably under normal conditions. That is, in the great majority of clocks the switch operates satisfactorily and causes no trouble. It is known, however, that in relays and other devices having light or lightly adjusted contact springs, a certain amount of trouble is encountered due to contact sticking. The exact cause of the trouble does not appear

to be fully understood. The contacts do not weld together, but merely stick together for some reason or other. They can generally be separated by a slight jar and may not stick again for a long time, if ever. In the occasional automobile clock in which the trouble is encountered, it manifests itself by stoppage of the clock for a period of a few minutes up to an hour or more. This occurs generally at night, when the car is in the garage, as any motion of the car is usually sufficient to jar the contacts apart and start the clock running again.

In many devices it is possible to prevent contact sticking, or at least substantially eliminate it, by increasing the spring tension. This expedient has been followed in the case of the clock described herein, as previously explained. The clock is rather small, however, and there is a limit to the size of the permanent magnet that can be used, which limits the amount of spring tension that can be employed. Since it is desirable in the case of an automobile clock to absolutely eliminate all danger or even possibility of stoppage, a further improvement is introduced whereby if contact sticking should occur the contacts are positively separated, causing the clock to continue running as though no trouble had occurred. This improvement will now be described.

Referring to Fig. 2, it will be seen that the permanent magnet **30** has an attachment which includes two arms **40** and **41** located on opposite sides of the magnet. These arms are in the plane in which the magnet oscillates and accordingly are operatively related to the armature **31**, as will be explained.

The construction of the attachment is illustrated in Figs. 3 and 4. Before forming, it has the shape shown in Fig. 3, being a stamping from some non-magnetic sheet metal, preferably beryllium copper, which can be hardened after forming. By means of a suitable die the central portion of the blank shown in Fig. 3 is given a semi-circular formation to fit the lower end of the magnet **30** and at the same time the perforated ear **42** is bent at right angles along the dotted line so that it will rest against the side of the magnet when assembled thereto. Another ear **43** may be provided, if desired, to engage the opposite side of the magnet. The formed blank is secured to the magnet by means of a headed metal sleeve **44** which passes through the hole in ear **42** and a corresponding hole in the magnet, in which it has a press fit. The sleeve **44** may be additionally secured by staking at the end opposite the head. The complete magnet assembly, including the described attachment and the sleeve **44**, is carried on the arbor **14**.

Reference may now be made to Figs. 5 and 6 for a more detailed explanation of the operation of the device. In these figures semi-circular arcs have been drawn to show the path of the end of the magnet **30** and the path of the ends of the arms **40** and **41**.

In Fig. 5 it is assumed that the magnet assembly is rotating in the direction of the arrow. The magnet **30** has just released the armature **31** and the contacts have separated in the normal manner due to the tension in spring **27**. As the result of this normal operation the armature **31** has moved outside the path of the ends of arms **40** and **41** and will not be engaged by arm **40** when it passes the armature.

In Fig. 6 the magnet assembly is assumed to be rotating in the opposite direction, although the direction of rotation is immaterial. The magnet

32 has released the armature **31**, as in the preceding case, but due to the contacts sticking together the switch has remained closed and the armature **31** has remained in attracted position. In this position the armature is in the path of the end of arm **41**, which engages the armature and positively separates the contacts.

The arms **40** and **41** should be spaced from the magnet in the plane of its rotation just enough so that during normal operation the armature **31** will have time to restore and move out of the path of the arms **40** and **41** before the approaching arm can engage it. As long as the switch operates normally, therefore, the arms **40** and **41** perform no function, that is, neither one of these arms will ever engage the armature. In case the restoration of the armature is delayed by contact sticking, however, the armature is instantly engaged by arm **40** or arm **41**, depending on the direction of rotation at the time, the contacts are forcibly separated, and the armature is restored by spring **27** in the usual manner, except for the momentary delay. The only effect produced by the sticking of the contacts is a slightly longer impulse to the electromagnet, which does no harm.

In connection with the foregoing it may be pointed out that when the permanent magnet is directly aligned with the armature, as shown in Fig. 2, the poles of the four pole armature **13** are symmetrically disposed relative to the poles **20** and **21** and since the armature poles are 90 degrees apart the balance can rotate 45 degrees before a pair of armature poles becomes aligned with the poles **20** and **21**. The switch must open before the armature poles reach this aligned position or the continued energization of the electromagnet will exert a retarding effect on the balance. It follows, therefore, that the spacing between the permanent magnet and the arms **40** and **41**, in the particular clock shown, should be somewhat less than 45 degrees. The spacing may be as small as 35 degrees, for example, which allows 25 degrees for release of the armature by the permanent magnet and 10 degrees for normal restoration of the armature by the contact spring.

It will be understood that the principles involved apply to other types of balance armatures and other types of electromagnet structures and that in any case the contact separating means will be suitably located so that the contacts will be separated in the proper timed relation to the motion of the balance and its normal oscillations will not be interfered with.

Attention may now be directed to the modification which is shown in Fig. 7. In this embodiment of the invention the permanent magnet **30'** has an attachment including the arms **50** and **51** which is similar to the attachment already described except that it is made of magnetic material, such as soft iron, for example. The arms **50** and **51** also are somewhat shorter that the arms **40** and **41**, and the ends or poles oscillate in the same path as the end of the permanent magnet. The armature **31'** is polarized, that is, it is a small permanent magnet. The magnets **31'** and **30'** are so poled that in the position in which the parts are shown in Fig. 7 the magnet or armature **31'** will be attracted to close the switch.

Describing the operation of this modification briefly, it may be assumed that the permanent magnet **30'** is rotating in a clockwise direction, as shown by the arrow. As the permanent magnet passes the armature **31'** the latter is attracted to close the switch. After further rotation of about 25 degrees the armature is released by the perma-

nent magnet and the switch is opened, assuming normal operation. As the rotation continues the arm or pole comes within operative range of the armature 31' with the result that if the contacts have stuck together the armature 31' is restored by magnetic repulsion and the contacts are separated. The operation during rotation in the other direction is the same except that arm or pole 51 is operative.

In this modification since the poles 50 and 51 become operative with respect to the armature before coming into alignment therewith these auxiliary poles should be spaced somewhat farther from the permanent magnet than the arms 40 and 41 in the other modification.

The application of the magnetic repulsion principle is somewhat more costly, inasmuch as it requires two permanent magnets instead of one. It has the advantage, however, of avoiding all mechanical contact with oscillating parts and the further advantage that the auxiliary poles reduce the length of the air gap and render the permanent magnet somewhat more efficient, which makes it possible to use a somewhat stiffer contact spring.

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 clock, an electromagnet, a switch for controlling the circuit of said electromagnet, an oscillatory system driven by said electromagnet, a polarized armature associated with said switch, and a magnetic structure included in said oscillatory system and adapted to cooperate with said armature to actuate said switch by magnetic attraction and to restore said switch by magnetic repulsion.

2. In a clock, an electromagnet, a switch for controlling the circuit of said electromagnet, said switch comprising a relatively fixed contact and a movable contact, a contact spring rigidly supported at one end and carrying said movable contact at the other end, an armature carried by said contact spring, an oscillating system driven by

said electromagnet and including a permanent magnet cooperating with said armature to periodically close said switch, and means for stiffening said contact spring to prevent flexing thereof between said armature and movable contact when the movement of the armature is arrested by closure of the switch.

3. In a clock, an electromagnet, a switch for controlling the circuit of said electromagnet, an armature for operating said switch, an oscillating system including a permanent magnet for periodically attracting said armature, a clock frame on which said parts are supported, and means including adjusting screws threaded in a part of said frame for adjusting the air gap between said permanent magnet and said armature in its attracted and non-attracted positions.

4. In a clock, a balance, an electromagnet for driving said balance, a switch for controlling the circuit of said electromagnet, a frame for supporting said parts, said frame comprising a front plate, a center plate, and a removable back plate, means including pillars for supporting said plates in spaced relation, said center plate being cut away to provide space for said balance, an auxiliary frame member extending between two of said pillars to strengthen the frame where said center plate is cut away, and means including screws threaded in said frame member for adjusting said switch.

JEAN FINK.

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