SWITCH CIRCUIT AND ACTUATING MECHANISM

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This invention relates to electric clocks and more particularly to an improved switch mechanism and circuit for such clocks and similar applications.

Electric clocks adapted for energization from direct voltage sources have been devised which utilize an electromagnetic drive mechanism for maintaining the balance wheel assembly in oscillation and for developing voltage and magnetic impulses for energizing a suitable indicator. Such arrangements commonly employ an energizing circuit including switch contacts which are actuated in synchronism with the oscillations of the balance wheel. The repetitive operation of the switch contacts results in rapid contact deterioration such as the development of films and oxides on the contact surfaces which prevents good electrical contact without sufficiently high contact pressure to penetrate such films and oxides. In accordance with this invention, means are provided for momentarily increasing the contact pressure when the contacts close. This is accomplished by the use of an electromagnet or pull-in coil adjacent the movable contact and which is energized for a short duration by the discharge of a condenser.

Additionally, in such clocks it is desired to operate the switch contacts synchronously with the balance wheel without a direct mechanical connection so that the contacts may be contained within a sealed casing to promote long operating life. This is accomplished in accordance with this invention by a magnetic coupling between a driving member on the balance wheel and a switch actuator. This arrangement also permits the switch to be constructed as a unitary component so that it may be readily replaced.

A more complete understanding of this invention may be had from the detailed description which follows taken with the accompanying drawings in which:

Figure 1 is a fragmentary view showing the general arrangement of a clock embodying the present invention;

Figure 2 is a view taken on lines 2—2 of Figure 1;

Figure 3 is a diagrammatic representation of the inventive switch mechanism and circuit;

Figure 4 is a diagrammatic representation of an alternate embodiment of the switch operating mechanism; and

Figure 5 is an enlarged pictorial view with portions cut away to show details of the switch structure.

Referring now to the drawings there is shown an illustrative embodiment of the invention in an electric clock of the electromagnetic impulse type. In general, the clock comprises a balance wheel assembly 10 with an associated electromagnetic drive 12 provided with an energizing circuit 14. The circuit includes a switch 16 operatively coupled with the balance wheel assembly 10 for synchronous operation therewith and an electromagnet 18 is associated with the switch 16 to ensure uniformly good electrical contact operation.

Referring now to Figures 1, 2, and 3, the invention will be described in detail. The balance wheel assembly 10 comprises a balance wheel 20 mounted upon a pivot staff 22 which is resiliently constrained by the hairspring 26. Periodic oscillation of the balance wheel is maintained by the magnetic field of the pole pieces 24 of the electromagnetic drive 12. An indicator drive train including mechanism 60 is driven by an armature (not shown) coupled with pole piece extensions 25. A periodic magnetic impulse is provided for the pole pieces 24 and 25 by the energizing circuit 14. This circuit includes a voltage source 28 having one terminal connected to a point of reference potential or ground and the other terminal connected through the energizing or driving coil 30 of electromagnetic drive 12 and thence through the coil 32 of the electromagnet 18 to the fixed contact 34 of the switch 16. This circuit is completed from the movable contact 36 through the contact support member 40 and switch actuating arm 42 to ground. The energizing circuit 14 additionally includes a condenser 44 connected in parallel with the coil 32 and the switch contacts 34 and 36 for a purpose to be described subsequently. In order to prevent sparking of the contacts 34 and 36, a resistor 46 and condenser 48 are serially connected across the contacts.

The electromagnet 18 has a pole piece 38 disposed adjacent the contact support member 40 which is of magnetic material and subject to attraction by the magnetic field of the electromagnet. The support member 40 is secured to the switch actuating arm 42 for displacement therewith and the arm is mounted at one end upon the support pin 50 for angular deflection by pivotal or flexing motion of the arm 42 about this support. The free end of the arm 42 supports a permanent magnet 52 which is coupled by magnetic linkage with the driving member or armature 54. The armature 54 is mounted upon the pivot staff 22 as part of the balance wheel assembly and thus has an oscillatory motion concurrent with the balance wheel. The armature 54 has rim elements 56 and 58 of magnetic material which are axially offset from each other. The element 58 has a circumferential length somewhat less than the oscillatory displacement of the balance wheel 20. The magnet 52 serves to couple the switch actuating arm 42 to the elements 56 and 58 of the armature by magnetic linkage therewith. Since the arm 42 is constrained against motion in the plane of the armature but has freedom of movement in a plane perpendicular to this plane, rotation of the armature will cause the arm 42 to reciprocate in following the rim elements 56 and 58. This causes opening and closing of the contacts 34 and 36 depending upon the direction of movement of the armature 54.

In Figure 4, there is shown a modification of the actuating mechanism for the switch 16. In this modification the armature 64 has a rim including circular element 66 and a radial projection or element 68 of circumferential extent somewhat less than the oscillatory displacement of the balance wheel 20. The switch 16 is oriented relative to the armature 64 so that the actuating arm 42 has freedom of movement in a plane transversely of the armature 64 or parallel to the axis thereof. Accordingly, rotation of the armature 64 will cause the actuating arm 42 to follow the configuration of the rim elements 66 and 68 by virtue of the magnetic coupling with the permanent magnet 52. Accordingly, when the contacts 34 and 36 will be opened or closed depending upon the direction of movement of the armature 64.

As shown in Figure 5, the switch 16 is suitably constructed as a unitary component to facilitate replacement in the maintenance of the clock. The switch 16 thus is provided with a casing 62 which may be hermetically sealed and filled with a liquid or gas to promote long service life of the switch. In this construction, the entire casing 62 or at least the end wall 70 is of non-magnetic
material to permit flux linkage of the permanent magnet 52 with the external armature. The electromagnet 18 may be coupled with the contact support member 40 by a magnetic plug 72 in the wall of the casing 62.

The invention will be further understood from a consideration of a cycle of operation. Consider first the balance wheel in oscillation at its clockwise limit of rotary displacement. In this position, the armature 54 has its rim element 56 opposite the motor magnet 52 and, accordingly, the actuating arm 42 opens the contacts 36 and 34. The voltage source 28 causes a current flow, limited by the resistance value of driving coil 30, to charge the condenser 44. As the balance wheel 22 swings back in a counterclockwise direction toward its reference position, the magnet 52 and actuator arm 42 follow the rim element 56 and thus the contacts 34 and 36 are closed. Accordingly, the condenser 44 immediately discharges through the low resistance path of the winding 32 of electromagnet 18 and the closed contacts 34 and 36 to ground. This discharge current causes the electromagnet 18 to develop an attractive force on the support member 40 which pulls the movable contact 36 into engagement with the fixed contact 34. A momentary increase of contact pressure is produced to penetrate any oxides or other films on the contact surfaces. The discharge of condenser 44 lowers the potential thereacross and permits a current impulse to be delivered from voltage source 28 through the driving coil 30. This current impulse in the driving coil 30 produces a magnetic impulse in the pole pieces 24 to impart rotative effort to the motor magnet 52 and to sustain oscillations thereof. The time constant of the discharge path provided for condenser 44 is sufficiently low that the pull exerted by the electromagnet 18 diminishes to a negligible value prior to the rotation of the balance wheel 22 to its counterclockwise limiting position. Thus, when the rim element 56 of armature 54 is opposite the magnet 52 in its counterclockwise swing, the same force is required for opening as is required for closing since the influence of the electromagnet in this position is negligible. With the contacts open the condenser 44 is recharged and during the clockwise rotation of the balance wheel 22, the contacts 34 and 36 are again closed by coaxiality of the armature 54 and permanent magnet 52. Simultaneously, a driving impulse is developed through the coil 32 of the electromagnet 18 in the same manner as previously described. Accordingly, the balance wheel continues its clockwise rotation to its limiting position during which the contacts are again opened and the condenser 44 is recharged. This cyclic operation is, of course, repeated at a rate corresponding to the period of the balance wheel assembly 10.

Although the description of this invention has been given with respect to a particular embodiment, it is not to be construed in a limiting sense. Numerous modifications and variations within the spirit and scope of the invention will now occur to those skilled in the art. For a definition of the invention, reference is made to the appended claims.

We claim:

1. An energizing circuit for a clock comprising a voltage source, an oscillatory member having an electromagnetic drive including an energizing coil, a switch having a fixed contact and a movable contact, a reciprocable actuator connected with the movable contact, a driving member connected with the oscillatory member and being movable transversely of the actuator and magnetically coupled therewith for alternate opening and closing of the contacts in synchronism with the oscillations of the oscillatory member, an electromagnet mounted adjacent said movable contact; said energizing coil, electromagnet and switch contacts being serially connected across the voltage source whereby closing of said contacts causes a current impulse to energize said energizing coil to maintain oscillation of the balance wheel, and a condenser connected across said energizing coil and said switch contacts whereby closing of said contacts causes a current impulse from the condenser through the electromagnet to increase the engaging pressure of the contacts.

2. An energizing circuit for a clock comprising a voltage source, an oscillatory balance wheel having an electromagnetic drive including a driving coil, a switch having a fixed contact and a movable contact operatively connected with the balance wheel for alternate opening and closing of the contacts in synchronism with the oscillations of the balance wheel, a condenser, said voltage source and said driving coil serially connected across the condenser and providing a relatively long time constant charging circuit for the condenser, an electromagnet mounted adjacent said movable contact and having an energizing coil connected serially with said switch contacts across said condenser and providing a relatively short time constant discharging circuit for the condenser whereby closing of said contacts causes a current impulse to energize said driving coil to maintain oscillation of the balance wheel, and causes a current impulse from the energizing coil to momentarily increase the engaging pressure of the contacts.

3. A switch having a pair of oppositely disposed contacts, one of the contacts being movable in the direction toward and away from the other, an actuator adapted for reciprocating motion and being operatively connected for displacement of the one contact in said direction, a rotatable driving balance wheel and a condenser, the condenser being offset from each other in the direction of said reciprocating motion, a permanent magnet mounted on said actuator adjacent said elements for magnetic linkage therewith through a substantially constant air gap whereby rotation of the driving member causes the actuator to execute reciprocating motion and operates the switch contacts due to the attraction between the magnet and the rim portion.

4. In combination, a switch having a pair of oppositely disposed contacts, one of said contacts being movable in the direction toward and away from the other, an actuator operatively connected for displacement of the one contact and being adapted for movement in said direction, a magnet mounted on the actuator, a driving member movable in a transverse direction, said driving member including a pair of magnetic elements spaced in said direction and spaced in the transverse direction, said magnet being adapted to couple said actuator with said elements whereby movement of the driving member in the transverse direction causes movement of the actuator and the one contact in said direction, a voltage source, an electromagnet mounted adjacent the movable contact and having an energizing coil connected serially with said switch contacts across said voltage source whereby closing of said contacts by movement of the actuator energizes the electromagnet to aid the magnet in closing said contacts.

5. In combination, a voltage source, an oscillatory member having an electromagnetic drive including a driving coil, a scaled casing including a non-magnetic wall portion and enclosing a switch, said switch including a pair of oppositely disposed contacts, one of said contacts being movable in a direction toward and away from the other, an actuator adapted for reciprocating motion within the casing and being operatively connected for displacement of the one contact and being adapted for movement in said direction, a magnet mounted on the actuator adjacent said wall portion, a rotatable driving member outside the casing and adjacent said wall portion and having a continuous magnetic rim portion including a pair of circumferentially displaced magnetic elements offset from each other in the direction of said reciprocating motion, said magnet coupling said actuator with said
driving member whereby rotation of the driving member causes actuation of the one switch contact, and a voltage source serially connected with said driving coil and said switch contacts for periodic energization of said electromagnetic drive to sustain oscillations of said oscillatory member.