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J. M. SHAULL

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TIMING DEVICE

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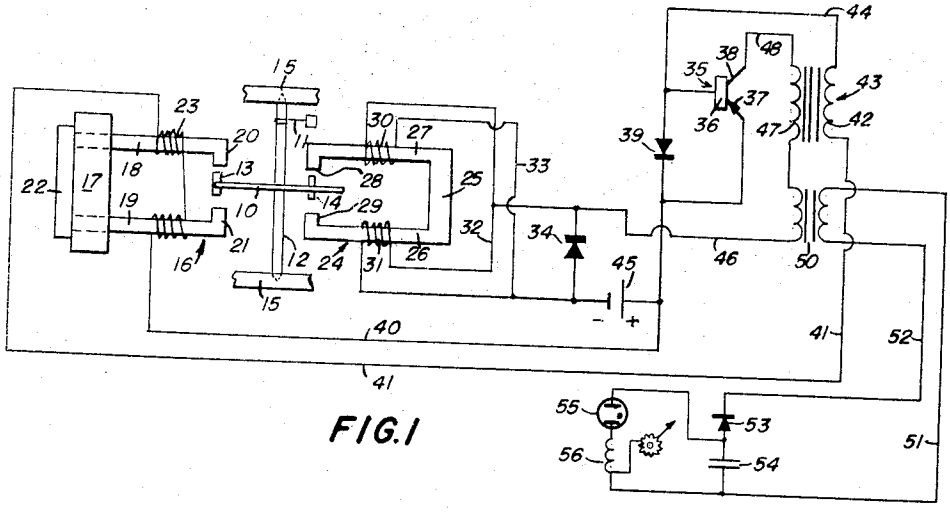


FIG. 1

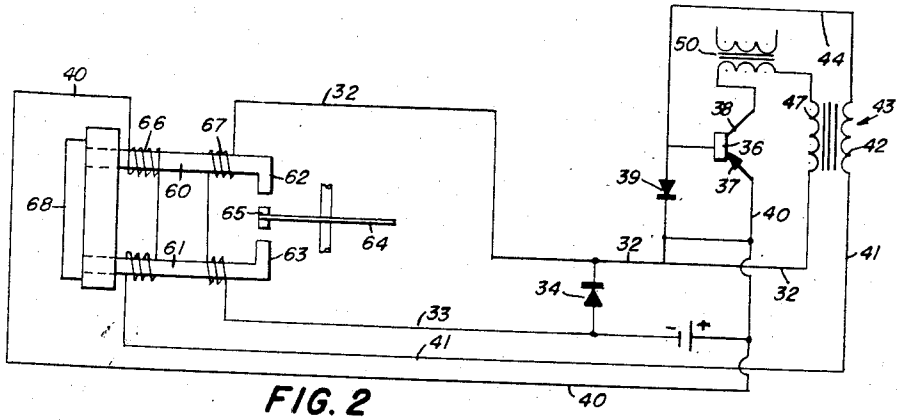


FIG. 2

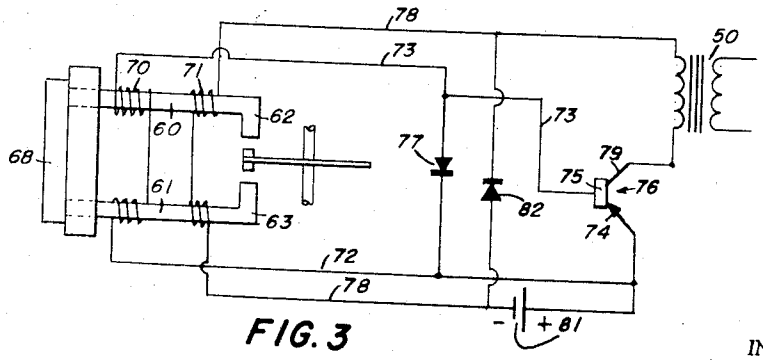


FIG. 3

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TIMING DEVICE

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2 Claims. (Cl. 318—128)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to timing means and particularly to electric timing means controlled by a transistor blocking oscillator.

It is an object of this invention to provide an electric timer including a balance wheel, and having means to actuate the balance wheel without employing switches and switch contacts.

It is an object of this invention to provide an electric timer including a balance wheel and having means responsive to a transistor blocking oscillator to actuate the balance wheel.

It is an object of this invention to provide an electric timer including a balance wheel with a magnetic circuit assembly having an air gap in which the balance wheel oscillates, and to provide the magnetic assembly with windings energizable by a transistor blocking oscillator to effect a gain in momentum of the balance wheel by reducing the magnetic drag of the magnetic assembly on the balance wheel.

It is an object of this invention to provide an electric timer including a balance wheel with a magnetic assembly having an air gap in which the balance wheel oscillates, to provide the magnetic assembly with windings responsive to a transistor blocking oscillator to actuate the balance wheel, and to cause said windings to function as a transformer for the transistor blocking oscillator.

It is an object of this invention to provide an electric timer having a balance wheel with a magnetic circuit assembly having an air gap in which the balance wheel oscillates, to provide the magnetic assembly with a winding to generate a voltage upon a certain movement of the balance wheel to trigger a transistor blocking oscillator, and to provide the magnetic assembly with a winding responsive to the transistor blocking oscillator to actuate the balance wheel.

It is an object of this invention to provide an electric timer having a balance wheel with a magnetic assembly having an air gap in which the balance wheel oscillates, to provide a generator winding and also a motor winding of the magnetic assembly connected to a transistor blocking oscillator, and to provide a diode in shunt with the motor winding to delay deenergization of the motor winding.

It is an object of this invention to provide an electric timer having a balance wheel with a magnetic assembly having an air gap in which the balance wheel oscillates, to provide a generator winding and also a motor winding on the magnetic assembly connected to a transistor blocking oscillator having base, emitter and collector electrodes, and to provide a diode in shunt with the base and the emitter electrodes of the transistor.

It is an object of this invention to provide an electric timer having a balance wheel with a magnetic assembly having an air gap in which the balance wheel oscillates,

to provide windings on the magnetic assembly in circuit with a transistor blocking oscillator having a plurality of electrodes, and to provide a diode in shunt with a certain pair of the plurality of electrodes to prevent sustained oscillations in said transistor.

It is an object of this invention to provide an electric timer having a balance wheel with a magnetic assembly having an air gap in which the balance wheel oscillates, to provide a generator winding and also a motor winding on the magnetic assembly connected to a transistor blocking oscillator, and to provide a transformer for the blocking oscillator which comprises the generator and motor windings.

It is an object of this invention to provide an electric timer having a balance wheel with a magnetic assembly having an air gap in which the balance wheel oscillates, to provide a winding on the magnetic assembly in circuit with a transistor blocking oscillator, to connect the primary winding of a transformer in series with this winding and to connect the secondary winding of this transformer to a circuit having a capacitor and a rectifier in series, and to connect an actuating device to the terminals of the capacitor.

The specific nature of the invention as well as other objects, uses and advantages thereof will clearly appear from the following description and from the accompanying drawing, in which:

Figure 1 is a wiring diagram of an electric timer,

Figure 2 is a wiring diagram of a modified form of the timer,

Figure 3 is a wiring diagram of a further modification of the timer.

In Figure 1 there is shown a balance wheel **10** with its conventional hairspring **11** and a balance staff **12** suitably placed in a mounting **15**. The wheel is provided with a first iron pellet **13**, and with a second iron pellet **14** which is placed opposite the first pellet. The second pellet is secured inwardly of the rim of the wheel on one of its spokes so that as the wheel swings about 200 degrees the first pellet will not be impeded by whatever magnetism is in it as it passes poles **28** and **29** of a motor magnet **25**.

A generator **16** comprises a short piece of brass **17** on a suitable support (not shown). This piece of brass supports a pair of arms **18** and **19** having inwardly extending poles **20** and **21**, and also a permanent magnet **22** which is disposed adjacent the arms **18** and **19**. The arms **18** and **19** are of a suitable magnetizable material such as permalloy. The permanent magnet may be a short rod of the magnetic material known under the trade name of Alnico, or of other materials used in permanent magnets. A winding **23** is wound about the arms **18** and **19**.

A motor **24** has a soft iron yoke **25** from which extends arms **26** and **27** of soft iron having bent ends defining poles **28** and **29**. Windings **30** and **31**, respectively, are wound on the arms **26** and **27**, and are connected in parallel by wires **32** and **33**. These windings are shunted by a low impedance germanium diode **34**, so that there is a path for the kick of voltage from the windings as current to the windings from a source is suddenly interrupted and to so delay the dying down of the current in the windings **30** and **31**.

A blocking oscillator **35** comprises a PNP transistor having a base electrode **36**, an emitter electrode **37**, and a collector electrode **38**. The base and emitter electrodes are shunted by a low impedance germanium diode **39** to prevent continuous oscillations. The diode is of the junction or relatively large area type.

The generator winding **23** is connected by a wire **40** to the emitter electrode **37**, and by a wire **41** through a winding **42** of a transformer **43**, and then to the base electrode **36** by a wire **44**. The motor **24** has its windings connected to a small battery **45**, of one or two mercury cells,

and through a wire 46, and through a winding 47 of the transformer 43, to the collector electrode 38, by a wire 48. The battery 45 is also connected to the wire 40 connected to the emitter electrode to complete its circuit. The transformer has a ferrite core, and its windings are connected conventionally to give a positive feedback.

When the wheel 10 is oscillating, the generator 16 generates a negative voltage in its winding 23 as the pellet 13 approaches the poles 20 and 21 of the magnet to decrease the reluctance of the air gap. When this voltage is about 0.1 volt it triggers the transistor, and after the slight delay due to the time constants of the circuits the transistor current through the motor windings 30 and 31 produces an accelerating impulse on the pellet 14, and almost immediately thereafter the transistor is cut off. As the transistor cuts off, the self-induced voltage in the motor windings 30 and 31 has a path for current through the diode 34 so that the pellet accelerating impulse is momentarily sustained.

As the current in the transistor is suddenly cut off there is a positive kick of voltage applied to the base of the transistor by the winding 42, by the diode 39 bypasses this kick so that the transistor may cut off without having sustained oscillations.

The effect of the permanent magnet on the generator magnetic assembly is adjusted so that the maximum swing of the balance wheel is around 200 degrees.

A small step-up ferrite core transformer 50 has its primary winding connected in series with the wire 46 and has its secondary winding connected by wires 51 and 52 to a circuit which comprises a silicon rectifier 53 in a series with a capacitor 54. A gas discharge tube 55 is connected in series with an operating coil 56 of a stepping relay, or the like, and they are connected to form a load on the capacitor. When the impulses of voltage from the transformer 50 have raised the voltage of the capacitor to the firing voltage of the tube 55 the tube will discharge through the operating coil of the stepping relay to discharge the capacitor to the point at which its voltage is around the extinguishing voltage of the tube, and then the tube will open the circuit.

It is well understood that the charging circuit of the capacitor can be adjusted so that the firing voltage of the tube is obtained once per second for a given number of voltage impulses of a certain value. However, more impulses per second of the firing voltage are permissible if the stepping relay is suitably geared to a hand to indicate seconds. Thus, we have means to indicate seconds through electrical impulses obtained from the circuit of the balance wheel driving means and without employing switches and switch contacts.

The balance wheel is not self-starting in its oscillations. For many applications of the timer self-starting is not desired. However, when the wheel is momentarily oscillated about 30 degrees it will usually start oscillating under the control of the transistor.

In Figure 2 there is shown a modification of the timer. In this figure there is only one magnetic assembly and only one pellet on the balance wheel. The generator and the motor windings are both wound on the arms subject to magnetization by the permanent magnet.

In Figure 2 the magnetized arms 60 and 61 extend forwardly from a permanent magnet 68, and have bent pole ends 62 and 63 defining an air gap. The balance wheel 64 has a single pellet 65 of iron or the like. A generator winding 66 is wound on the arms 60 and 61, and is connected to the wires 40 and 41, going to the emitter electrode 37 and to the winding 42 of the transformer 43. A motor winding 67 is also wound on the arms 60 and 61, and is connected to the wires 32 and 33 and to the battery 45, as in Figure 1.

When the pellet is moving counterclockwise and is leaving the zero position under the poles 62 and 63, a voltage is generated in the generator winding 66 to trigger the transistor. The current from the transistor through the motor winding 67 will then produce a magnetic effect to offset the magnetic bias of the permanent magnet so that the wheel will swing farther than it would otherwise do.

The wheel will, of course, trigger the transistor as the pellet leaves the poles in going in a clockwise direction so that the transistor is triggered in both directions of movement of the wheel.

The permanent magnet may be reversed so that the triggering voltage appears as the pellet is advancing towards the poles, but it has been found that the mode just described appears to give the best results.

In a further modification of the invention as shown in Figure 3, the transformer 43 is removed and its function is taken over by the magnetically coupled generator and motor windings. In Figure 3, the generator winding 70 is wound on the arms 60 and 61, and the motor winding 71 is also wound on the arms 60 and 61. In a particular example, which is given merely for illustration purposes and not by way of limitation, the generator winding had 4000 turns of wire while the motor winding had 2000 turns.

The generator winding 70 is connected by wires 72 and 73 to the emitter electrode 74 and to the base electrode 75 of a transistor 76. The motor winding is connected by a wire 78 to the collector electrode 79 of transistor 76, and by a wire 80 through a mercury cell 81 to the emitter electrode 74. A low impedance germanium diode 77, such as 1N91, shunts the base and emitter electrodes to prevent oscillations of the blocking oscillator.

The generator winding triggers the transistor in the manner already described, and the current in the motor winding tends to offset the bias of the permanent magnet as already described. The current in the motor winding also, by transformer action, induces a negative voltage in the generator winding and on the base electrode of the transistor. As the transformer effect is dying down there is an opposite voltage induced in the generator winding, and then the transistor is suddenly cut off. A diode 82 connected across the motor winding absorbs the back kick of the motor winding as the current to the motor winding is suddenly interrupted.

The mode of operation may be reversed by reversing the permanent magnet as already discussed. The transistor is triggered as the pellet leaves the poles in both directions of motion of the balance wheel as in the other examples given.

The base current of the transistor flowing through the generator winding tends to slightly nullify the effect of the motor winding current as is the case for the primary and secondary current in any transformer, but the effect is very slight because of the resistance of the generator winding.

The transformer 50, already described, may be connected with its primary winding in series in wire 78, to step up the current impulses fed through it to charge the capacitor through the rectifier.

It will be apparent that the embodiments shown are only exemplary and that various modifications can be made in construction and arrangement within the scope of the invention as defined in the appended claims.

I claim:

1. An electric timer comprising in combination: a balance wheel having a magnetizable pellet thereon, a magnetic assembly including a permanent magnet and having an air gap, said balance wheel being oscillable in said air gap, a generator winding and a motor winding on said magnetic assembly, a transistor having base, emitter and collector electrodes, a transformer having a first winding and a second winding, the electrodes of said transistor and the windings of said transformer being connected for operation as a blocking oscillator, said generator winding being connected in the blocking oscillator circuit so as to trigger the blocking oscillator in response to the motion of said pellet away from said air

gap, said motor winding being connected in the blocking oscillator circuit so that the pulse produced by said blocking oscillator is applied to said motor winding to offset the magnetic bias of said permanent magnet, thereby permitting the pellet to leave the air gap with less loss of momentum than the amount gained as the pellet approached the air gap, the oscillations of said balance wheel once started thus being sustained.

2. An electric timer comprising in combination: a balance wheel having a magnetizable pellet thereon, a magnetic assembly comprising a permanent magnet and first and second magnetized arms extending forwardly from said permenent magnet, said arms having bent pole ends defining an air gap, said balance wheel being oscillable in said air gap, a generator winding and a motor winding on the arms of said magnetic assembly, a PNP transistor and a transformer connected for operation as a blocking oscillator, said transistor having base, emitter and collector electrodes, and said transformer having a first winding and a second winding, said emitter being connected through said generator winding to one side of the first winding of said transformer, the other side of said first winding being connected to said base, a battery for powering said blocking oscillator, the positive side of said battery being connected to said emitter and the negative side of said battery being connected through said motor winding to one side of the second winding of said transformer, the other side of said second winding

being connected to said collector, a first diode having its plate connected to said base and its cathode connected to said emitter, and a second diode having its plate connected to the negative side of said battery and its cathode connected to said one side of the second winding of said transformer, said transformer windings and said motor and generator windings being so constructed and arranged in cooperation with said transistor that the motion of said pellet away from said air gap generates a voltage in said generator winding which triggers said blocking oscillator, the pulse produced by said blocking oscillator thereupon being applied to said motor winding to offset the magnetic bias of said permanent magnet, thereby permitting the pellet to leave the air gap with less loss of momentum than the amount gained as the pellet approached the air gap, the oscillations of said balance wheel once started thus being sustained.

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