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ELECTROMECHANICAL TIMING DEVICE

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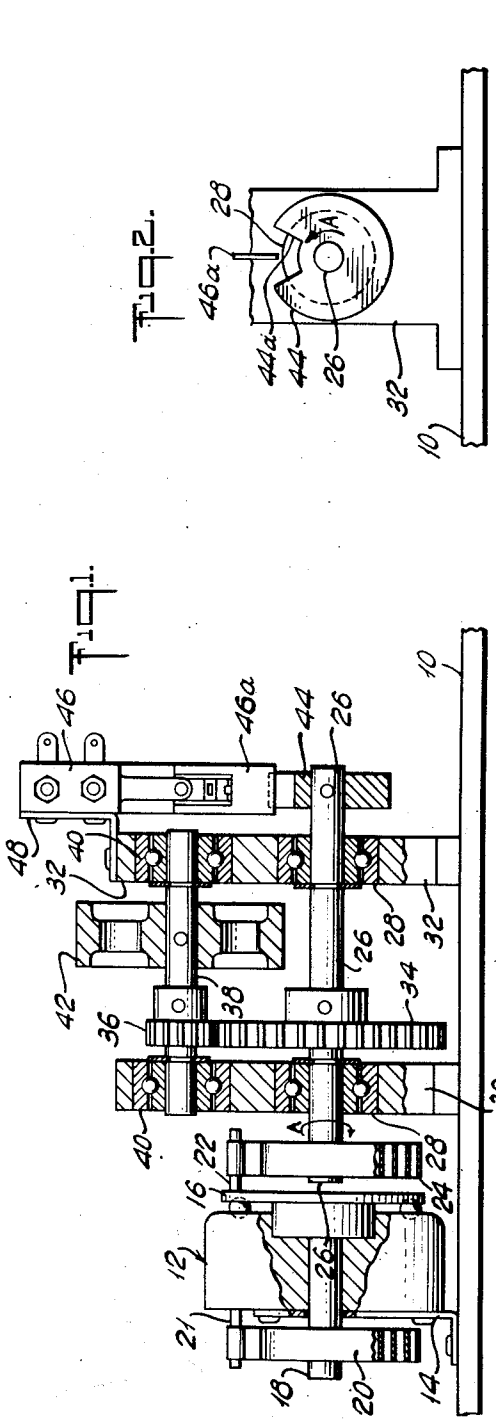


FIG. 1.

FIG. 2.

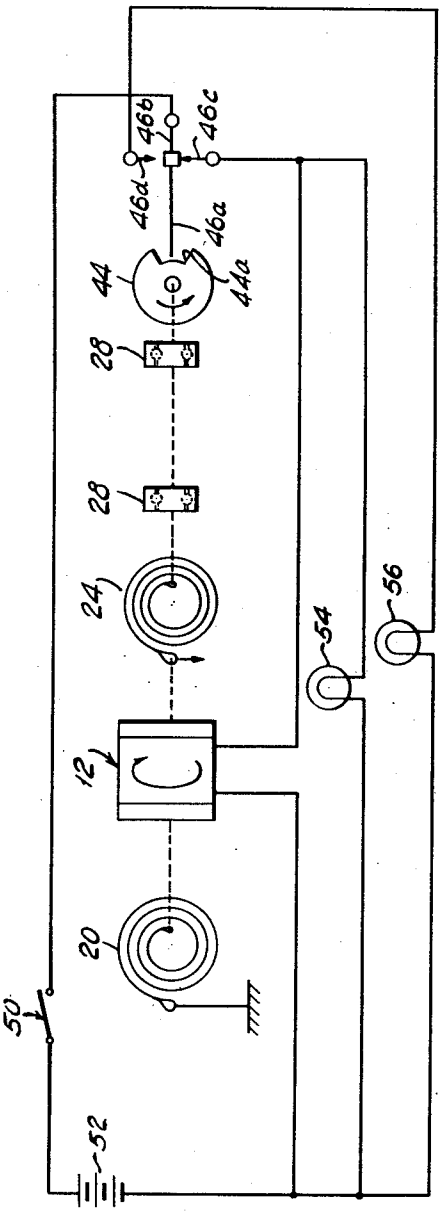


FIG. 3.

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ELECTROMECHANICAL TIMING DEVICE

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5 Claims. (Cl. 200—90)

This invention relates to electromechanical timing devices, and particulary concerns an improved electromechanical timing device capable of maintaining a predetermined frequency of operation despite mechanical vibration and fluctuation of its supply voltage.

In this application the invention is shown as employed in a circuit for flashing the wing and tail lights of an airplane on and off at a predetermined frequency. In such an environment, a timing device may be subjected to extreme vibration for prolonged periods. Moreover, the operating voltage provided for the timing device by the aircraft electrical system may be poorly regulated and subject to considerable variation in accordance with such factors as the operating speed of the aircraft engines and varying load demands on the airplane's electrical source as various items of electrically powered equipment in the airplane go into and out of operation. Although the present invention is particularly well adapted to overcome the difficulties of this particular application, it is by no means so limited in its utility, but, on the contrary, is equally well adapted for a wide variety of other uses.

In the drawings:

Figure 1 is a side elevational view, partly in section, of a timing device embodying features of the present invention;

Figure 2 is an end elevational view of the device, looking toward the end which appears at the right in Figure 1; and,

Figure 3 is a schematic diagram of an electrical wiring circuit incorporating the timing device of the present invention for the purpose of flashing the wing and tail lights of an airplane.

As may be seen in Figure 1, the various elements of the timing device are mounted on a base plate **10**. Near the left-hand end of this base plate, as viewed in Figure 1, is mounted a rotary solenoid **12**, said solenoid being supported above the base **10** by means of a bracket **14**. The solenoid **12** includes a rotatable plate **16** secured at one end of a horizontal shaft **18** which extends through the body of the solenoid **12** and through the bracket **14** and projects a short distance beyond. The rotary solenoid **12** is of a commercially available type wherein energization of the solenoid causes the plate **16** to rotate rapidly in the direction indicated by the arrows A through an angle of approximately 67 degrees.

The plate **16** is normally maintained against a stop (not shown) by the action of a spiral return spring **20**, the inner end of the return spring **20** being secured to the shaft **18** while its outer end is secured to a pin **21** projecting from the case of the solenoid **12**. The solenoid **12** develops sufficient power to rotate the plate **16** rapidly in the direction indicated against the resistance of the spring **20**.

Projecting forwardly from the plate **16** is a pin **22** which engages the outer end of a spiral buffer spring **24**, the inner end of which is secured at the left-hand end

of an oscillatory shaft **26**. This shaft **26** is rotatably supported in ball bearings **28** carried by vertical plates **30** and **32** which project upwardly from the base plate **10**.

The oscillatory shaft **26** has keyed to it a spur gear **34** which meshes with a pinion **36** of smaller diameter which is keyed to a countershaft **38** rotatably supported above the oscillatory shaft **26** in ball bearings **40** carried by the vertical plates **30** and **32**. Also fixed on the countershaft **38** is a flywheel **42** having an appreciable mass which is principally concentrated near its periphery, and which is symmetrically disposed with respect to the axis of revolution of the countershaft so that the flywheel is substantially balanced both statically and dynamically.

At the right-hand end of the oscillatory shaft **26** beyond the vertical plate **32** is secured a switch-operating cam **44** which is adapted to cooperate with the actuating leaf **46***a* of an electrical switch **46** secured above the cam **44** on a bracket **48** which extends from the upper end of the adjacent vertical plate **32**. In Figure 2 the cam **44** is shown in the position which it occupies when the timer is at rest, with the rotatable plate **16** of the solenoid **12** against the aforementioned stop. In this position, it is out of engagement with the leaf **46***a* of the switch **46**.

As may be seen in Figure 3, the switch **46** is a single-pole double-throw switch having a movable contact blade **46***b*, a normally closed fixed contact **46***c*, and a normally open fixed contact **46***d*. The contact blade **46***b* of the switch **46** is connected through a single-pole single-throw on-off switch **50** to one terminal of a source of electrical power **52**, in this diagram schematically indicated as a battery. The other terminal of the source **52** is connected to one terminal of the winding of the solenoid **12**, the other terminal of this winding being connected to the normally-closed fixed contact **46***c* of the switch **46**. One set of incandescent electric lamps, indicated schematically at **54**, is connected in parallel with the winding of the solenoid **12**. Another set of electric lamps, indicated schematically at **56**, is connected between the latter terminal of the power source and the normally open fixed contact **46***d* of the switch **46**.

The operation of this mechanism is as follows: Closure of the on-off switch **50** (Figure 3) completes the circuit through the switch **46** and the winding of the solenoid **12**. Thus the solenoid is energized and its movable plate **16** is rapidly rotated in a direction indicated by the arrow A in Figure 1 against the resistance of the spiral return spring **20**. This motion, imparted through the pin **22** to the outer end of the spiral buffer spring **24**, yieldably urges the oscillatory shaft **26** in the same direction. However, because of the considerable inertia of the oscillatory members, and particularly of the flywheel **42**, a finite time will elapse before the oscillatory shaft **26** can follow the movement of the plate **16** of the solenoid **12**.

Eventual rotation of the oscillatory shaft **26** and of the cam **44** brings a shoulder **44***a* (Figure 2) of the cam into contact with the resilient leaf **46***a* of the switch **46** and actuates the switch **46** to throw its contact blade **46***b* out of engagement with the fixed contact **46***c* and into engagement with the fixed contact **46***d*. This opens the circuit to the solenoid **12** and deenergizes the solenoid. Since the return spring is "stiffer" than the buffer spring **24**, the deenergization of the solenoid **12** will allow the return spring **20** to rotate the movable plate **16** rapidly back to its starting position against the stop. This movement is imparted to the outer end of the buffer spring **24**, and this yieldably urges the oscillatory shaft **26** back toward its starting position. Again, however, because of the inertia of the system, a finite time will elapse before the oscillatory shaft **26** can follow the rotation of the plate **16** of the solenoid. When the shaft **26** does return

to its initial position, the cam **44** disengages the leaf **46***a* of the switch **46**, again actuating the switch **46** to the position indicated in Figure 3. This results in reenergizing the solenoid **12** and initiating a repetition of the cycle just described.

The oscillatory shaft thus oscillates back and forth at a frequency determined principally by the stiffness of the spring **24** and by the effective inertia of the system, the latter factor depending upon such variables as the mass and diameter of the fly wheel **42** and the ratio between the gears **34** and **36**. These variables may be changed to achieve any frequency of operation desired within wide limits.

As the oscillatory shaft **26** oscillates back and forth, the armature **46***b* of the switch **46** alternates between contact with the two fixed contacts **46***c* and **46***d*. When it is in engagement with the fixed contact **46***c* the lamps in the circuit **54** are illuminated, and when it is in engagement with the fixed contact **46***d* the lamps in the circuit **56** are illuminated. The lamps in the two circuits **54** and **56** are thus illuminated intermittently in alternation. The rotational position of the cam **44** on the oscillatory shaft **26** may be adjusted to move the shoulder **44***a* toward or away from the leaf **46***a* of the switch **46** in the position of rest. This makes it possible to cause one of the lamp circuits to operate more than half of the total cycle and the other a correspondingly lesser part of the cycle, if desired.

A study of the mechanism illustrated will reveal that each of the moving parts therein has a rotative movement about a fixed axis and that its mass is symmetrically disposed with respect to this axis. It will thus be understood that even violent translational accelerations will produce only a negligible effect on these moving parts and will not affect their frequency of oscillation. The device is thus highly immune to the adverse effects of vibration.

Because of the gear ratio between the spur **34** on the oscillatory shaft **26** and the pinion **36** on the countershaft **38**, the countershaft **38** and flywheel **42** rotate at a substantially greater angular velocity than the shaft **26**. This increases the effective inertia of the flywheel **42** and allows the use of a flywheel of relatively small mass to make possible a timing device which is quite compact and light in weight.

Since the time consumed by movement of the movable member **16** of the solenoid **12** is only a very small percentage of the period of oscillation of the oscillatory shaft **26**, the operating voltage supplied to the device may vary over an exceptionally wide range without producing more than a very slight effect on the frequency of operation of the device.

Because the contacts **46***b* and **46***c* of the switch **46** are closed in the condition of rest, electrical current is supplied to the lamp circuit **54** even in the event of burning out of the solenoid **12** or jamming of the oscillating mechanism or other similar types of failures. Thus one set of lights on the airplane will be illuminated to maintain a degree of safety under practically all conditions.

It will therefore be appreciated that the present invention provides a timing device which is relatively simple in construction and operation and which is capable of maintaining its frequency of operation despite severe vibration and extreme voltage fluctuation. It will therefore be appreciated that the aforementioned and other desirable objectives have been achieved. However, it should be emphasized that the particular embodiment of the invention which is shown and described herein is intended as merely illustrative and not as restrictive of the invention.

I claim:

1. A timing device comprising an oscillatory member mounted for rotational oscillatory movement on an axis about which its mass is substantially symmetrically disposed, a solenoid having a movable member, a spring connected between the movable member of said solenoid and said oscillatory member whereby movement of said movable member upon the actuation of said solenoid yieldably urges said oscillatory member to rotate in a predetermined direction, and a switch arranged to be actuated by the rotational movement of said oscillatory member, said switch being connected to control the energization of said solenoid whereby movement of said oscillatory member in said one direction actuates said switch so as to deenergize said solenoid.

2. A timing device comprising an oscillatory member mounted for rotational oscillatory movement on an axis about which its mass is substantially symmetrically disposed, a rotary action solenoid having a movable member which is rotated in one direction by the energization of said solenoid, a return spring urging said movable member in the opposite direction, a spiral spring having one end connected to said oscillatory member and its other end connected to the movable member of said solenoid whereby energization of said solenoid yieldably urges said oscillatory member to rotate in said one direction, said spiral spring exerting a weaker force on the movable member of said solenoid than said return spring, and a switch arranged to be actuated by the rotational movement of said oscillatory member, said switch being connected to control the energization of said solenoid whereby movement of said oscillatory member in said one direction actuates said switch so as to deenergize said solenoid.

3. A timing device comprising an oscillatory member mounted for rotational oscillatory movement, a flywheel assembly mounted for rotational oscillatory movement on an axis about which its mass is substantially symmetrically arranged, driving elements interconnecting said flywheel assembly and said oscillatory member at such a drive ratio as to cause said flywheel assembly to rotate at an angular velocity in excess of that of said oscillatory member, a solenoid having a movable member, a return spring urging said movable member in the opposite direction, a spiral spring having one end connected to said oscillatory member and its other end connected to the movable member of said solenoid whereby energization of said solenoid yieldably urges said oscillatory member to rotate in said one direction, said spiral spring exerting a weaker force on the movable member of said solenoid than said return spring, and a switch arranged to be actuated by the rotational movement of said oscillatory member, said switch being connected to control the energization of said solenoid whereby movement of said oscillatory member in said one direction actuates said switch so as to deenergize said solenoid.

4. A timing device comprising an oscillatory member mounted for rotational oscillatory movement on an axis about which its mass is substantially symmetrically disposed, a rotary action solenoid having a movable member which is rotated in one direction by the energization of said solenoid, a spiral return spring connected at its inner end to the movable member of said solenoid and at its outer end to the frame of said device, a spiral buffer spring connected at its inner end to said oscillatory member and at its outer end to the movable member of said solenoid whereby energization of said solenoid yieldably urges said oscillatory member to rotate in said one direction, said buffer spring exerting a weaker force on the movable member of said solenoid than said return spring, and a switch arranged to be actuated by the rotational movement of said oscillatory member, said switch being connected to control the energization of said solenoid whereby movement of said oscillatory member in said one direction actuates said switch so as to deenergize said solenoid.

5. An intermittent electrical control device comprising an oscillatory member mounted for rotational oscillatory movement on an axis about which its mass is substantially symmetrically disposed, a solenoid having a movable

member, a spring connected between the movable member of said solenoid and said oscillatory member whereby movement of said movable member upon the actuation of said solenoid yieldably urges said oscillatory member to rotate in a predetermined direction, a switch actuating member mounted on said oscillatory member for movement therewith, a first pair of switch contacts arranged to be actuated by said switch actuating member, said first pair of switch contacts being connected to cause the de-energization of said solenoid whereby movement of said oscillatory member in said one direction actuates said switch so as to deenergize said solenoid, a second pair of switch

contacts adapted to be actuated by said switch actuating member, said second pair of switch contacts being adapted to control an external electrical circuit, and said switch actuating member being mounted on said oscillatory member for adjustment to various rotational positions to vary the times of actuation of said pairs of switch contacts.

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