July 21, 1964 P. G. GERHARD 3,141,290

RUGGED ELECTRIC CLOCK MOVEMENT

Filed Nov. 1, 1963

FIG. 1

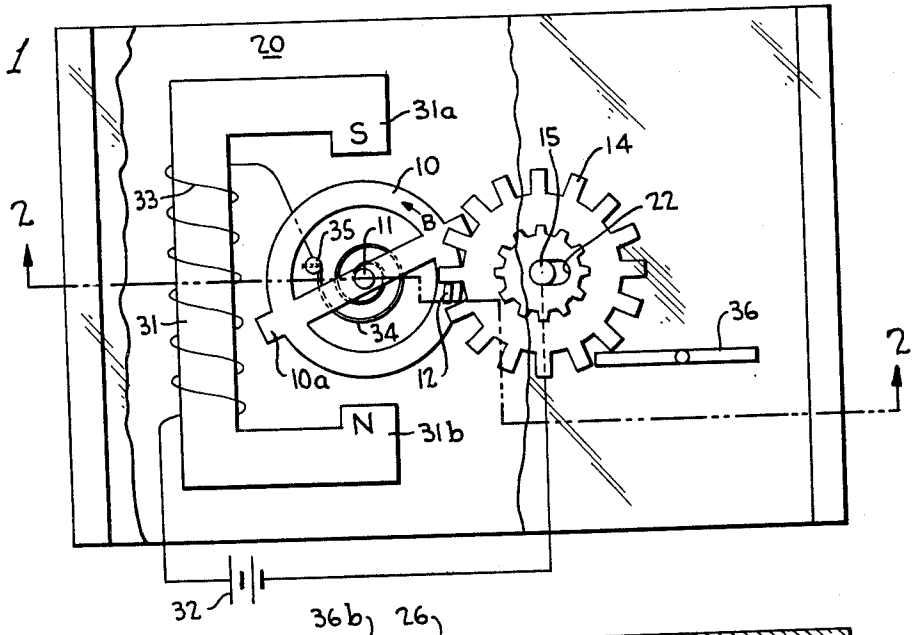


FIG. 2

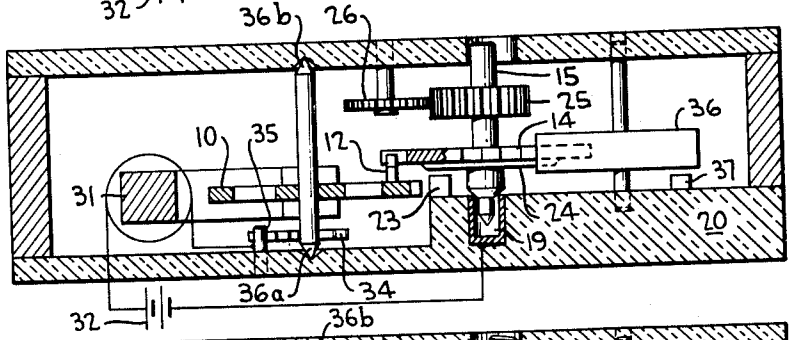


FIG. 3

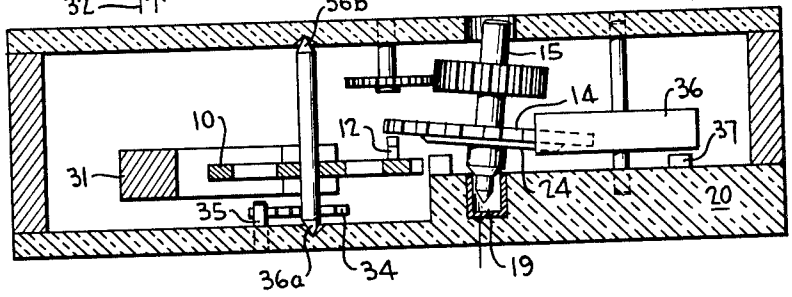


FIG. 4

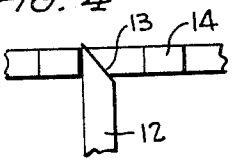
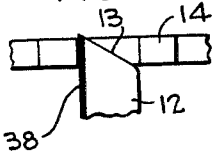


FIG. 5



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RUGGED ELECTRIC CLOCK MOVEMENT

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3 Claims. (Cl. 58—28)
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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment to me of any royalty thereon.

This invention relates to clock mechanisms, and more particularly to a rugged electric clock mechanism having a long shelf life, and which can be used to perform ordnance timing operations.

Clock mechanisms for use in ordnance applications must meet standards and criteria not found or needed in other applications. A high degree of long term accuracy is not necessary, but the mechanism must be rugged, simple, and inexpensive. Additionally, military specifications require that clock mechanisms which are to be used in land mines and other similar ordnance applications operate for periods of time longer than that obtainable from spring driven clocks. To meet the requirements of ruggedness, low cost, and long operation electrically powered timing mechanisms have been proposed for ordnance applications. The difficulty with such mechanisms is that oxides and films tend to form on the electrical contacts during storage and shipment, making their operation unreliable.

One object of this invention is to provide a reliable electrically powered clock mechanism which has a long shelf life.

In order that the power supply used to drive the electric clock mechanism be reasonable in size and cost, it is necessary that the clock mechanism have a low current drain. Therefore, another object of this invention is to provide an electric clock mechanism having a minimum number of contacting parts, reducing friction and electrical losses to a minimum.

A more specific object of the invention is to provide an electric clock mechanism having self cleaning contacts.

An additional object of this invention is to provide an electric timing mechanism which can provide fail safe operation. That is, in fuzing applications, if the clock fails it is desirable that the fuze be unarmed.

These and other objects of this invention are accomplished by using a tilting index wheel and making the electrical contact identical with the mechanical contact between the indexing wheel and the indexing pin. In this manner, the number of contacting parts is a minimum reducing the drag on the indexing wheel to a minimum, and the sliding action between the indexing pin and the tilting indexing wheel provides a self cleaning action for the electrical contacts.

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 drawings, in which:

FIG. 1 is a plan view of the timing mechanism of this invention with the left side of the top cut away.

FIG. 2 is a side elevation of the clock mechanism of this invention showing the index wheel in the drive position.

FIG. 3 is a side elevation, similar to FIG. 2, showing the indexing wheel in the tilted position.

FIG. 4 shows one embodiment of the combination contact-index pin constructed in accordance with the teaching of this invention.

FIG. 5 shows another embodiment of the combination contact-index pin constructed in accordance with the teachings of this invention.

Referring to FIGS. 1 and 2, a balance wheel **10** is mounted upon a shaft **11** for oscillation. Fixed to the periphery of the balance wheel **10** is an indexing pin **12**. As is more clearly shown in FIGS. 4 and 5, the upper end of the pin **12** is flush with the upper planar surface of the index wheel **14**. Pin **12** is beveled at its upper end to form an incline surface **13**. The lowest point of the inclined surface **13** should be slightly below the lower planar surface of the index wheel **14** to insure that the pin slides underneath the wheel.

Shaft **15** is tapered abruptly at both ends. The shaft **15** contacts the edge of circular hole **19** formed in the housing **20** so that the upper end of the shaft **15** can move longitudinally in oval slot **22**. Hole **19** has a diameter which is large enough to allow pivotal movement of the lower end of the shaft **15** therein. In order to clearly illustrate the position of shaft **15** in hole **19** and slot **22**, the housing **20** has been shown to be composed of clear plastic. Of course, housing **20** may be composed of any suitable material within the scope of this invention.

Shaft **15** is returned to a vertical position with respect to the housing **20** by permanent magnet **23**. Magnet **23** is positioned opposite a magnetizable circular disc **24**, which is cemented or otherwise fixed to the lower surface of index wheel **14**.

Attached to the shaft **15** is a gear **25** which drives a second gear **26**, the latter gear meshing with other gears in a gear train (not shown). Rotation of gear **26** can be utilized to close an electrical switch or any other purpose, as will be apparent to those skilled in the art.

Surrounding the balance wheel **10** is a C shaped magnetic core **31**, which has opposed poles **31***a* and **31***b*. A magnetizing coil **33** is wrapped around the core **31**, and the coil **33** is energized by a battery **32**. A hair spring **34** is attached at one end to shaft **11** and secured at the other end to a post **35**, which is affixed to the housing **20**. As is common in the art, the hair spring **34** exerts a restoring force on the balance wheel **10** when it has been rotated by the energized magnetic core **31**. One end of the magnetizing coil **33** is connected to post **35** and hair spring **34**. If housing **20** is made of a conducting material, the post **35** must be insulated from the housing and the shaft **11** should be insulated from the housing by insulating, or jeweled bearings, **36***a* and **36***b*. One side of the battery **32** is connected to the coil **33** and the other side of the battery **32** is connected to shaft **15**. If housing **20** is made of a nonconducting material, the connection to shaft **15** may be accomplishhed by using a conducting liner in hole **19**, as shown.

The electrical circuit for the clock mechanism may be traced, starting at the positive side of the battery **32**, through the coil **33**, hair spring **34**, post **11**, balance wheel **10**, beveled pin **12**, index wheel **14**, shaft **15**, and back to the negative side of the battery. As will be apparent to those skilled in the art, the circuit is complete when beveled pin **12** makes contact with index wheel **14**, and the circuit is broken when the beveled pin and index wheel are out of contact.

In operation the mechanism is an impulse type electric clock, that is, each time the balance wheel **10** makes one oscillation an electrical impulse is applied to coil **33**, and armatures **31***a* and **31***b* magnetically attract a soft iron armature **10A** positioned on the balance wheel **10**. Thus, a rotational force is periodically applied to the balance wheel, keeping it oscillating. As the balance wheel **10** rotates in the direction B, the beveled pin **12** pushes the index wheel **14** ahead one tooth. Rotation of the balance wheel **10** in the opposite direction tilts the index wheel **14** as the sloping surface **13** of pin **12** slides underneath the index wheel tooth. The elongated hole **22** in

the top plate allows the shaft 15 to be displaced, while permanent magnet 23 underneath the index wheel returns the wheel to its normal position after the pin 12 has passed beneath a tooth. A pivoted arm 36, which is biased by a permanent magnet 37 drops in back of the index teeth as the wheel is moved ahead, and thus keeps the wheel from rotating in the reverse direction as the pin 12 slides underneath. In the drawing, the pivoted arm 36 is resting on the tip of a tooth since the index wheel is in the process of being pushed ahead.

Since it is not necessary that the pin 12 clear the index wheel 14 on its return, the pin 12 may push each tooth completely ahead so that the succeeding tooth will be in place to be pushed ahead by pin 12, held there by arm 36. In this manner oscillation of the balance wheel 10 can be made impossible when the index wheel 14 is jammed, and this provides a fail-safe feature. By powering the detonator from a supply inductively coupled to the coil 33, a jamming of the timing mechanism prevents the periodic making and breaking of the circuit, which prevents the alternate buildup and collapse of the magnetic field, which in turn would remove the power from the detonator.

FIGS. 4 and 5 show in detail two embodiments of the novel contacting system of this invention, which applies a pulse to the electro-magnet during each oscillation of the balance wheel. The same components which convert the oscillatory motion of the balance wheel to rotational motion of the index wheel make up the contacting system; no additional components are used. The embodiment of FIG. 4 shows an uninsulated version of the pin 12. As the beveled pin 12, in the embodiment of FIG. 4, strikes a tooth of the index wheel 14 in the process of pushing the wheel ahead, the electrical circuit between the pin 12 and the wheel 14 is completed and the electro-magnet 31–33 is energized. At this time the armature is approaching the pole pieces 31*a* and 31*b*, as shown in FIG. 1, and is pulled toward the pole pieces by the magnetic field. Before the armature has lined up with the pole pieces 31*a* and 31*b*, the beveled pin 12 has moved beyond the teeth of the index wheel 14, and the electric circuit is opened. As the balance wheel 10 is rotated by hair spring 34 in the opposite direction and the pin 12 tilts the index wheel 14, the electric circuit is again closed. At this time the armature is moving away from the pole pieces, and the magnetic field applies a breaking force; however, by having narrow teeth on the index wheel and a sharp slope on the beveled pin 12, as shown in the embodiment of FIG. 4, the duration of contact is so short as to be negligible. In pushing wheel ahead, a force of several thousand pounds per square inch is developed between the index wheel 14 and the pin 12, and this force insures reliable electrical contact. Additionally, some wiping and cleaning action is provided by the relative motion between the pin and tooth as the pin pushes the wheel ahead.

A preferred embodiment is shown in FIG. 5. In the embodiment of FIG. 4 the desired electrical contact for keeping the clock running was made as the pin 12 pushed the index wheel ahead. Although contact was made as the pin slid under the wheel the duration of this contact was so short as to be insignificant. In the embodiment of FIG. 5, the situation is reversed, that is, the desired contact is made as the pin 12 moves under the index wheel 14. To lengthen the duration of this contact the slope 13 on the top of the pin is made gradual, and the index wheel teeth are made wider. Since the pin 12 is in contact with the index wheel 14 for a longer period of time when it pushes the wheel ahead than when it moves under the wheel, it is necessary to apply a layer of insulating material 38 to the front of the pin in order to prevent electrical contact as the index wheel is pushed ahead. The advantage of the embodiment of FIG. 5 is that better cleaning action is provided between the contacts as the pin scrapes under the edge of the index wheel teeth. However, the insulated pin of the embodiment of FIG. 5 is more expensive than the uninsulated pin of FIG. 4.

FIG. 5 operates essentially the same as FIG. 4. As the pin 12 slides under the index wheel 14, the coil 33 is energized attracting the pole pieces 10*a* on the balance wheel 10. Contact is broken after the pin has passed under the tooth, and the hair spring 34 powers the balance wheel to move in the opposite direction causing the insulated front of pin 12 to push the index wheel ahead.

In operation, the first 18 to 20 oscillators of the balance wheel 10 will be powered mechanically from without the timing mechanism as the fuze is set. This starts the contact cleaning action, and the contacts are thereafter continually cleaned throughout the operation of the timer.

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 as my invention:

1. An electric timing mechanism comprising:

(*a*) a balance wheel mounted for oscillatory movement, and an index wheel mounted for rotation about an axis perpendicular to the plane of said balance wheel, the plane of said index wheel being parallel to the plane of said balance wheel during rotation of said index wheel,

(*b*) said index wheel tiltable a predetermined amount in said plane, and a series of teeth spaced around the periphery of said index wheel, said teeth overlapping a portion of the periphery of said balance wheel,

(*c*) a pin fixed adjacent the periphery of said balance wheel with the longitudinal axis thereof perpendicular to said plane, said pin being small enough to enter the space between adjacent index wheel teeth, said pin having a perpendicular surface which engages a tooth of said index wheel upon movement of said balance wheel in one direction, and said pin having an inclined surface tilting said tooth and said index wheel said predetermined amount which is sufficient to allow said pin to pass under said tooth and into the space between said tooth and an adjacent index wheel tooth,

(*d*) an electro-magnet having alined opposed poles, said balance wheel being centrally disposed between said poles, and an armature connected to said balance wheel with its longitudinal axis intercepting the axis of rotation of said wheel,

(*e*) means to periodically energize said electro-magnet, said means to energize including said pin and said index wheel, said pin and index wheel periodically making and breaking a circuit between said electro-magnet and a power supply whereby the wiping action caused by the relative movement between said pin and said index wheel frees said contacts of corrosion.

2. An electrical timing mechanism as in claim 1 wherein said inclined surface of said pin is sharply sloped and said contact is made when said perpendicular surface of said pin engages said tooth, the duration of contact between said inclined surface and said index wheel teeth being short.

3. An electric timing device as in claim 1 wherein said perpendicular surface of said pin is insulated, said slope is gradual, and contact is made when said index wheel slides over said pin.

No references cited.