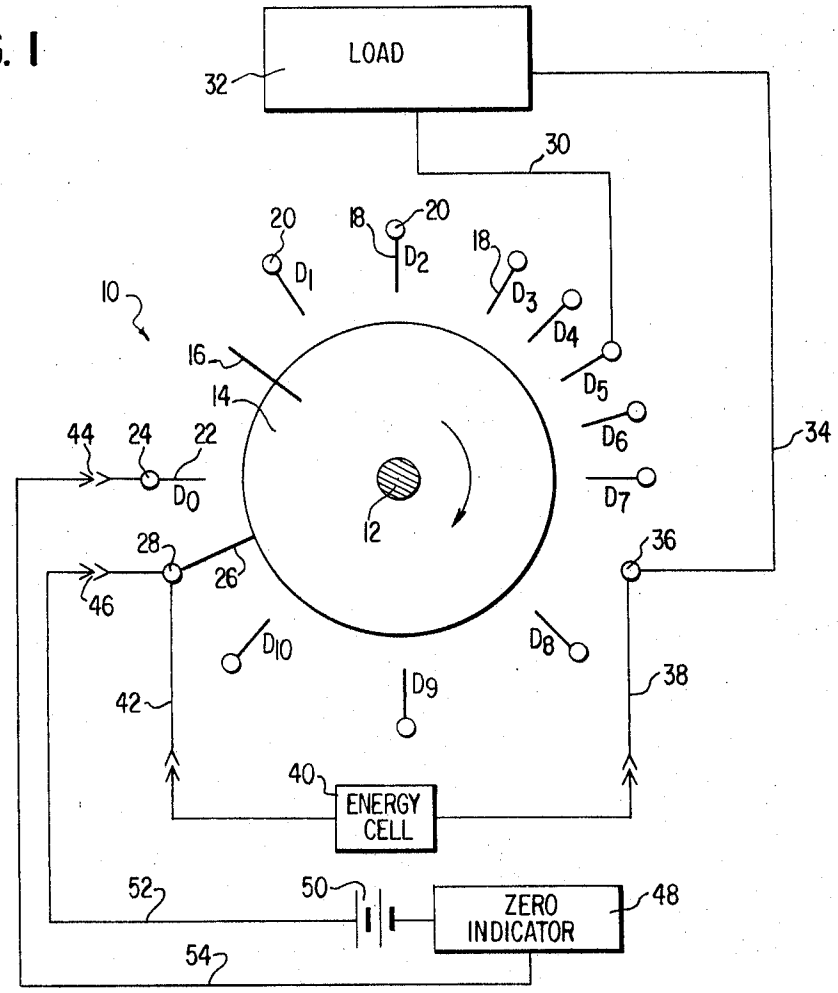
Feb. 18, 1969 R. G. ESHLEMAN ET AL 3,428,763

DELAY TIMER WITH SELECTOR SWITCH

Original Filed April 5, 1965 Sheet 1 of 3

FIG. 1



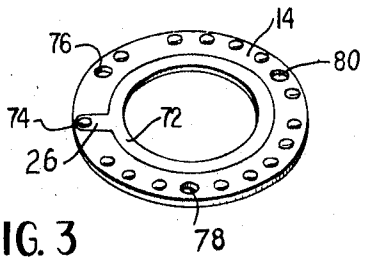


FIG. 3

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DELAY TIMER WITH SELECTOR SWITCH

Original Filed April 5, 1965

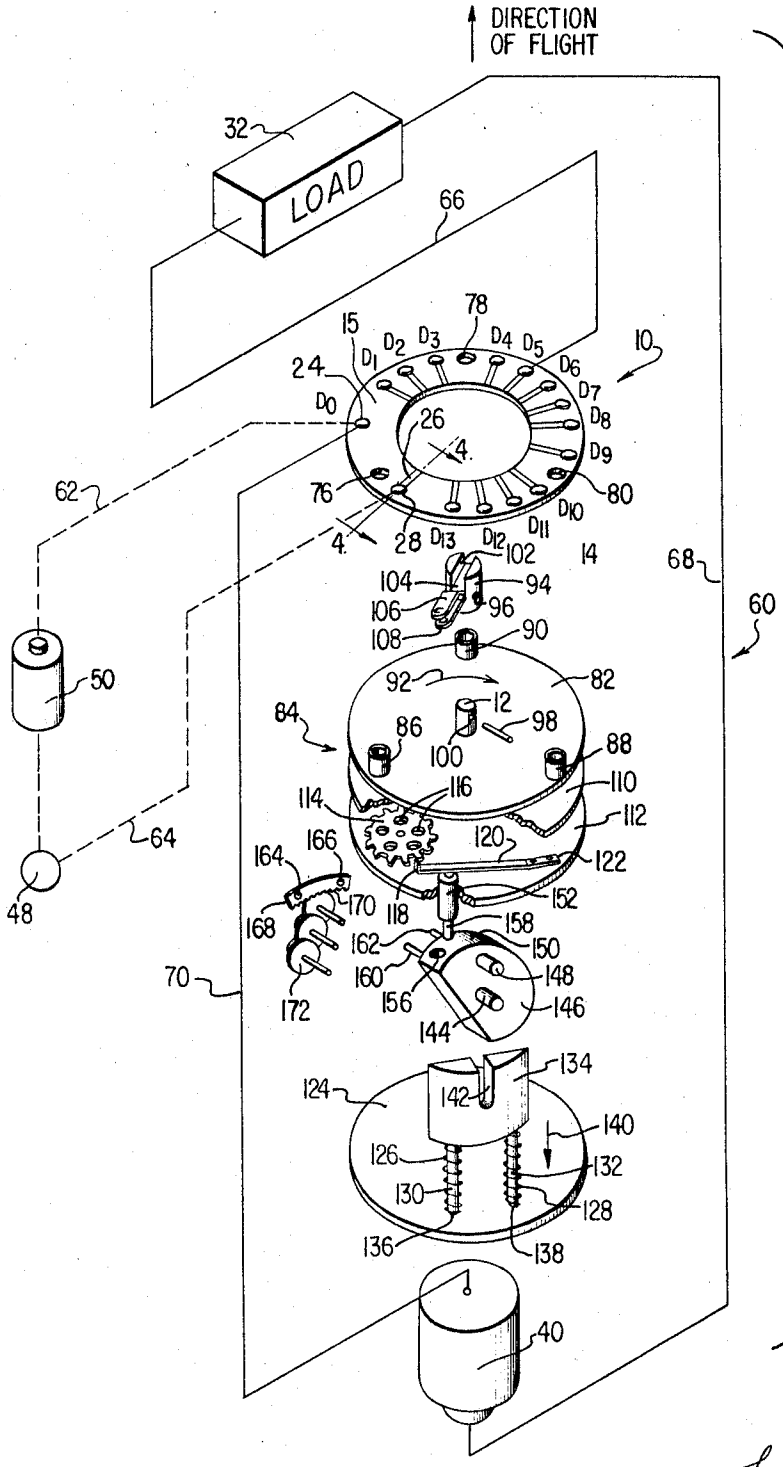


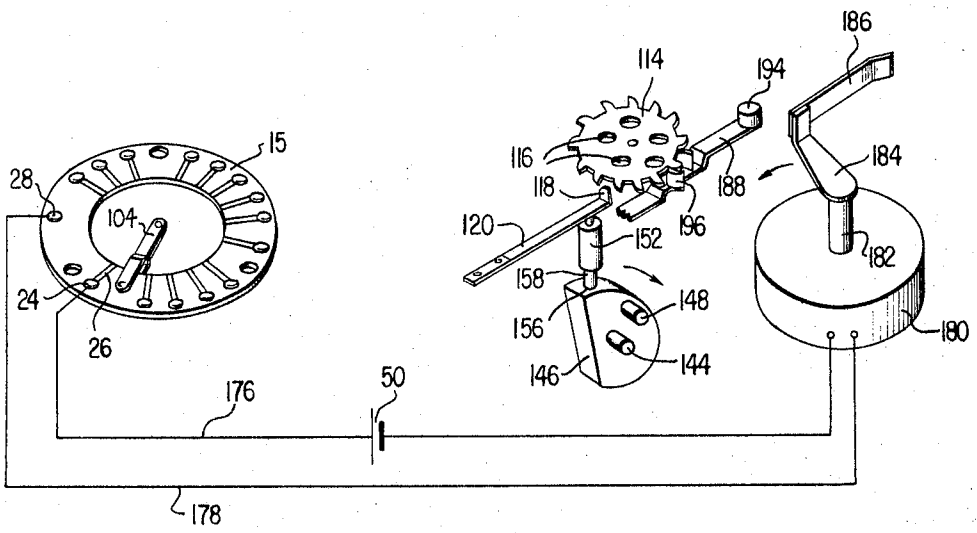
FIG. 2

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FIG. 5



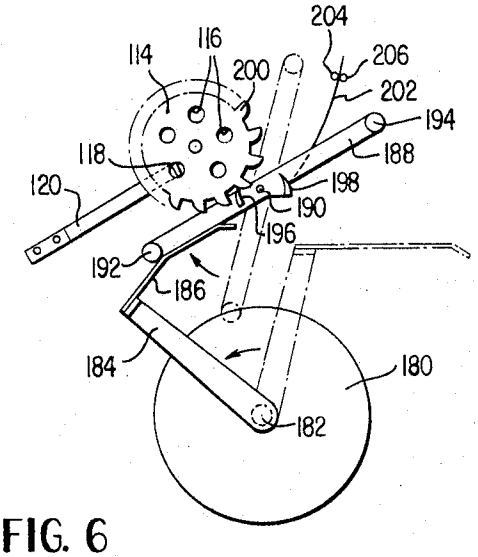
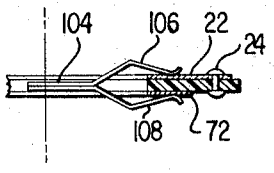


FIG. 6

FIG. 4



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3,428,763

DELAY TIMER WITH SELECTOR SWITCH

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Continuation of application Ser. No. 445,550, Apr. 5, 1965. This application May 29, 1967, Ser. No. 642,243
U.S. Cl. 200—33 12 Claims
Int. Cl. H01h *43/10*

ABSTRACT OF THE DISCLOSURE

Disclosed is a sequential timing switch particularly suited for igniting rocket motors. A spring driven clock mechanism drives an escapement controlled wiper arm over a series of contacts to complete one or more load circuits after a predetermined time. Important features include an arrangement for accurately zeroing the switch, a solenoid brake for automatically stopping the switch at its zero setting, a short delay clock for releasing the brake, and utilization of a set-back mass for starting the switch in response to acceleration forces.

The present application is a continuation of copending application Ser. No. 445,550, filed Apr. 5, 1965, now abandoned.

This invention relates to a timing device and more particulary to a mechanical timer or delay unit particularly suited for use in igniting rocket motors. The device is completely mechanical in operation and incorporates a novel zero setting arrangement which eliminates the need for clutches, brakes, or the other similar mechanical devices of previous timers. It provides an increase in timing accuracy of approximately an order of magnitude over currently used delay pyrotechnic igniters for rocket motors.

In firing a rocket, missile or other type of projectile it is frequently desirable that some additional function or operation be performed at a certain given time subsequent to lift-off or firing of the missile. For example, artillery shells, rockets, and other military projectiles are frequently provided with timing devices which arm the projectile only after it has traveled a safe distance from the point of initiation. In devices of the military projectile type, the arming delay may be measurable in terms of only fractions of a second so that the accuracy of the timing device is not too important. Consequently these devices are more often designed with an eye to reliability and safety rather than extreme timing accuracy.

On the other hand, with the advent of multi-stage rockets and missiles, it frequently occurs that the desired function, such as ignition of a second or subsequent stage rocket motor, must be performed quite some time after a lift-off, i.e., as much as 30 seconds or more subsequent to the firing of the missile. In situations of this type the accuracy of the time delay becomes quite important since the firing accuracy and ultimate path of the missile depends to a large extent upon accurately timed ignition of the rocket engines. Variations of only a fraction of a second can seriously affect not only the final velocity but also the ultimate path of travel of the missile.

The present invention is directed to an intermediate type igniting or timing device standing between the cheap, simple, and very inaccurate powder train delay used in sounding rockets and the like and the complex units used in high-yield military missiles. The subject device realizes about 95% of the accuracy of the sophisticated timers with a cost comparable with that of the pyrotechnic delay.

The delay systems currently in use for firing sounding rocket secondary stage engines are based upon a pyrotechnic delay having an accuracy of only approximately ±20%. On the other hand, the mechanical delay timer of the present invention is capable of accuracies of ±2% and better, which represents at least an order of magnitude improvement over present practices.

The entire timing system of the present invention is of relatively small size and light weight particularly suited for space applications. It includes: first a safety and arming device incorporating a spring-mass accelerometer and a short delay clock; second a long delay mechanical clock based upon a conventional Junghans fuze escapement; and third a selector switch driven by the long delay clock. The unit is adjustable to provide any one of a variety of selectable delay times and is susceptible of rapid and simple adjustment even in the field.

As is well known, the accuracy of any mechanical timing device depends not only upon its running accuracy but also the accuracy with which it is initially set or zeroed. Important features of the present invention include a simplified arrangement for accurately zeroing the mechanical timer of this invention, which zeroing operation can be performed either at the factory, or in the field, or both. In addition, simplified and improved auxiliary apparatus is provided for automatically zeroing the timer in situations where greater accuracy is desired.

It is therefore one object of the present invention to provide a novel improved timer.

Another object of the present invention is to provide a timer particularly suited for use in igniting rocket motors.

Another object of the present invention is to provide a novel and improved mechanical rocket engine delay igniter.

Another object of the present invention is to provide a timer having improved means for zeroing the timer.

Another object of the present invention is to provide an accurate, relatively inexpensive delay timer having light weight and small size, particularly suited for areospace applications.

Another object of the present invention is to provide a spring driven mechanical timer particularly suited for determining the delay in firing of a second or subsequent stage in a multi-stage rocket. The device of the present invention includes a novel rotary selector switch having a wiper arm adapted to engage in sequence a plurality of output terminals, which terminals provide a selectable delay for the system. Also provided is a zero setting terminal adapted to be engaged by the wiper arm which zero terminal cooperates with a common terminal of the selector switch to accurately indicate a zero setting for the switch. Once the selector switch is seen to be in the zero position it may be manually stopped by the operator. Alternatively a novel solenoid stopping mechanism is provided in the present invention for automatically and accurately stopping the timer at the zero position. Initiation of the timing sequence commences when the unit is subjected to acceleration forces at lift-off.

These and further objects and advantatges of the invention will be more apparent upon reference to the following specification, claims and appended drawings wherein:

FIGURE 1 is a diagrammatic view showing the novel selector switch incorporated in the present invention.

FIGURE 2 is an exploded view showing the overall timer and the relationship of the mechanical elements of the timer.

FIGURE 3 is a perspective view showing the underside of the timing wafer forming a portion of the selector switch of FIGURES 1 and 2.

FIGURE 4 is a cross-section through the timing wafer taken along line 4—4 of FIGURE 2 is not shown.

FIGURE 5 is a diagrammatic view showing the automatic zero setting stopping mechanism of the timer of this invention, and

FIGURE 6 is a diagrammatic plan view further illustrating the stopping and starting mechanism of the timer.

Referring to the drawings, FIGURE 1 shows the selector switch of the present invention generally indicated at **10** comprising an output shaft **12** which carries for rotation therewith a rotor **14** and a wiper arm or shorting clip **16**. As more fully described below, shaft **12** is driven from a spring powered mechanical timer or clockwork mechanism hereinafter referred to as the long delay mechanical clock.

Shorting clip **16** is adapted to sequentially engage a plurality of delay contacts **18** labelled D_1 through D_{10} with each of the delay contacts suitably coupled to a corresponding output terminal **20**. Also positioned in the path of movement of the shorting arm or spring clip **16** is a zero contact **22** coupled to terminal **24**. In addition shorting clip **16** is continuously coupled through the rotor **14** to a common contact **26** and hence to a switch terminal **28**.

Each of the delay contacts D_1 through D_{10} is spaced circumferentially around rotor **14** but they are not necessarily equidistant from each other. Since the rotor is driven by the timing mechanism at a substantially constant angular velocity, the angular distance between each of the delay contacts from the zero contact **22** determines a particular delay which may be selected by the operator when the unit is wired up. This desired delay is selected by the technician when he wires in the next component and in the embodiment illustrated delay intervals of, for example, 10, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 26, 28 and 30 seconds or higher may be chosen as desired depending upon the number and the spacing of the delay contacts. FIGURE 1 illustrates delay contact D_5 as coupled by way of an output lead **30** to a load **32**. In the preferred embodiment this load constitutes at an igniter for a rocket motor or engine such that when an electrical circuit is completed through it the load unit **32** acts to ignite or fire the motor. The other terminal of the load **32** is returned by way of lead **34**, terminal **36** and lead **38** to a power source **40** in the form of a battery or energy cell. Thus, when the shorting clip **16** rotates from the zero contact **22** to delay contact D_5 the circuit from energy cell **40** is completed to load **32** by way of lead **42**, terminal **28**, contact **26**, rotor **14**, shorting clip **16**, contact D_5, lead **30** and back through the load **32** to the other side of the energy cell.

In order to accurately zero the spring driven switch **10**, the unit is provided with couplings **44** and **46** for attaching to the unit zero indicator **48** and battery **50** by way of leads **52** and **54**. In operation of the switch **10** of FIGURE 1, the timer is first run to drive rotor **14** until the shorting clip **16** engages the zero contact **22**. At this time the circuit is completed through zero indicator **48** to indicate that the switch and hence the clockwork mechanism driving it is zeroed. When this indication is received the operator either at the factory or in the field as the case may be may manually stop the clockwork drive so that the unit is accurately zeroed and ready for energization at the lift-off of the rocket. The quick disconnect couplings **44** and **46** make is possible to quickly connect and disconnect the zero indicator **48** and its power supply **50** to and from the switch.

FIGURE 2 shows the overall timer unit generally indicated at **60** as incorporated in a missile and includes the selector switch **10** of FIGURE 1, the energy cell or battery **40** and the igniter load **32**. Also indicated as coupled to the switch by dash lines **62** and **64** are the zero indicator **48** illustrated in the form of an incandescent light in FIGURE 2 and its battery **50**. The dash line showing is to indicate that the zero indicator is coupled to the unit only to zero the switch and its timer, either in the factory or in the field, and is later disconnected and removed from the unit before the missile is actually fired.

In FIGURE 2 the rotor engages delay contacts on an annular printed circuit board or wafer of suitable electrical insulating material upon which are deposited the conductive leads or contacts D_1, D_2, etc. Which are of electrically conductive copper and which may be deposited by any of the conventional printed circuit techniques including etching, printing, and the like. Any number of leads may be provided as desired and some thirteen delay leads are illustrated in FIGURE 2. As before, the output is taken from the terminal of delay lead D_5 by way of lead **66** to the igniter load **32**. Lead **68** from the other side of the load returns the load directly to one side of the energy cell or battery **40**. The other side of the energy cell is connected by lead **70** to the common terminal **28**. The underside of the timing wafer **15** is illustrated in FIGURE 3 as having on its bottom surface a circular common conductive lead **72** of electrically conductive copper, which lead is connected to a conductive eyelet **74** passing completely through the printed circuit board so that the opposite end of the eyelet in FIGURE 3 forms the common terminal **28** in FIGURE 2. Similar conductive eyelets passing completely through the wafer **14** and spaced radially outward from the common lead **72** form the delay terminals D_1, D_2, etc. and the zero terminal **22** (D_0).

As illustrated in FIGURES 2 and 3, timing wafer **15** is provided with three equally spaced apertures **76**, **78** and **80** by means of which the wafer **15** is secured to a top plate **82** rotatably receiving the output shaft **12** of the mechanical clock or long delay timer **84**. Screws (not shown) pass through the apertures **76**, **78** and **80** of the wafer and are threadedly received in the internally threaded posts **86**, **88** and **90** carried by the top plate **82**. The shaft **12** is indicated as rotatable in the clockwise direction in FIGURE 2 by the arrow **92**.

Received over the end of output shaft **12** for rotation therewith is rotor **14** in the form of an arbor **94** made of suitable electrically insulating material which arbor is provided with a keyway or aperture **96** adapted to receive pin **98** which passes through the keyway **96** and through the similar keyway or aperture **100** in the end of shaft **12** with a friction fit to secure the arbor **94** on the end of the shaft. Arbor **94** is bifurcated or slotted at its upper end in FIGURE 2 as illustrated at **102** and secured in this slot by a screw or other suitable fastening device is an electrically conductive spring metal shorting clip **104** having spaced upper and lower resilient spring arms **106** and **108** as more clearly illustrated in FIGURE 4. Spring arms **106** and **108** are adapted to wipe over the upper and lower surfaces, respectively, of wafer **15** adjacent its inner edge so as to sequentially engage the delay contacts D_1, D_2, etc., common lead **72**, and zero setting contact **22**. The upper spring arm **106** sequentially engages the delay contacts and the zero setting contact whereas the lower spring arm **108** continuously engages common lead or contact **72** during the entire 360° rotation of shaft **12** and arbor **94**.

Long delay clock **84** in addition to top plate **82** includes a pair of further spaced parallel plates **110** and **112** on which is mounted a conventional spring driven timing clock works including escape wheel **114**. This escape wheel forms part of a Junghans fuze escapement, more fully shown in FIGURES 5 and 6 and more completely described below. The escape wheel is provided with a plurality of apertures **116**, any one of which is adapted to receive the up-turned semi-circular end **118** of a detent spring or starting lever **120**. The other end of this flexible and resilient metallic spring lever **120** is attached to the lower plate **112** as illustrated in FIGURE 2 at **122**.

The lower end of the timing assembly terminates in a base plate **124** to which is secured one end of a pair of

coiled compression springs **126** and **128**. These springs are wrapped around pins **130** and **132** pressed into plate **124** at **136** and **138**. Seismic set back mass **134** is suitably drilled so as to slide freely over pins **130** and **132**. The other end of springs **126** and **128** support the seismic set back mass **134**. In this way springs **126** and **128** bias setback mass **134** upwardly to its uppermost position but are adapted to be compressed when an acceleration force is applied to the setback mass **134** in the direction of arrow **140** in FIGURE 2. When the acceleration force is applied, setback mass **134** moves downwardly, sliding over and guided by pins **130** and **132** and compressing springs **126** and **128**.

The upper end of the setback mass **134** is slotted as at **142** so that in its uppermost position it passes over arbor **144** on which is rotatably mounted an eccentric mass **146** and the edges of the slot **142** engage a pin **148** carried by the eccentric mass **146**. When the timer is at rest and in the locked position pin **148** is in vertical alignment with the arbor **144** so that both are received in the slot **142**. The eccentric inertial mass **146** is provided with a cam surface **150** which is engaged by one end of a cam follower pin **158** slidably received through a suitable bushing **152** friction fitted in plate **112**.

The other end of the follower pin **158** engages the underside of resilient starting lever **120**. This lever normally resiliently biases the pin into engagement with cam surface **150** before the unit is started. However, when the device is subjected to a force of acceleration in the direction of the arrow **140**, mass **146** rotates in a clockwise direction, bringing an aperture **156** in cam surface **150** into alignment with the lower end of follower pin **158** such that the end of pin **158** falls into the aperture or hole **156**. This permits the pin to move downwardly under the bias of the starting lever **120** and in so doing the upturned end **118** of the lever is withdrawn from aperture **116** of escape wheel **114**. By design, escape wheel **114** is inherently self starting. Therefore, upon release of escape wheel **114**, long delay clock **84** starts to run.

Provided on the back side of the inertial eccentric mass **146** are a pair of additional pins **160** and **162** which are received with a friction fit through apertures **164** and **166** of a sector gear **168** such that the sector gear is carried for limited rotational movement with the mass **146**, i.e., the sector gear rotates with the mass **146** from the position illustrated in FIGURE 2 to the position assumed by the mass when the end of follower pin **158** falls into the hole **156**. Annular sector gear **168** carries teeth **170** engaged with the teeth of the first gear of a gear train **172** terminating in a verge (or "clutter") escapement that controls the rotation of eccentric mass **146**.

In operation of the timing unit **60** of FIGURE 2, either at the factory or in the field, the zero indicator **48** and its battery **50** are first coupled to the switch **10**. The mainspring (not shown) of long delay clock **84** is then completely wound and the clock manually started and run to drive shorting clip **104** until the resilient spring finger **106** engages zero setting contact **26** of wafer **15**. At this time the spring fingers complete a circuit to the zero indicator or light bulb **48** by way of leads **62** and **64** and a visible indication of the position of output shaft **12** and of the switch **10** is given. At this time the operator then manually stops the long delay clock **84**. The clock is in this way accurately zeroed in a position wherein the shorting clip **104** is engaging the contact **26** and the delay provided by clock **84** is dependent only upon the accuracy of the clock since the distance through which the output shaft must rotate, i.e., the distance from contact **26** to delay contact D_5 (or any of the other delay contacts previously wired in) is accurately determined.

After the long delay clock **84** has been stopped, mass **146** is rotated to the position illustrated in FIGURE 2 such that the end **118** of the starting lever **120** moves into the closest one of the apertures **116** of escape wheel **114**. The bias of the starting lever holds pin **158** in the correct position. During rotation of the mass **146**, set back mass **134** is manually depressed but when the arbor **144** (mounted on a suitable support which is not shown) and pin **148** are brought into vertical alignment set back mass **134** is released so that slot **142** engages pin **148** thus locking the entire assembly in the proper position.

Before insertion into the rocket the zero indicator **48** and its battery **50** are uncoupled and removed from the unit. At lift-off the set back mass **134** is moved downwardly against springs **126** and **128** by the forces of acceleration which must be of sufficient magnitude to cause the set back mass **134** to move downwardly far enough to release pin **148**. These same acceleration forces cause eccentric inertial mass **146** to rotate in a clockwise direction, the rotation of this mass being governed by the clutter gear escapement **172**. After a relatively short time, i.e., a fraction of a second as determined by the clutter escapement, pin **158** falls into the hole **156** releasing escape wheel **114**, causing the long delay clock **84** to start up. Operation of the clock **84** drives output shaft **12** in turn moving shorting clip **104** from zero contact **26** over the delay contacts until it reaches delay contact D_5. At this time the circuit is completed from energy cell **40** through common lead **70**, common contact **72**, the conductive shorting clip **104**, delay contact D_5, and output lead **66** to the igniter load **32**. The return from the load to the other side of the battery is by way of lead **68**. Thus the total time between the initiation of sufficient inertial forces to actuate the device and the activation of load **32** is governed almost exclusively by the running time of the long delay clock **84**.

FIGURES 5 and 6 show an arrangement for even more accurately providing a correct zero setting for the long delay clock **84** of FIGURE 2. In FIGURES 5 and 6 like parts bear like reference numerals. As illustrated in FIGURE 5, wafer **15** is detachably coupled by way of leads **176** and **178** through power supply battery **50** to the input terminals of a rotary solenoid **180**. The solenoid is provided with a rotary output shaft **182** on which is mounted a lever arm **184** carrying a thin, flexible and resilient metallic strip **186**. This strip is provided to stop the running of the long delay clock **84** when the solenoid **180** is energized.

As previously mentioned, the clock **84** is provided with a Junghans fuze escapement including the usual pallet **188** rotatably mounted at **190** which pallet carries small weights **192** and **194** at each end. Carried by the pallet are the usual pallet pins or jewels **196** and **198** adapted to alternately engage the successive teeth **200** of the escaped wheel **114**. In the Junghans escapement the jewels **196** and **198** are conventionally made of metal rather than of ruby or other jewel material. The escapement is also provided with the usual elongated balance spring, a portion of which is illustrated at **202** in FIGURE 6, engaging the spaced banking pins **204** and **206**. It is understood that the balance spring or hair spring **202** is connected to the pallet **188** in the usual manner and is provided with a second portion extending to the other side of the pallet and engagable with a second pair of banking pins (not shown). Balance spring **202** sustains oscillations of the pallet between the full line position illustrated in FIGURE 6 where jewel **196** engages a tooth **200** to the dotted line position illustrated where jewel **198** engages the next tooth **200** of the escape wheel **114**. The escape wheel is urged or biased for rotation in the conventional manner by a suitable main spring (not shown).

In FIGURE 5, the starting lever **120** is shown moved downwardly clear of the escape wheel **114** by its own bias and the long delay clockwork **84** is started so as to drive the spring clip **104** with the mainspring of the delay clock fully wound or substantially so. When shorting clip **104** engages zero contact or segment **26** on the wafer **15** the circuit is completed from power supply **50** to the rotary solenoid **180**. Upon energization the output shaft

of the solenoid rotates moving resilient detent strip **186** from the dash line position in FIGURE 6 to the solid line position illustrated in that figure. In so doing strip **186** engages the pallet **188** moving the arm of the pallet carrying weight **192** radially inwardly toward the escape wheel causing jewel **196** to engage and lock against a tooth **200** of the escape wheel, thus automatically stopping the escape wheel and hence the running of the long delay clock **84**. Once the long delay clock has been stopped by the solenoid with the shorting clip **104** engaging zero setting contact **26**, turned over end **118** of starting lever **120** is inserted in one of the apertures **116** in the escape wheel and mass **146** is locked in the correct position in the manner previously described. The unit is ready for operation and the stopping circuit including the power supply **50** and rotary solenoid **180** are uncoupled and removed from the unit.

It is apparent from the above that the present invention provides a novel timing device particularly suited for use in aerospace applications which provides a very accurate long time delay. While described in conjunction with the ignition of a rocket motor it is apparent that the switch and timing mechanism of the present invention has general utility in suitations where it is desired to provide an accurate, relatively long delay, i.e., in the order of ten to thirty seconds and more.

In one embodiment constructed in accordance with the present invention, the unit incorporated as a source of output energy to be released by closure of the selected set of contacts an energy cell **40** in the form of an Eveready type E93 alkaline cell. The cell was friction fitted in a metallic case and is rated to deliver 6 amperes flash current at 1¼ volts positive, at zero degrees centigrade. Higher outputs are available at higher temperatures. In this embodiment time delays from ten to thirty seconds are selectible depending on which one of the delay terminals is wired to the load **32**. The delay begins when the device is subjected to an axial acceleration of 5 *g*'s or greater and of sufficient duration to permit the safety and arming device, i.e., the setback mass and short delay timer clutter **172** to operate. After this arming delay dependent upon the value and time of acceleration the safety and arming device unlocks the long delay clock **84**. The output shaft of the long delay clock makes one complete revolution in about 35 seconds, driving the rotor **14** as it rotates.

The total time delay is the sum of the arming delay and the long delay timer. The arming delay is conventionally on the order of a fraction of a second, typically arming delays (i.e. calibrations) being furnished for minimum accelerations of 5, 10, 15, 20 and 25 *g*'s. The accuracy of the long delay timer depends both on making the proper connection to the correct output delay terminal and also properly zeroing the clock. The zeroing can be readily performed in an efficient manner by a skilled technician, and may be accomplished using a simple continuity tester to an accuracy of ±½ second. If the factory type setting system such as that illustrated in FIGURES 5 and 6 is used the zero setting error can be reduced by a factor of 10 or more.

In the embodiment described the entire device complete with battery carrier is less than 5¼ inches long. It mounts in a 1¼ inch bore. Mounting is by set screws threaded radially through the ⅛ inch wall of the mounting tube and seating radially in a central plate of the timer. The unit may be prepared for shipment by being assembled complete, finally wound, the long delay clock zeroed, and the whole device including battery sleeve sealed in a plastic envelope and commercially packed. The components are secured to each other by suitable threaded fasteners, pins and eyelets to make a rigid general assembly except for the battery case which is normally friction fitted to permit readily access for installing the energy cell. The battery cell may be secured to the next component if desired (or it can be screwed to its base) by a bayonet lock, or similar attachment. This serial construction (as best seen in FIGURE 2) along the axial line of the missile insures that the direction of the flight is such as to assist rather than to buck the detenting system used to arm the long delay clock.

Important features of the present invention include the zeroing segment or contact on the switch **10** which makes it possible to zero the device accurately by running it until a circuit is made across the common and zeroing contacts and then stopping the escapement of the long delay clock. The accuracy of zero setting is a function of the sophistication of the stopping system. For best results, as described, this is an electromechanical system utilizing a solenoid to stop the escapement. Such a system repeats within a very few, approximately 5, milliseconds. Manual field resetting can be accomplished by a technician using a continuity checker to within one-half second. Accuracy of the Junghans fuze escapement is on the order of 0.1%.

In addition to the increased accuracy provided, the setting and zeroing system described completely eliminates the necessity for clutches, brakes, and the other more complicated and hence expensive mechanical devices previously used. As compared to the pyrotechnic igniters for rockets having an accuracy of approximately ±20% the delay unit of the present invention provides a timing delay having accuracies of ±2% or better. This represents at least an order of magnitude improvement over present practice.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A sequential timing switch comprising a spring driven clockwork having an escapement controlled rotatable output shaft, an electrically conductive wiper arm carried by said output shaft for timed rotation with said shaft, a plurality of delay contacts angularly spaced adjacent the path of movement of said wiper arm whereby said wiper arm sequentially engages said delay contacts, said delay contacts including a zero contact, a common contact continuously coupled to said wiper arm, and means connected to said zero and common contacts for coupling an electrical indicator between said zero contact and said common contact.

2. A switch according to claim **1** wherein said coupling means comprises a pair of electrical terminals, and a quick disconnect coupling for electrically connecting an electrical indicator to said terminals.

3. A switch according to claim **1** including an electrical indicator and power supply coupled in series between zero contact and said common contact.

4. A switch according to claim **3** wherein said indicator comprises an electric light.

5. A sequential timing switch comprising a spring driven clockwork having an escapement controlled rotatable output shaft, a stationary annular wafer of insulating material having spaced, flat opposite sides positioned adjacent said output shaft, a plurality of planar delay contacts angularly spaced along its radial inner edge on one side of said wafer, said delay contacts including a zero contact, an annular common planar contact on the other side of said wafer adjacent said inner edge, a shorting clip rotatably mounted within said wafer on said output shaft, said clip being insulated from said shaft, said shorting clip having spaced arms resiliently engaging said sides of said wafer while said arms wipe over said contacts, a contact terminal on said wafer for each of

said contacts, means connected to said common and zero contact terminals for coupling an electrical indicator between said common contact terminal and said zero contact terminal, and means for coupling at least one of said delay contact terminals other than said zero contact terminal to an output load.

6. A switch according to claim 5 including means coupled to said clockwork for stopping said clockwork.

7. A switch according to claim 5 including a load and first power supply coupled in series between said common contact terminal and said other contact terminal, and an indicator and second power supply coupled in series between said zero contact terminal and said common contact terminal.

8. A switch according to claim 5 including means coupled to said spring driven clockwork for braking rotation of said output shaft, and a second escapement controlled timing movement including an unbalanced mass coupled to said braking means for releasing said braking means in response to acceleration forces acting on said mass.

9. A delay device comprising a spring driven clockwork having a rotatable output shaft, an electrically conductive wiper arm carried by said output shaft, a plurality of delay contacts angularly spaced adjacent the path of movement of said wiper arm whereby said wiper arm sequentially engages said delay contacts, said delay contacts including a zero contact, a common contact continuously coupled to said wiper arm, means for coupling an electrical indicator between said zero contact and said common contact, an electrical indicator and power supply coupled in series between said zero contact and said common contact, said indicator comprising a solenoid having a movable armature, and means coupled to said armature for stopping said clockwork upon movement of said armature.

10. A delay device comprising a spring driven clockwork having a rotatable output shaft, a stationary annular wafer of insulating material having spaced, flat, opposite sides positioned adjacent said output shaft, a plurality of planar delay contacts angularly spaced along its radial inner edge on one side of said wafer, said delay contacts including a zero contact, an annular common planar contact on the other side of said wafer adjacent said inner edge, a shorting clip rotatably mounted within said wafer on said output shaft, said clip being insulated from said shaft, said shorting clip having spaced arms resiliently engaging said sides of said wafer whereby said arms wipe over said contacts, a contact terminal on said wafer for each of said contacts, means for coupling at least one of said delay contact terminals other than said zero contact terminal to an output load, means for stopping said clockwork, said clockwork including an escape wheel and resilient force responsive means coupled to said escape wheel for locking said clockwork against operation.

11. A timer comprising a selector switch having a plurality of output terminals and a zero terminal, a power supply, a load coupled to one of said output terminals, a spring driven clockwork for sequentially coupling said power supply to each of said output terminals, movable force responsive means coupled to said clockwork for braking said clockwork, and means for coupling an indicator circuit to said zero terminal for indicating the zero position of said selector switch, said force responsive means including a seismic mass working against a verge escapement.

12. An ignition timer comprising a selector switch having a plurality of output contacts, means for coupling an ignition load to one of said output contacts, a rotor having a wiper arm sequentially engageable with each of said output contacts, a spring operated long delay clock operably connected to said rotor, a power supply having one side coupled to said load, and its other side to said wiper arm, braking means coupled to said long delay clock, a force responsive short delay clock coupled to said long delay clock for releasing said braking means, said short delay clock comprising an unbalanced mass mounted for movement against the retarding force of a clutter escapement, and set-back mass means coupled to said unbalanced mass, for locking said unbalanced mass against movement for acceleration forces of less than a predetermined amount.

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