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MINIATURE ELECTROLYTIC TIMER WITH AN ERODABLE ANODE

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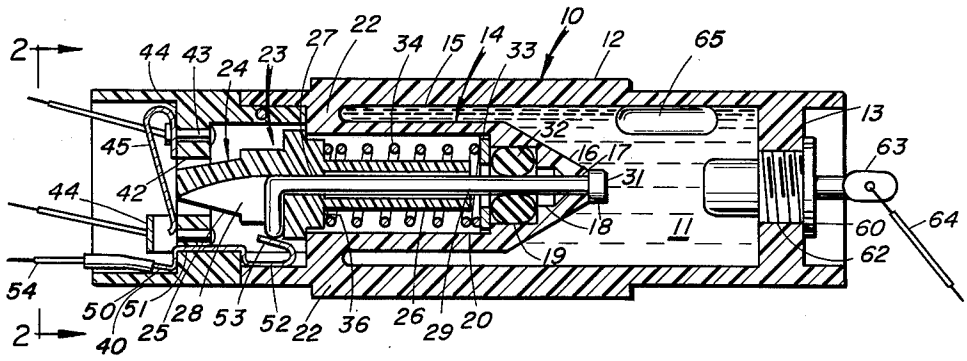


FIG. 1

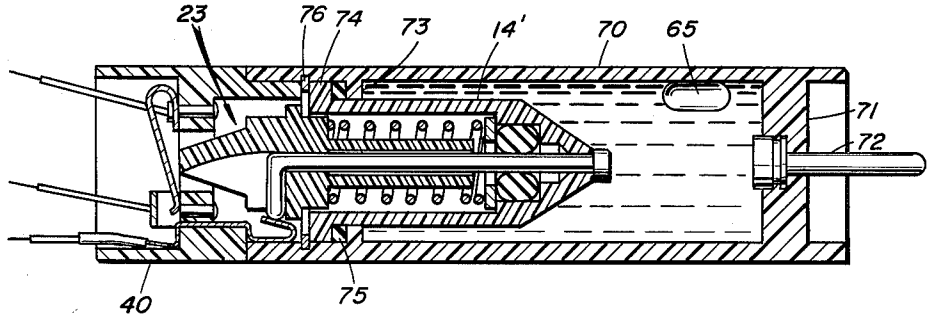


FIG. 3

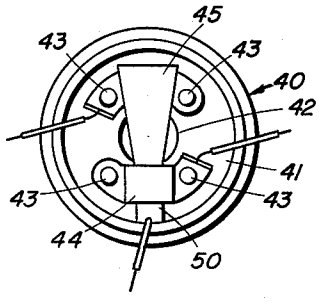


FIG. 2

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MINIATURE ELECTROLYTIC TIMER WITH AN ERODABLE ANODE

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8 Claims. (Cl. 200—61.05)
(Granted under Title 35, U.S. Code (1952), sec. 266)

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 of any royalties thereon or therefor.

This invention relates to the art of time delay mechanisms. More particularly, the invention relates to an electrolytic interval timer in which a spring biased plunger is restrained by means of an electrolytically erodable anode element which after being eroded for a predetermined period of time will release the plunger to allow it to move forward under the action of the spring. The motion of the plunger may then be utilized in any desired manner as, for example, to actuate an electric switch.

Previous electrolytic timers of the nature of the present device have had the disadvantage of being relatively heavy and large. As such, they have not been suitable for use in missile, mines, satellites and like applications where space and weight are important. Moreover, previous timers have not been sufficiently reliable in operation for various reasons. For example, some used lead electrodes and lead base electrolytes which produced a highly conductive sludge during the deplating operation, with the consequent danger of shorting the anode to the cathode.

It is therefore an object of the invention to provide an electrolytic timer which is smaller and lighter in weight than previous timers so as to be useful where space and weight are important, such as in missiles and satellites.

It is a further object of the invention to provide an electrolytic timer which is reliable and accurate in operation. Acceptable accuracy for an interval of as much as several weeks is about ±15%.

The objects of the invention are achieved by the present device in part by details of construction which result in small size and light weight. A clean electrolyte is maintained by a selection of electrode materials and electrolyte which do not produce sludge. The particular electrolyte selected provides a further advantage in that the subject timer is operative at as low a temperature as —10° F.

In general, the timer of this invention consists of an electrolytic cell for controlling a spring biased plunger between a retracted position and an advanced position, the motion of the plunger from the first to the second position actuating an electric switch. The plunger is restrained in the retracted position by an enlarged head portion of an anode element which extends into a chamber containing an electrolyte. When an electric current is passed through the electrolyte, erosion of the anode takes place, and depending on the size of the anode and the magnitude of the current, operation may be delayed for a predetermined time, after which the restraint provided by the anode will be removed to permit the plunger to move forward to the extended position.

Other objects and advantages of the invention will become apparent from a consideration of the following de-

tailed description when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a longitudinal cross-section through one embodiment of the invention;

FIG. 2 is an end view of an electrical switch that may be employed with the subject timer and,

FIG. 3 is a view, similar to FIG. 1, of another embodiment of the invention.

Referring now to FIG. 1, the electrolytic cell of the invention is there seen to consist of a plastic cell housing **10** defining an electrolyte chamber **11** therein. Cell housing **10** is formed with an outer cylindrical wall **12**, and a transverse end wall **13** near one end thereof. The end of the casing opposite wall **13** is closed by a plunger housing **14** which consists of a cylinder **15** of smaller outer diameter than the inner diameter of wall **12** and a conical end portion **16**. Plunger housing **14** is provided with a coaxial central bore **17**, which opens through the apex end of portion **16**, and with counterbores **18**, **19** and **20**, which serve to support various elements as will appear hereinafter, although the term "counterbores" is not meant to include only a machined structure. The designated shape can clearly be produced by molding as well as machining.

In the FIG. 1 embodiment, plunger housing **14** is integrally formed with outer wall **12** being joined thereto as indicated at **22**.

In order to facilitate the manufacture of the device, transverse wall **13** may be made in this embodiment as a separate element and heat sealed in housing **10** after plunger housing **14** is fabricated.

In the FIG. 3 embodiment, the plunger housing is a separate element as will appear in more detail hereinafter. In this embodiment transverse wall **13** may if desired be integrally molded with housing **10**.

The anode and plunger assembly, generally indicated at **23**, is the same for both embodiments and will be described in detail only with respect to FIG. 1. The plunger **24** itself consists of a head **25** and a tubular tail **26**. Head **25** has a bore **27** coaxial with tail **26** and a slot **28** intersecting the bore **27** and of at least the same width as the diameter of bore **27**. The anode is an elongated wire **29** which passes through bore **17** and terminates in an enlarged head portion **31** within electrolyte chamber **11**. An O-ring **32** is disposed in counterbore **19** to provide a fluid seal between the anode wire **29** and plunger housing **14**.

The distance from O-ring **32** to the apex of portion **16** is chosen so as to be greater than the maximum distance of travel of the plunger. With this construction, the anode wire **29** cannot be pulled out of the O-ring **32** and the seal is maintained both before and after operation of the timer and no leakage of electrolyte out of the chamber can take place. A washer **33** rests against the step between counterbores **19** and **20**, serving to hold O-ring **32** in place and also serving to provide a support for the innner end of biasing spring **34** which acts between washer **33** and the rear end **36** of the head **25** of plunger **24**.

In assembling the plunger assembly, anode wire **29** is first passed through bore **17** from the inside of the chamber. O-ring **32**, washer **33** and spring **34** are then dropped into place in proper order. Plunger **24** is then slid over anode wire **29** and pressed in, compressing spring **34**, until wire **29** protrudes out into slot **28**. Wire **29** is

then bent over as shown in order to secure the plunger in the retracted position.

Connected in any suitable manner to the left end of cell housing **10** is a switch element **40** having a transverse mounting plate **41**, made of an insulating material, with an aperture **42** centrally disposed therein to accommodate the forward end of plunger **24**. Attached to plate **41** in any suitable manner, as by rivets **43**, are a stationary contact **44** and a movable contact **45** fabricated of sheet metal. In the illustrative embodiment shown, it is clear that the switch is arranged to be normally open and to be closed when forward motion of the plunger **24** moves contact **45** into engagement with contact **44**. It should be apparent, however, that the parts may be arranged so that the switch is moved from closed to open position, or other switch arrangements may be employed if desired.

Electrical connection is made to the anode by means of a connector **50** which extends through an opening **51** in plate **41**. At the inner end, connector **50** is bent into a generally hooklike shape as shown at **52**. Connector **50** is at least slightly resilient so that the free end **53** will be biased against the end of anode wire **29** when the switch element **40** is connected to the cell housing **10**. A lead **54** extends to suitable control circuitry, not shown.

Completing the electrolytic cell is the cathode element **60** which extends through and is secured in wall **13** in any suitable manner as by a threaded connection **62**. Cathode element **60** has a terminal **63** thereon to which a lead **64** from the above-mentioned control circuitry may be attached. The opening in which the cathode is secured may also serve as the filling opening through which the electrolyte may be introduced into chamber **11**. The insertion of cathode element **60** then closes and seals the chamber. It should be here noted that it is desirable not to completely fill the chamber with electrolyte so as to leave an air bubble **65** in the chamber to allow for expansion and contraction of the electrolyte during temperature changes. It is contemplated that the present timer may be used in areas where the temperature may at times get low enough to freeze the electrolyte and the presence of the air bubble insures that the casing will not be ruptured if this occurs. It is also noteworthy that the construction of the plunger housing to place the anode head **31** at the end of conical section **16** serves to insure that bubble **65** will not surround head **31** in the event that the timer should find itself in a position in which the anode is uppermost in the casing. The device would obviously be inoperative if the anode were not completely immersed in the electrolyte.

As stated above, in the FIG. 3 embodiment, the plunger housing, designated **14**, is a separate and distinct element although it is formed with the same configuration as described above. In this embodiment, the cylindrical wall of the cell is designated **70** and the transverse end wall **71**. The cathode **72** is here molded into end wall **71**, filling of the electrolyte chamber being possible from the other end of the chamber.

Near the end of the chamber opposite wall **71**, cylindrical wall **70** is formed with an internal annular flange **73**. Plunger housing **14'** has an annular flange **74** thereon which cooperates with flange **73** to define the inserted position of housing **14'**. A gasket **75** is employed to provide a fluid seal between the parts. Housing **14'** is held in place by means of a retaining ring **76** disposed in a suitable groove in wall **70**.

As pointed out above, the plunger assembly **23** is the same in the FIG. 3 embodiment as in FIG. 1. This is true also of the switch assembly **40**, so that nothing more need be said about the construction of the FIG. 3 embodiment.

In order to avoid the problems of sludge formation and thereby increasing reliability, the anode and cathode have been made of silver, and the electrolyte is silver fluoborate, which has been found to be a satisfactory combination of materials. The silver fluoborate electrolyte provides the added advantage of allowing operation of the device at as low a temperature as −10° F.

In the operation of both described embodiments, the size of anode head **31** and the current to be passed through the electrolyte are first predetermined in order to establish the delay time. When it is desired to start the device, the control circuit is closed to supply the predetermined current to the cell. Electrolytic erosion of the silver anode head **31** then takes place until the size of the head is reduced far enough to remove the restraint on the spring biased plunger. At that time, the plunger moves forward to actuate switch **40**, and the cycle is complete.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. An electrolytic time delay device comprising:
- a cell having an electrolyte chamber therewithin,
- a cathode element at one side of said cell and extending into said chamber,
- a plunger housing at the other side of said cell, said plunger housing having an opening therein extending into said cell,
- an anode element in said opening and having an enlarged head portion larger than said opening disposed within said chamber,
- a plunger attached to said anode element,
- a spring acting between said plunger housing and said plunger for urging said plunger away from said chamber until said head portion engages the wall of said chamber, thereby defining a retracted position for said plunger, and
- an electrolyte in said chamber,
- whereby when an electric current is established in said electrolyte, said enlarged head portion on said anode is eroded until it is small enough to pass through said opening whereupon said plunger is moved forward by said spring to an advanced position.

2. A device as recited in claim **1**, wherein said plunger housing and said cell are each of plastic material and are molded as a single piece.

3. A device as recited in claim **2**, wherein both said anode and said cathode are made of silver, and said electrolyte is silver fluoborate.

4. A device as recited in claim **1**, wherein said plunger housing and said cell are each of plastic material and are formed as separate elements,
- said cell having an aperture therein,
- said plunger housing having a portion extending through said aperture and a flange for cooperation with the wall of said cell around said aperture,
- a gasket between said flange and said wall of said cell, and
- retaining means for holding said plunger housing in place in said aperture.

5. A device as recited in claim **4**, wherein both said anode and said cathode are made of silver, and said electrolyte is silver fluoborate.

6. An electrolytic time delay device comprising,
- a cell housing formed of plastic material and having an electrolyte chamber therewithin, said cell housing further having a cylindrical wall and a transverse wall near one end thereof, said transverse wall having a silver cathode extending therethrough,
- a plastic plunger housing closing the end of said cell housing, said plunger housing comprising a cylinder of smaller outside diameter than the inner diameter of said cylindrical wall extending into said chamber and having a conical end portion thereon, and a coaxial central bore in said plunger housing which opens through the apex of said conical end portion,
- a silver anode in said bore, said anode having an enlarged head thereon disposed within said chamber,

larger in transverse extent than the diameter of said bore,

a plunger attached to said anode,

a spring acting between said plunger and said plunger housing for urging said plunger outward of said plunger housing, outward motion of said plunger being limited by engagement of said enlarged head with the apex of said conical portion, and

a silver fluoborate electrolyte in said chamber, said chamber being incompletely filled with electrolyte so as to leave an air bubble, therein,

whereby when an electric current is passed through said electrolyte, said enlarged head on said anode is eroded until it is small enough to pass through said

bore, whereupon said plunger is moved forward by said spring.

7. A device as recited in claim 6 wherein a switch element is attached to said cell in position to be actuated by the forward movement of said plunger.

8. A device as recited in claim 6 wherein said cell housing and said plunger housing are molded as a single element.

References Cited by the Examiner

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BERNARD A. GILHEANY, *Primary Examiner.*