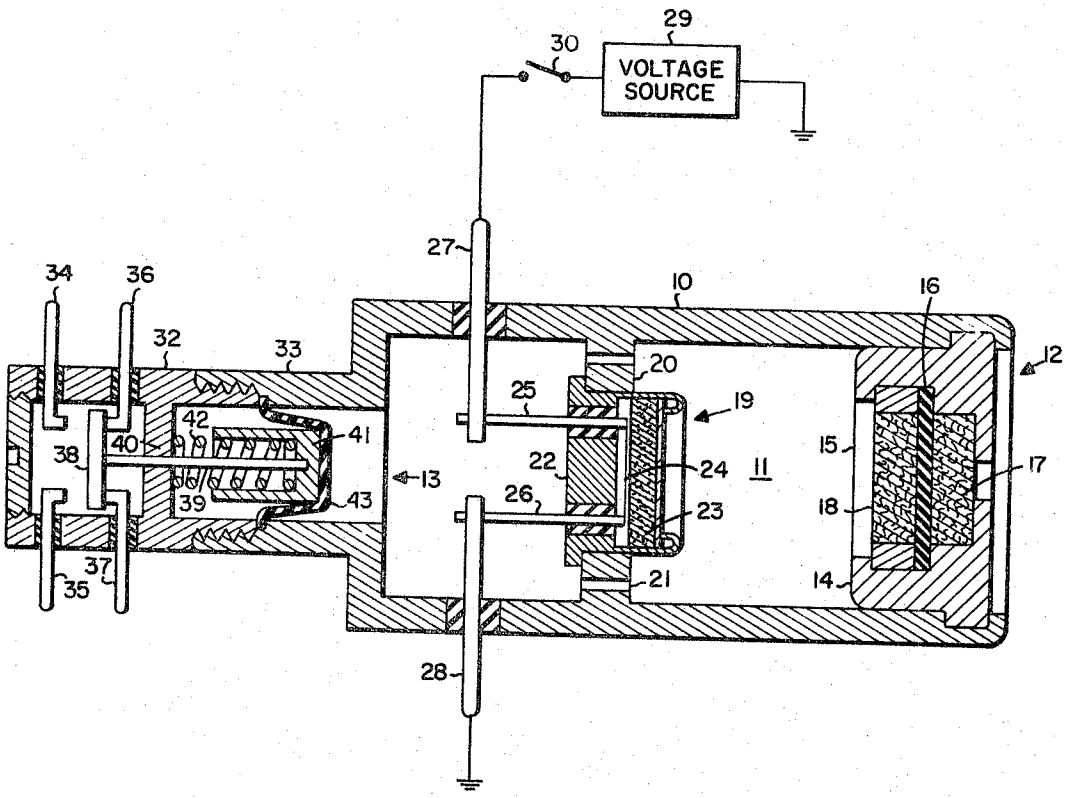
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PRESSURE RETARD SWITCH

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PRESSURE RETARD SWITCH

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ABSTRACT OF THE DISCLOSURE

A fuze mechanism including an electrically actuated pellet for generating a gas in a closed chamber and a pressure sensitive output mechanism responsive to the time required for the pressure within the chamber to decrease to a predetermined level.

This invention relates generally to the art of timing devices and more specifically concerns the design of a timing device in which a gas generator is utilized to produce a high pressure within a closed chamber, the gas in the chamber then being allowed to escape at a controlled rate through a restrictor assembly.

Various mechanical, electrical and chemical timing devices have been devised for use in the many systems in which it is necessary to provide a means for establishing a certain period of time between the occurrence of two events. The present invention, an interval timer, is primarily useful in those applications that require a non-reusable, one-shot timer. Most systems in which timing devices are used require that the timing device be resettable. For those applications, the usual clock escapement mechanism or fluid dash-pot type of system may be applicable. In other systems, only a single timing action is required. For example, many military applications utilize one-shot timers. In munition fuzing it is common practice to incorporate a timing device to assure that a fuze does not arm until the munition has reached a safe distance from the launch position. The present invention is a one-shot timer that could successfully be incorporated into such a system.

The present invention utilizes the basic principle of a fluid being metered through an orifice at a controlled rate to obtain a timing action. Although the basic principle is well known, the present invention provides a unique method of generating a known quantity of gas that is allowed to escape from a closed chamber at a controlled rate. Since the size of the chamber is fixed, the quantity of gas is known, and the size of the orifice is known, the time required for the gas to escape from the chamber can be accurately predicted.

The present invention has many advantages over one-shot timers disclosed in the prior art. Because of its simplicity, it can be easily manufactured. It has only a single moving part, that part being a pressure sensing device. Even that could be modified to eliminate much of the movement. Because of the fact that the pressure is generated only when the device is being used, a pressure storage vessel is not required. There are thus no problems with leakage should storage for a long period of time be necessary. This device can also be packed in a very small container because of its inherent simplicity. The timed interval can also be easily changed by changing the various parameters of the timer design. For example, the pressure sensing device can be changed to respond to a different level of pressure to obtain a different time interval. The restrictor assembly can also be changed easily to change the timing interval.

It is therefore a primary object of the present invention to provide a one-shot timing device in which a gas generator is mounted in a closed chamber, the gas being generated only at the time the device is being utilized as a timer to thereby generate a known pressure within the chamber, the gas being allowed to escape from the chamber through a restrictor assembly at a controlled rate to establish the timed period.

Other objects of the invention will become apparent from the following specification and claims, and from the accompanying drawing, wherein the single figure is a sectional, side view of the preferred embodiment of the interval timer in the non-actuated position.

The cross-sectional side view of the timing device illustrated in the accompanying drawing discloses all of the elements of the invention. The timing device includes a tubular or cylindrical housing member **10** having a chamber **11** formed therein with a first open end **12** and a second open end **13**. Although housing member **10** is formed in the shape of a cylinder in the preferred embodiment of the invention, the particular configuration is not critical. Mounted within first end **12** of housing member **10** is a fluid restrictor assembly **14**. Fluid restrictor assembly **14** has a central opening **15** through which a gas contained within chamber **11** can escape to the exterior of housing member **10**.

Mounted across opening **15** of restrictor assembly **14** is a silicone rubber restrictor **16**. Restrictor **16**, being composed of silicone rubber in the preferred embodiment, is thus a permeable or porous material that will allow air or other gases to pass from chamber **11** to the outside of housing member **10**. Since the pores in restrictor **16** are quite small, the gas flow therethrough is relatively slow. Under normal storage conditions, the pressure within chamber **11** is the same as atmospheric pressure since air will diffuse through permeable restrictor **16** to equalize the pressure on both sides thereof. Although silicone rubber is used as the restrictor material in the preferred embodiment of the invention, other permeable material such as polystyrene film could be utilized to vary the rate of air flow from chamber **11**.

Since restrictor **16** is manufactured from rather a flexible material, it must be supported so that the high pressure that is developed within chamber **11** will not destroy its integrity. A sintered metal or other porous downstream filter member **17** is thus mounted between restrictor **16** and open end **12**. Filter **17** is much more porous than restrictor **16** so that air or gas will pass freely through it. Since filter **17** is non-flexible, however, it will prevent the collapse of restrictor **16** when pressure is applied.

If necessary for the particular application, an upstream filter **18** can be mounted between restrictor **16** and chamber **11**. Filter **18** is also manufactured from a sintered metal or other solid porous material that will allow air or gas to pass relatively freely through it. Filter **18** provides at least three functions in the operation of this device. First, filter **18** physically supports flexible restrictor **16**. Secondly, filter **18** acts as an upstream filter to prevent large particles of dust or other foreign material from reaching restrictor **16**. Because of the relatively impervious nature of restrictor **16**, it is important that large particles of foreign material not be allowed to impinge thereon. Thirdly, filter **18** acts as a heat sink to absorb heat from the hot gas that is generated within chamber **11**. The hot gas, if directly applied to restrictor **16**, could cause damage to it. Tests conducted with the PG–1 propellant indicate that filter **18** is not required in all cases. The gas temperatures generated with the PG–1 propellant were not high enough to damage the silicone rubber and no dust or other particles were generated to plug restrictor **16**. However, filter **18** would be required if a propellant were used that burned at higher temperatures or created undesirable residue.

Mounted near the center of chamber **11** is a gas generating assembly **19**. The gas generating assembly is mounted on a support member **20** having a series of holes such as **21** formed therein so that the gas within the chamber **11** can pass freely around the gas generating assembly. Gas generating assembly **19** includes a casing **22** having a pellet **23** of solid propellant material mounted therein. Mounted adjacent propellant material **23** is a bridge wire **24**. A pair of electrodes **25** and **26** extend through casing **22** and are connected to the ends of bridge wire **24**. A second pair of electrodes **27** and **28** extend through housing **10** and are connected to electrodes **25** and **26** respectively. Connected across electrodes **27** and **28** is a voltage source **29** and a switch **30**.

When switch **30** is closed, voltage source **29** is connected across bridge wire **24**. A current thus flows through bridge wire **24** to heat or explode the bridge wire. When bridge wire **24** is heated, solid propellant **23** is ignited to produce a known quantity of gas. In the preferred embodiment of the invention, a solid propellant having the trade name "PG–1" manufactured by Amoco is utilized. This propellant is a mixture of silver carbonate and carbon that, when ignited, generates pure carbon dioxide gas leaving a residue of silver and carbon: The yield of carbon dioxide gas is 24% by weight. Other propellant materials could also be utilized since the type of gas is not critical to the invention. In order to minimize delay time variations, however, it is desirable to select a combination of restrictor material and gas that is compatible. For example, the combination of silicone rubber with CO_2 gas will minimize delay variations with temperature as will the combination of polystyrene film and nitrogen gas.

Attached to second open end **13** of housing **10** is a pressure responsive switching device **32** to indicate the pressure variations occurring within chamber **11**. Switching device **32** is attached by means of a threaded portion to a similarly threaded cylindrical extension **33** of housing **10**. Switching device **32** includes a pair of normally open contacts **34** and **35** and a pair of normaally closed contacts **36** and **37**. A common contact **38** is attached to an operating rod **39** that extends through a support member **40** within switching device **32**. The opposite end of rod **39** is connected to a piston member **41** that lies in line with open end **13**. Mounted between piston **41** and support **40** is a coiled spring **42** that holds common contact **38** against normally closed contacts **36** and **37** under normal conditions. Mounted between piston **41** and open end **13** is a flexible diaphragm **43** that prevents air or gas from escaping from chamber **11**. Diaphragm **43** is firmly sealed into the connection between switch **32** and housing extension **33**.

Operation

Under normal storage conditions the subject timing device remains in the position or condition shown in the drawings. Switch **30** is open so that no voltage is applied to bridge wire **24**. The pressure within chamber **11** is the same as the pressure outside of housing **10** since air can diffuse through restrictor **16**. Common contact **38** is connected across normally closed contact **36** and **37** to indicate this status.

When it is desired to begin the timing interval, switch **30** is closed. Current from voltage source **29** passes through bridge wire **24** to cause ignition of pellet **23**. When pellet **23** ignites, a large volume of carbon dioxide gas is formed that is trapped within chamber **11**. In the preferred embodiment of this device, the initial pressure within chamber **11** is approximately 500 p.s.i.

The high initial pressure within chamber **11** causes piston **41** to compress spring **42**. Diaphragm **43** flexes to allow this movement of piston **41**. Diaphragm **43** continues to seal chamber **11** to prevent escape of the gas. When spring **42** is compressed, common contact **38** is driven against normally open contacts **34** and **35** to complete a circuit between them. Suitable circuitry (not shown) can be connected to contacts **34** and **35** to indicate the beginning of the time interval.

The pressure within chamber **11** immediately begins to dissipate as the gas escapes through restrictor assembly **14**. The gas within chamber **11** is at a relatively high temperature because of the reaction of pellet **23**. As previously mentioned, upstream filter **18**, if used, tends to absorb most of this heat before the gas reaches restrictor **16**. Filter **18** also filters out any products of combustion that would tend to clog the pores in restrictor **16**.

As the gas pressure within chamber **11** decays, spring **42** will tend to overcome the pressure acting against piston **41**. At a predetermined reduced pressure, spring **42** drives piston **41** to the position shown in the drawing so that normally closed contacts **36** and **37** are again connected. This return of common contact **38** to the original position indicates the end of the time interval. It can be seen that the size of piston **41** and the strength of spring **42** can be adjusted so that the time interval is ended at any predetermined reduced pressure within chamber **11**. In the actual embodiment of the device, the switching device was designed to return to its normal position when the pressure within chamber **11** was equal to 40 p.s.i. The particular switching device that is disclosed in the drawing is not critical to the invention. Many other switching arrangements or signal output devices could be substituted without departing from the invention.

Tests have shown that the timing period can be accurately controlled and also adjusted from unit to unit by carefully controlling the device parameters. An actual model of the device has provided a time delay of 72 hours. The housing on that device displaced a volume of one-half cubic inch.

From the above description, it will be apparent that we have invented a novel timing device. Although the form of the invention described herein constituted a preferred embodiment, it will be understood that changes may be made within the spirit of the invention limited only by the scope of the appended claims.

We claim as our invention:

1. A timing device, comprising:

(a) a cylindrical housing member having a chamber therein with first and second opposite open ends;

(b) a fluid restrictor assembly mounted in said first open end including a silicone rubber restrictor to restrict the flow of a gas from said chamber, a porous downstream filter mounted adjacent said open end to support said silicone rubber restrictor, and a porous upstream filter mounted adjacent said chamber to act as a preliminary filter and as a heat sink to absorb heat from a gas passing through said restrictor assembly;

(c) a carbon dioxide generator mounted in said chamber including a pellet of solid propellant material having a metal bridge wire mounted adjacent thereto;

(d) a pair of metal electrodes mounted in said housing member and connected to opposite ends of said bridge wire;

(e) means including pressure sensing means mounted in said chamber at said second end to seal said second open end and to provide an output indicative of the pressure in said chamber;

(f) means for impressing a voltage across said electrodes to heat said bridge wire and ignite said propellant material, said propellant material when ignited generating a known quantity of carbon dioxide to thereby increase the pressure in said chamber, said carbon dioxide flowing through said restrictor assembly at a controlled rate to decrease the pressure in said chamber; and

(g) means responsive to the output from said pressure sensing means to signal the time required for the pressure to decay to a predetermined level.

2. A timing device, comprising:

(a) a housing member having a cylindrical chamber therein with first and second open ends;

(b) a fluid restrictor assembly mounted in said first end including permeable restrictor means to restrict the flow of a gas therethrough and a downstream filter member mounted adjacent said open end to support said permeable restrictor means;

(c) gas generating means mounted in said chamber including a pellet of solid propellant material and a bridge wire;

(d) a pair of conductors mounted in said housing member and connected to opposite ends of said bridge wire;

(e) means including pressure sensing means mounted in said chamber at said second end to seal said second end and to provide an output indicative of the gas pressure in said chamber;

(f) means for impressing a voltage across said conductors to heat said bridge wire and ignite said propellant material, said propellant material thereby generating a known quantity of gas to increase the pressure in said chamber, said gas flowing through said restrictor assembly to decrease the pressure in said chamber; and

(g) means responsive to the output from said pressure sensing means to signal the time required for the pressure to decay to a predetermined level.

3. A timing device, comprising:

(a) a housing member having a chamber therein with first and second open ends;

(b) fluid restrictor means mounted in said first open end to restrict the flow of a gas from said chamber;

(c) a gas generator mounted in said chamber including a pellet of solid propellant material having a metal bridge wire mounted in close proximity thereto;

(d) a pair of electrodes mounted in said housing member and connected to opposite ends of said bridge wire;

(e) means for impressing a voltage across said electrodes to ignite said propellant material, said propellant material when ignited generating a known quantity of gas to thereby increase the pressure in said chamber, said gas flowing through said restrictor means at a controlled rate to decrease the pressure in said chamber; and

(f) means including pressure sensing means mounted in said chamber at said second end to seal said second open end and to provide an output indicative of the time required for the gas pressure in said chamber to decay to a predetermined level.

4. A timing device, comprising:

(a) a housing member having a chamber therein;

(b) a fluid restrictor assembly, mounted in an opening in said housing member, including permeable restrictor means to restrict the flow of a gas from said chamber and a downstream filter member to support said permeable restrictor means;

(c) gas generating means mounted in said chamber;

(d) means including pressure sensing means mounted in said housing member to provide an output indicative of gas pressure in said chamber;

(e) means for initiating said gas generating means to thereby generate a quantity of gas to increase the pressure in said chamber, said gas flowing through said restrictor assembly to decrease the pressure in said chamber; and

(f) means responsive to the output from said pressure sensing means to signal the time required for the pressure to decay to a predetermined level.

5. A timing device, comprising:

(a) a housing member having a chamber therein;

(b) fluid restrictor means mounted in said housing member to restrict the flow of a gas from said chamber;

(c) gas generating means mounted in said chamber including a pellet of solid propellant material;

(d) means including pressure sensing means mounted in said housing member to provide an output indicative of the time required for the pressure in said chamber to decay to a predetermined level; and

(e) means for igniting said propellant material, said propellant material thereby generating a known quantity of gas to increase the pressure in said chamber, said gas flowing through said restrictor means to decrease the pressure in said chamber.

6. A timing device, comprising:

(a) a housing member having a chamber therein;

(b) fluid restrictor means mounted in said housing member to restrict the flow of a gas from said chamber;

(c) gas generating means mounted in said chamber;

(d) means for initiating said gas generating means to thereby generate a known quantity of gas to increase the pressure in said chamber, said gas flowing through said restrictor means to decrease the pressure in said chamber; and

(e) means including pressure sensing means mounted in said housing member to provide an output indicative of the time required for the pressure in said chamber to decay to a predetermined level.

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