

Jan. 10, 1967

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3,296,969

TIME DELAY INITIATOR

Filed Oct. 14, 1964

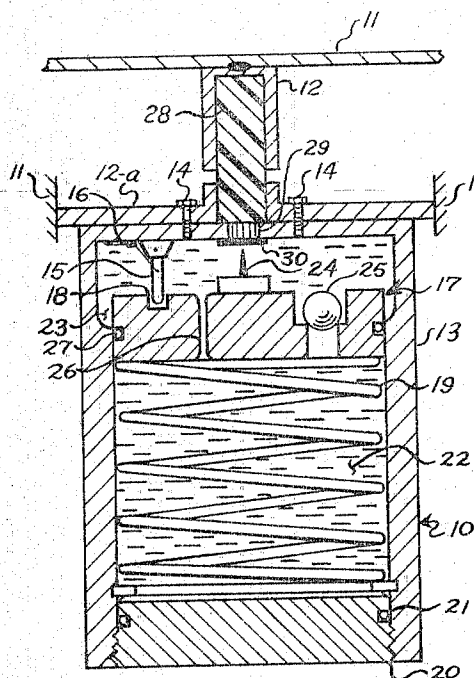


Fig. 1.

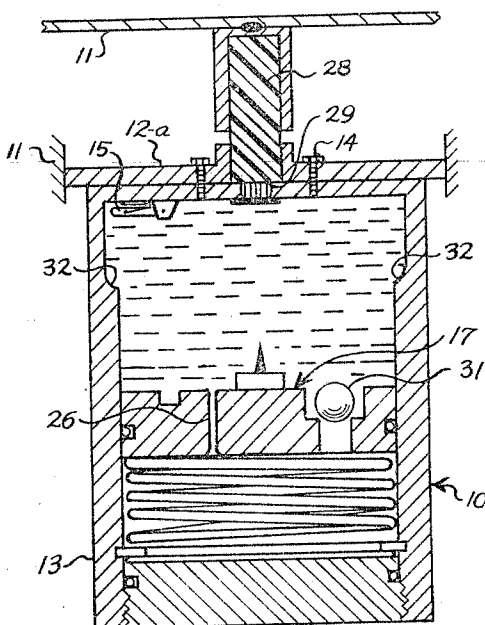


Fig. 2.

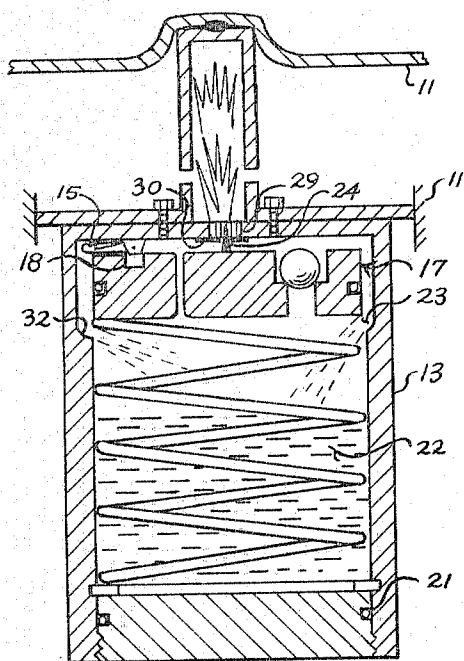


Fig. 3.

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1

3,296,969

## TIME DELAY INITIATOR

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Filed Oct. 14, 1964, Ser. No. 406,655  
7 Claims. (Cl. 102-82)

This invention relates to initiators for combustible material or pyrotechnic actuators and the like for use in missiles and other flying bodies, and more particularly, to initiators of this general character which incorporate a time delay means whereby ignition of the pyrotechnic is delayed for a predetermined period of time or until acceleration forces on the body carrying the device have diminished to very low levels or disappeared entirely. There are numerous devices now being used which utilize pyrotechnics to perform certain functions in a missile or flying body after initiation of combustion thereof by percussion caps or primers and the like, and these range from electrically fused explosive valves through shaped charges to solid combustible material containing gas generators. In the prior art operation is accomplished by a remotely applied signal after a predetermined time has elapsed after launching of a missile, artillery shell or other flying body. These devices are also utilized for example, to vent tankage by instantaneously exploding an opening therein, to initiate combustion in a rocket motor, especially a succeeding stage of a multi-stage missile, to separate stages by explosively shearing or destroying the outer shell thereof, and numerous other applications in mining and construction are within their scope of usefulness. In most instances, however, these prior art devices require costly, complex and/or sensitive electrical circuit components, timers and the like to accomplish their desired ends.

In this invention however, these disadvantages are overcome by the provision of a low cost, mechanical-hydraulic device which dispenses with all of the electrical circuits or components required for initiation of the pyrotechnic material utilized in prior art devices, and which, as an example, can initiate ignition of a second stage rocket motor in a multistage missile after a predetermined flight interval thereof has elapsed. Or, more specifically, after surcease of acceleration forces acting on the missile during its powered portions of flight.

It is, therefore, an object of this invention to provide an initiator which is contained in its own housing and wherein means is also incorporated to effect deflagration of a pyrotechnic material after launching in a flying body and after a predetermined portion of the flight path thereof has been traversed.

It is another object of this invention to provide a device of the type referred to wherein ignition of the pyrotechnic or explosive is initiated after undergoing or being subjected to the acceleration forces produced upon launching thereof in a rocket motor propelled missile.

It is a still further object of this invention to provide a device of the type referred to wherein a mechanical hydraulic time delay means is utilized in conjunction with a firing pin means to effect initiation of the pyrotechnic at the end of a predetermined time after launch.

Another object of the invention is to provide a device of the type referred to wherein hydraulic fluid contained in a housing is permitted to flow from one portion of the device to another under relatively free-flow conditions and pre-

2

vented from flowing in the opposite direction depending upon whether the device is subject to acceleration, zero acceleration or deceleration forces, and wherein a time delay interval in initiation of combustion of a pyrotechnic is provided by means of a metering orifice.

These and other objects will become more apparent from the description of the device which follows when viewed in conjunction with the drawing wherein:

FIGURE 1 is a schematic, sectional view of the invention illustrating the positions of its inner parts when at rest or in a "safe" or pre-launch condition;

FIGURE 2 is a view similar to FIG. 1 illustrating the positions of the inner parts of the invention when the device is "armed" and under the influence of vertical acceleration; and

FIGURE 3 is a view similar to FIGS. 1 and 2 illustrating the positions of the inner parts of the invention during zero acceleration and after initiation of firing of the pyrotechnic material contained therein.

Referring now to FIG. 1 there is shown a time delay initiator device 10 installed or attached to a portion of a missile body 11. Initiator device 10 is attached to body 11 by bolts 14 and collar 12-a shown in schematic form in the figures as being bolted to housing 13 although other means of attachment can be used and will occur to any skilled artisan using the invention. Housing 13, is, for purposes of description, a hollow cylinder having a removable bottom or end plate 20 threadably engaged thereto. Depending from the upper inner wall of housing 13 is a safety stop or limiting pin 15 mounted on spring-hinge 16 and held in the position shown in FIG. 1 by engagement thereof in a recess 18 in a firing pin assembly 17. Firing pin assembly 17 is mounted on, or otherwise supported by, a compressible, preloaded spring 19 positioned in housing 13 as shown. Spring 19 is itself supported by end plate 20 which incorporates an O-ring seal 21. Housing 13 is filled with a hydraulic fluid 22 for a purpose to be hereinafter described, and at its upper end provides a recess or by-pass 32 due to the enlarged inner diameter thereof, thereby providing an annular passage or by-pass 23 with pin assembly 17. Of course, guide means can be provided to prevent assembly 17 from tipping or skewing when cleared of the wall.

Firing pin assembly 17 is shown in FIG. 1 as a piston-like object and is its preferred form. Assembly 17, in addition to having a recess 18 for containing stop 15, comprises a ball check valve 25, a firing pin 24, O-ring seal 27 for permitting assembly 17 to slidably contact the inner surface of the vertical walls of housing 13, and a metering or time delay orifice 26.

Shroud or cup 12 is provided with means for attachment thereof to missile or flying body 11 (spot welding) and is also adaptable for receiving booster charge 28 which is formed therein of a combustible material or pyrotechnic.

The top wall of housing 13 in the central portion thereof is formed to receive and retain a primer or initiating device 29. A separating barrier 30 of plastic sheet or the like is placed over primer 29 to insure against contamination thereof by contact with fluid 22. Primer 29 is centrally positioned in the top most wall of housing 13 directly opposite and above firing pin 24. When finally assembled and installed on a flying body, device 10 is positioned with its vertical axis parallel to the direction of acceleration of the body.

For operation of the device, reference should be had to the drawing, and in particular to FIGS. 2 and 3.

In FIG. 2, pyrotechnic device 10 is shown undergoing acceleration as in a missile rising from a launching pad under rocket motor power. During this acceleration phase of the missile flight, firing pin assembly 17 is pressed against spring 19 compressing it to the position shown. Hydraulic fluid 22 flows through check valve 25 after unseating ball 31 therein. Pin assembly 17 in moving downward causes safety stop or limiting pin 15 to become disengaged from recess 18, and urged by its spring hinge 16 assumes the folded position shown in FIGS. 2 and 3. Hydraulic fluid 22 continues to flow to the upper side of firing pin assembly 17, being prevented from contacting the primer or initiator 29 by means of separating barrier, cover seal or disc 30. Leakage between pin assembly 17 and the vertical walls of housing 13 is prevented by O-ring 27, and to the exterior thereof by O-ring 21 in end plate 20. The spring constant of spring 19 is selected to insure the desired maximum distance between firing pin 24 and initiator or primer 29 as will become important from what follows.

At termination of its acceleration, missile 11 undergoes free or unaccelerated flight and spring 19 begins to urge pin assembly 17 to move upwardly with respect to housing 13. Thus, in FIG. 3 there is illustrated the result of this upward movement of pin assembly 17, which has now completed its upward movement. In undergoing this upward displacement, as indicated in FIGS. 2 and 3, the following sequence of events takes place. At the beginning of upward motion of pin assembly 17, ball 31 reseats and check valve 25 closes, preventing flow of hydraulic fluid 22 therethrough. Hydraulic fluid 22 is, therefore, forced to flow through time delay orifice 26. Because of the restriction provided by the relatively small size of orifice 26, firing pin assembly 17 rises in housing 13 in accordance with the flow rate of fluid 22 therethrough and the spring constant of spring 19. Near the end of the upward movement of pin assembly 17, however, the internal surface recess 32 in housing 13 forms annular by-pass 23 with the edges of assembly 17 and fluid 22 flows therethrough at a greatly increased rate. Resistance to the upward motion of firing pin assembly 17 abruptly decreases and firing pin 24 accelerates significantly to pierce cover 30 and detonate primer or initiator 29. Primer 29 on being detonated ignites, or otherwise initiates, deflagration of booster charge 28 pyrotechnic material. Depending, therefore upon the application of time delay device 10, as indicated in FIG. 3, and on whether charge 28 is an explosive, a hot gas generator, a shaped charge, or a rocket motor igniter, separation, partial destruction or simply a perforation in the wall or shell of missile 11 will instantly occur.

It is to be understood, therefore, that though booster charge 28 shown herein for illustration purposes as a simple explosive element, and that in operation will simply "blow" a hole in the missile it is installed in, many other devices are applicable hereto and are contemplated for use in this invention. Thus, charge 28 can be slow or fast burning gas generators used as power sources, shaped charges, remote high altitude explosion initiators, igniters for solid or liquid propellant rocket motors, valve actuators, tank venters and the like. This invention primarily is concerned with providing to the art a time delayed device of this type which performs as indicated and is easily manufactured, of extreme low cost, reproducibly operative and of high reliability.

It is, of course, obvious that a person of ordinary skill of the art to which this invention pertains, can from the description of the invention herein set forth, find other uses which will remain within its scope and spirit.

Therefore, having described the invention and its several parts, and its operation, it is to be understood that no undue limitations are to be placed thereupon except as provided by the subtended claims.

What is claimed is:

1. A device for initiating a deflagration in a combustible charge wherein said initiation is delayed for a predetermined time interval said device subjected to vertical acceleration in a flying body comprising, a walled housing, a quantity of hydraulic fluid in said housing, a compression spring in said housing, a removable fluid sealed end plate threadably engaged in the bottom of said housing for supporting said spring, a firing pin assembly supported on said spring in said housing for compressing said spring when said device is subjected to vertical acceleration comprising a firing pin, a check valve, and a hydraulic time delay means, a limiting pin swiveled on the upper, inner wall of said housing, said limiting pin engaging said pin assembly prior to acceleration of said device and disengaging therefrom when said device is accelerated, primer means in said housing upper wall for initiating a deflagration in said charge upon contact by said firing pin, and a cup-like shroud mounted on said housing for containing said charge, said shroud adaptable for installing said device in a flying body.

2. A device for causing a deflagration in a combustible charge including a cylindrical housing having vertical walls of decreasing thickness in the upper portions thereof and a removable fluid sealed bottom cap for securing a time delay in initiating combustion in a deflagration device comprising, a compressible spring in the housing supported by said cap, a firing pin assembly mounted on said spring, a spring hinged, rotatable safety stop mounted in said housing engaging said pin assembly, said safety stop adapted to disengage from said pin assembly upon downward motion thereof, a container for said charge attached to said housing and adaptable for mounting in a flying body, means for initiating combustion of said combustible charge, means on said pin assembly for percussively detonating said initiator means, hydraulic fluid sealingly contained in said housing, means in said pin assembly for permitting free flow of hydraulic fluid by said pin assembly in at least one direction, and flow restrictor means in said pin assembly whereby said pin assembly is urged upwardly by said compressible spring at a controlled rate for a portion of its travel and increasing rapidly thereafter for the remainder of its travel.

3. The device of claim 2 wherein the one-way free flow means is a ball check valve.

4. The device of claim 2 wherein the time delay means is a flow metering orifice.

5. The device of claim 2 wherein the means for permitting increased rate of travel of said firing pin assembly after completion of said timed delay is an annular recess defined by said thinner upper housing wall and said pin assembly peripheral edges.

6. The device of claim 2 wherein the combustible charge is in the form of shaped charge.

7. A time delay initiating device for causing a separation of portions of a missile comprising, a cylindrical housing hydraulic fluid in said housing, a bottom plate threadably engaged in said housing comprising an O-ring seal, a compression spring mounted on said bottom plate in said housing, a firing pin assembly mounted on said compression spring comprising a check valve, a metering orifice, a peripheral O-ring slidably contacting the interior of said cylindrical housing, and having a recess in the upper surface thereof a spring hinged safety stop depending from the inner surface of the upper wall of said housing, said safety stop extendable from said upper, inner wall with its opposite end engaging said firing pin assembly recess for preventing further upward motion of said firing pin assembly and adaptable to be disengaged from said firing pin assembly recess upon downward movement thereof, a firing pin centrally positioned on said firing pin assembly, an initiator centrally mounted in the upper wall of said housing opposite said firing pin, a cup-like container attached to the top of said housing defining a substantially cylindrical space therewithin, combustible material in said

5

cylindrical space, means for attaching said container to said missile for separating said missile portions upon operation of said time delay initiator, and means within said housing inner walls defining an annular space between said inner wall and said firing pin assembly outer periphery.

## References Cited by the Examiner

## UNITED STATES PATENTS

|           |         |          |        |    |
|-----------|---------|----------|--------|----|
| 1,309,770 | 7/1919  | Newell   | 102—82 |    |
| 1,356,828 | 10/1920 | Rockwell | 102—78 | 10 |

6

|           |         |        |            |
|-----------|---------|--------|------------|
| 1,845,167 | 2/1932  | McGrew | 188—88.506 |
| 2,389,856 | 11/1945 | Jones  | 200—34     |
| 2,938,463 | 5/1960  | Jasse  | 102—71     |
| 2,959,001 | 11/1960 | Porter | 102—70 X   |
| 2,977,882 | 4/1961  | Jasse  | 102—82 X   |

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