April 11, 1961 P. OKSTEIN ET AL 2,978,983

MECHANICAL TIMING DEVICE

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FIG.1.

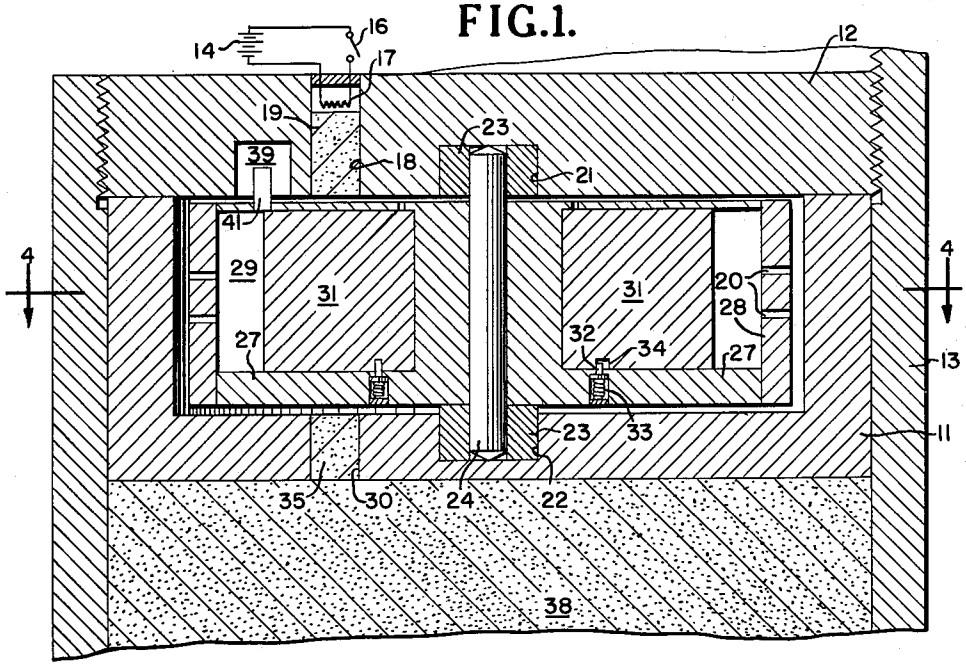
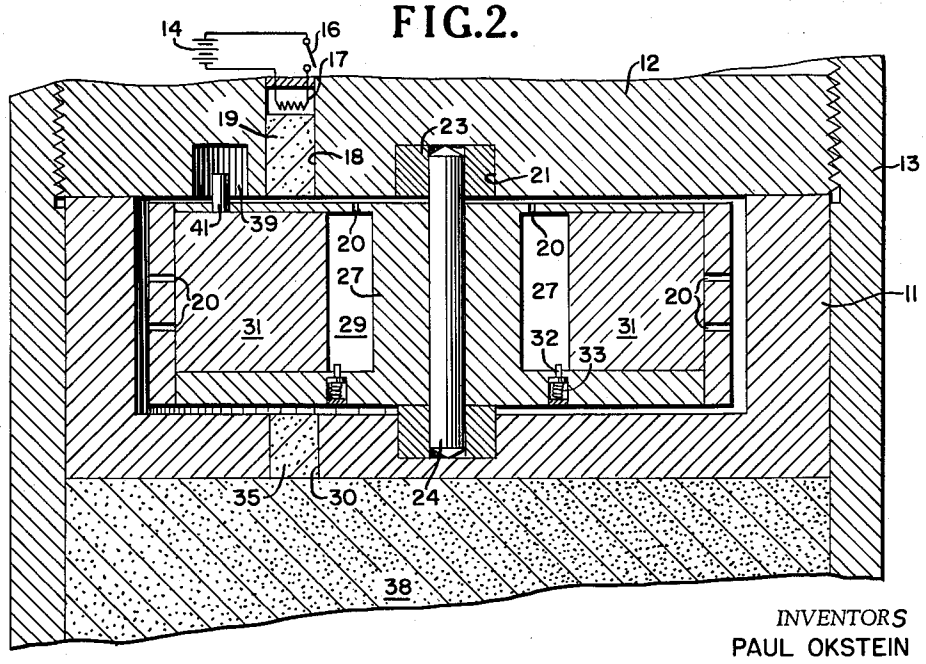


FIG.2.



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FIG.3.

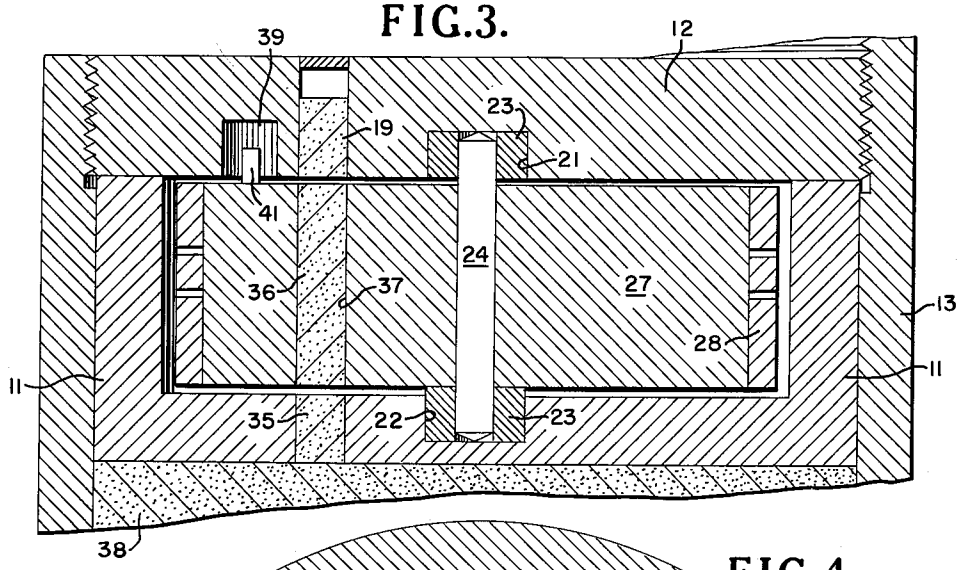
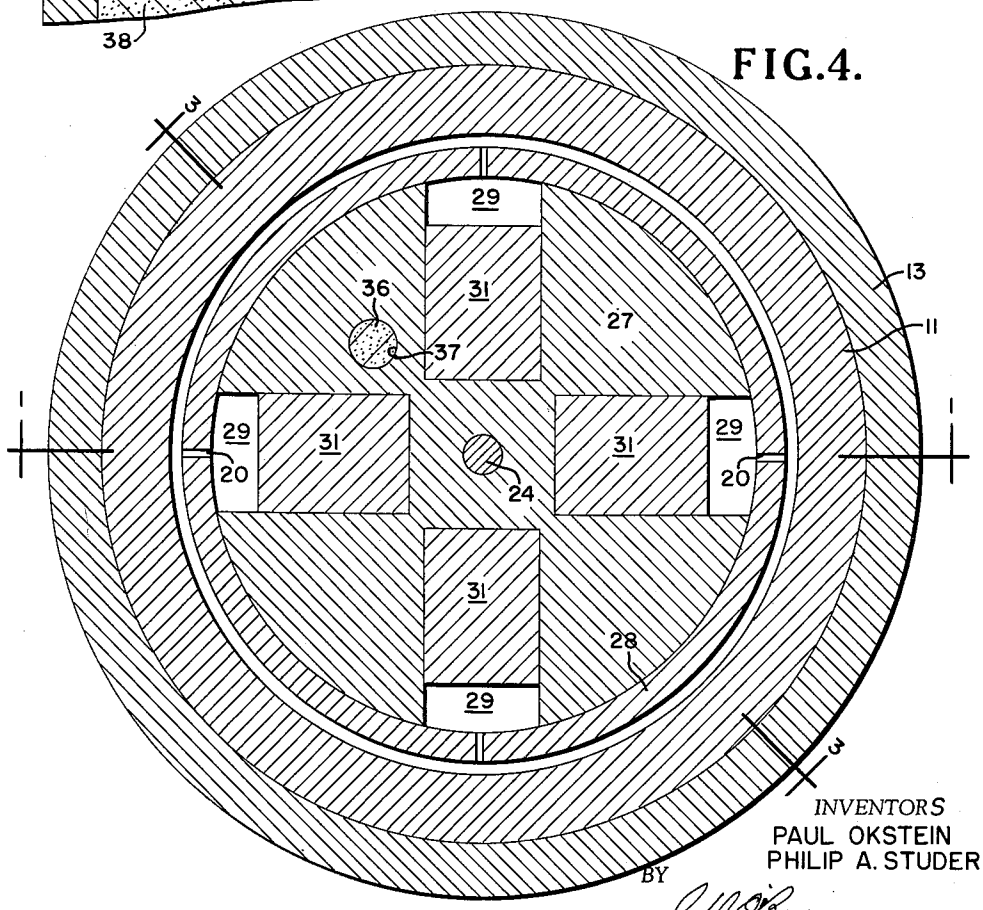


FIG.4.



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MECHANICAL TIMING DEVICE

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2 Claims. (Cl. 102—79)

This application relates generally to mechanical timing devices and more particularly to an inertia device for arming or firing a projectile.

It is an object of this invention to provide a timing mechanism for use in ordnance that possesses dependability of action and is completely safe during handling and storage.

Another object of this invention is to provide a mechanism for arming a projectile as soon as it has travelled a given distance from the launcher.

Still another object is the provision of a fuze timing mechanism for incorporation into an ordnance projectile or the like which mechanism is simple and of rugged construction.

Yet another object is the provision, in a mechanical timing device for a projectile of a rotary member having a moment of inertia which is altered by the spin of the projectile thereby providing a predetermined time delay.

An additional object of this invention is the provision of a rotating member carrying a portion of a fuze powder train of a bomb or projectile, the member being adapted to rotate with respect to the projectile housing to align the fuze train in active detonating relation at a predetermined time after the projectile is fired.

A further object of this invention is the provision of a rotatable shaft or rotor within a rotating ordnance projectile so that the difference between rotational velocity of the rotor and the remainder of the projectile produces a displacement between the shaft and the member in a given interval of time. This rotational displacement is utilized to bring a member of a chain of charges into alignment, make or break an electrical circuit, or act as a trigger to release other mechanism.

Older methods of accomplishing a time delay in the arming or detonation of an explosive projectile utilize unbalanced rotors which turn due to centrifugal force. Other types employed balls moving radially outward in spiral grooves to exert a torque on an internal shaft thereby turning it.

These methods were subject to the disadvantage that complex gear trains and escapement mechanisms were necessary to achieve the required rotational velocity, and in the case of the balls moving in the spiral grooves, complex machining operations were necessary to produce the spiral grooves.

Generally the apparatus of this invention includes a shaft free to rotate and disposed within a rotating casing, and carrying a plurality of weights which are releasably secured near the rotational axis of the shaft until the projectile is fired. The weights when released from their initial position near the rotational axis travel radially outward due to the centrifugal force acting upon them, until they reach a retaining ring which halts their outward movement. This outward displacement changes the moment of inertia of the shaft and weights assembly and decreases its rotational velocity thereby causing it to turn relative to the casing. This motion is utilized to rotate something at a particular velocity, move something

into a particular position, trigger a secondary mechanism after a definite period of time, or make or break an electrical circuit after a definite time.

The operation of this invention will be more readily understood when the following specification is read in conjunction with the attendant drawings wherein like numerals designate like or similar parts throughout the several views and in which:

Fig. 1 is a longitudinal section of a typical inertia timing mechanism disposed within a projectile or shell and shown in the unarmed position;

Fig. 2 is a longitudinal section of the inertia timing mechanism of Fig. 1 showing the apparatus in the intermediate position;

Fig. 3 is a longitudinal section taken along line 3—3 of Fig. 4 and showing the inertia timing mechanism in the final or armed position; and

Fig. 4 is a section taken along line 4—4 of Fig. 1.

Referring now to the drawings in more detail, it is seen that the inertia timing assembly is composed of a casing 11 and an adapter plate 12 threadedly secured into a projectile indicated generally at 13. Also disposed within the projectile 13 is a fuze shown schematically as a battery 14 and a switch 16 serially connected across a resistor 17 fitted within an open ended bore 18 in adapter plate 12. A quantity of primer explosive 19 is also disposed within this bore for initiation upon closing of the switch 16.

A pair of aligned recesses 21 and 22 are formed within adapter plate 12 and casing 11 respectively to provide a seat for bearings 23. Rotatively disposed in these bearings is the rotor shaft 24 which is preferably mounted concentrically with respect to the axis of spin or rotation of projectile 13 so that upon firing of the projectile the shaft 24 tends to rotate at the same speed as the projectile. Accordingly, there is no initial relative motion between the casing 11 and adapter plate 12 on the one hand and shaft 24 on the other.

Disposed within an appropriate recess 26 in casing 11 is a perforated rotor 27 having a perforated ring 28 secured to its outer periphery and which is fixed to shaft 24 for rotation therewith. A plurality of inertia weights 31 are disposed within the guideways 29 formed in rotor 27 at equi-angular intervals to prevent dynamic unbalance of the system when the projectile rotates as it moves through the air.

A plurality of setback pins 32 are disposed in the rearward end of the recessed portion of rotor 27 and are urged forwardly by a soft biasing spring 33. These pins normally project into guideways 29 and fit into appropriate recesses 34 in the inertia weights 31 to prevent them from flying radially outward and prematurely arming the projectile.

Disposed in the lowermost portion of casing 11, in alignment with primer 19 in adapter plate 12 is a bore 30 containing a quantity of explosive lead 35, while a quantity of detonator explosive 36 is disposed within the through bore 37 formed in the rotor 27 so that when the explosives 35, 36 and 19 are mutually aligned, firing of the primer 19 will initiate the main charge indicated at 38. A blind arcuate groove 39 is formed in the rearward surface of adapter plate 12 while a projecting finger 41 is fixed to the rotor 37 for movement within this groove. Accordingly, the rotation of rotor 27 with respect to casing 11 is limited by the length of groove 39 which length is selected so that when the finger 41 reaches the end of the groove, primer 19, lead 35 and detonator 36 are in alignment.

Operation

Figs. 1 through 3 show the sequence of operation of this device from the unarmed position to the armed position. Prior to firing, the setback pins 32 are disposed within the

recesses 34 in the respective inertia weights 31 to restrain outward movement of these weights. The setback force produced by firing of the projectile urges pin 32 rearwardly against the biasing force of spring 33, withdrawing the pins from inertia weights 31 allowing the weights to move radially outward in the respective guide portions 29 of rotor 27. The perforations 20 in the rotor permit the air in the rotor to be instantaneously redistributed to prevent undue cushioning of weights 31 as they move outwardly.

Prior to the commencement of the radial outward movement of the inertia weights, shaft 24 and rotor 27 rotate at the same speed as the rotation of the projectile so that there is no relative rotation between the shaft 24 and the remainder of the assembly. However, upon radial outward movement of inertia element 31 the moment of inertia of the rotor increases. Since the product $I\omega$ [moment of inertia $\times$ angular velocity prior to outward movement of elements 31] must equal the product $I_1\omega_1$ [moment of inertia $\times$ angular velocity after movement of weights 31] due to the law of conservation of momentum and since I_1 is greater than I, ω_1 must become less than ω. In other words, when the inertia weights are in their radially outwardmost position, the angular velocity of the rotor shaft 24 and rotor 27 decreases. Although the inertia weights are relatively heavy with respect to the rotor and rotor shaft, compared to the total weight of the shell or projectile the weights are relatively insignificant. Accordingly, the angular rotational velocity of the shell is not materially altered by the change in inertia of the timing assembly.

Since the rotor 27 is now rotating at a different speed than the remainder of the casing 11, the shaft 24 begins to rotate within the casing until the finger 41 reaches the end of the blind arcuate groove 39 thereby preventing further relative motion between the rotor and casing 11. At this time the detonator explosive 36 in the rotor is brought in alignment with the lead 35 and the primer 19. Accordingly, when switch 16 is closed, the main explosive charge 38 will be ignited by the now continuous powder chain. The rotating finger 41 itself may also be used to break or make an electrical contact as it moves through groove 31 to provide an optional method of electrically arming the projectile if it is so desired.

Although we have described this invention with reference to but one particular embodiment it is not to be construed as so limited but is susceptible of many alterations and modifications. Accordingly, the scope of the invention disclosed herein is to be determined by the scope of the appended claims only.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An inertia time delay mechanism for use in a projectile comprising; a hollow casing affixed within the projectile for rotation therewith, a shaft rotatably disposed within said casing, a balanced rotor having a plurality of radial guideways therein and affixed to said shaft, a pair of mutually aligned detonating elements disposed within said casing and initially mutually separated by said rotor, a plurality of inertia weights each slideably disposed within a respective guideway in said rotor in a manner to maintain substantial balance of the rotor and to promote initial conjunct rotation of the rotor and the casing, said inertia weights being slideable radially outwardly upon rotation of said projectile, thereby to change the moment of inertia of said shaft and said rotor to effect relative movement between said rotor and said casing, means disposed within said rotor adapted to operatively connect said detonating elements in said casing upon a predetermined movement of said rotor relative to said casing.

2. An inertia time delay mechanism for use in a spinning projectile comprising; a hollow casing having a blind internal groove therein disposed within said projectile, a shaft rotatably disposed within said casing along the axis of spin of said projectile, a rotor having a plurality of radial guideways therein affixed to said shaft, a pair of detonating means disposed within said casing and mutually separted by said rotor, intertia means disposed within the guideways in said rotor for freely sliding radial outward movement upon spinning of said projectile thereby changing the moment of inertia of said rotor to decrease the speed of rotation of said rotor and effect continuous relative rotational movement between the rotor and said casing, the relative rotational movement continuing after the radial outward movement of said inertia means ceases, stop means fixed to said rotor and operatively disposed within the groove in said casing to limit rotation between said rotor and said casing to a predetermined amount, means disposed within said rotor and adapted to provide an explosive connection between said pair of detonating means upon the predetermined movement of said rotor relative to said casing.

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