May 28, 1963 HIROSHI ONO 3,091,178

I.R. DETONATOR

Filed Nov. 15, 1960 2 Sheets-Sheet 1

FIG. 1

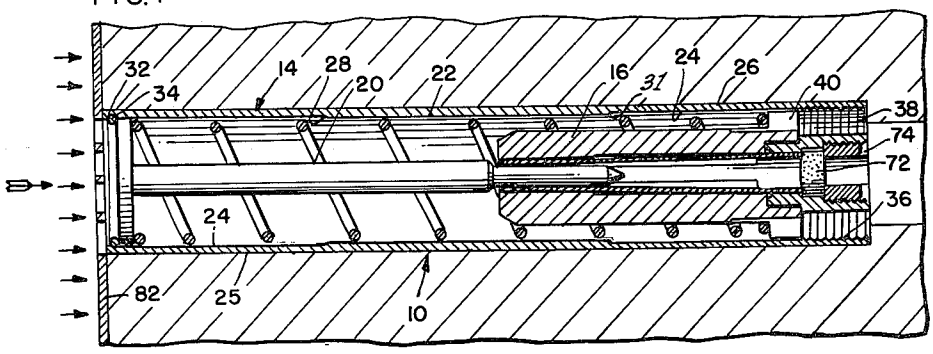


FIG. 1a

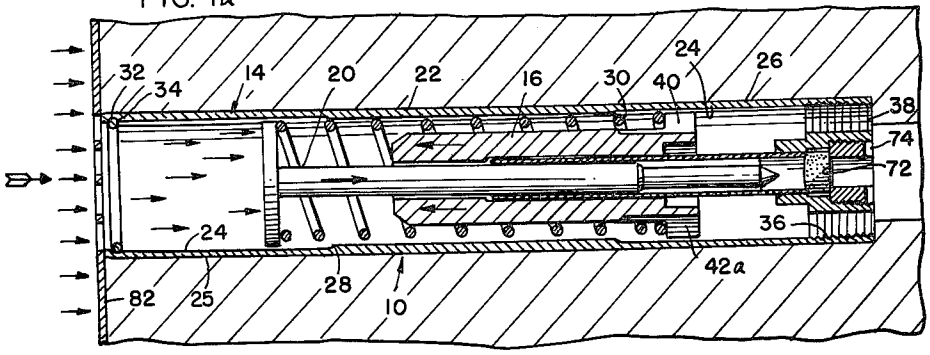
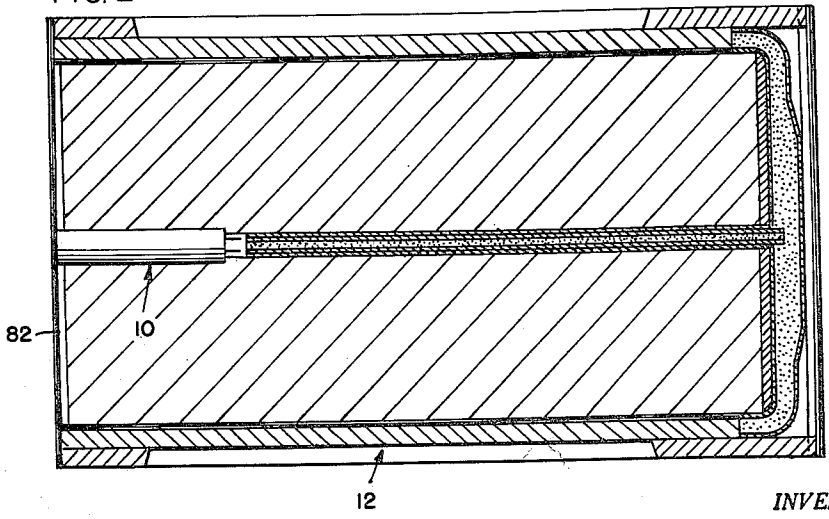


FIG. 2



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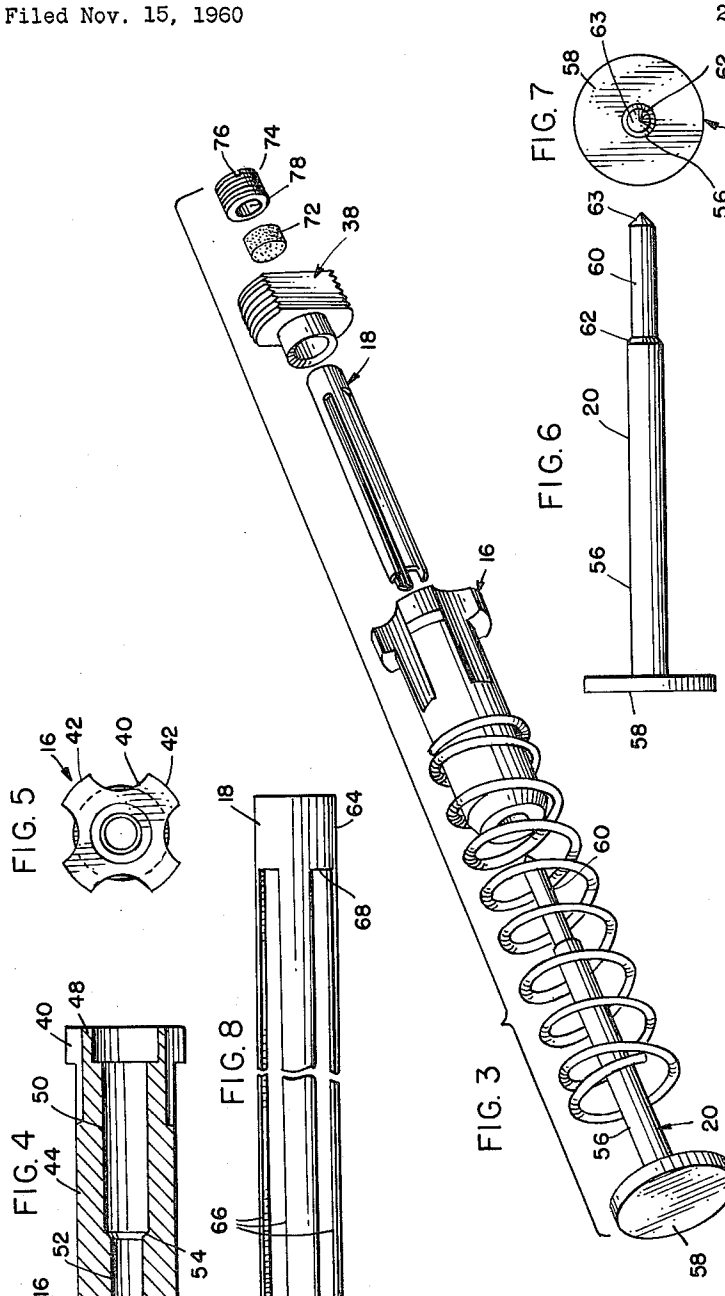
Filed Nov. 15, 1960 2 Sheets-Sheet 2



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3,091,178

I. R. DETONATOR

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6 Claims. (Cl. 102—70)

This invention relates in general to detonating devices and more particularly to a detonating device for projectiles that are ejected by a fluid force.

Heretofore, difficulty has been experienced by conventional detonating devices in that projectiles have been accidentally actuated because of striking, vibration or movement of the detonating device. Several unsuccessful safety precautions have been taken to protect these detonating devices, such as, shock mounting and protective covers and complete protective insulation or padding for the entire projectile to name but a few.

The detonating device of this invention finds its greatest utility in infra-red projectiles to be ejected from aircraft to aid in aerial photography and illumination of targets. In addition, the detonating device also finds extensive use in signal devices, fireworks, sighting devices and targets for thermal sensing devices.

To overcome the inherent danger of explosive and burning projectiles prior to and during actual use thereof, the detonating device of this invention is constructed to eliminate the possibility of accidental actuation, characteristic of conventional detonating devices, by requiring two independent forces to act simultaneously on the detonating device to effect actuation of the projectile.

It is therefore the primary object of this invention to provide an improved detonating device for projectiles ejected by a fluid force that eliminates the shortcomings of prior similar detonating devices and affords maximum safety prior to and during use of the projectiles.

A specific object of this invention is to provide an improved detonating device for projectiles ejected by a fluid force which requires two independent forces acting simultaneously to effect actuation thereof which arms and detonates the projectile at the time the projectile is fired.

Another object of this invention is to provide an improved detonating device for projectiles ejected by a fluid force which requires no additional safety devices to prevent accidental actuation thereof prior to and during use of the projectile.

A further object of this invention is to provide an improved detonating device for projectiles ejected by a fluid force which is automatically actuated by the inertia of a component part thereof as the projectile is being ejected.

A still further object of this invention is to provide an improved detonating device for projectiles ejected by a fluid force whereby actuation is effected by the force utilized to eject the projectile.

Another object of this invention is to provide an improved detonating device for projectiles ejected by a fluid force requiring acceleration of the projectile and fluid force of ejection to effect actuation of the detonating device.

A still further object of this invention is to provide an improved detonating device for projectiles ejected by a fluid force which is rugged in construction, efficient in its purpose and use and inexpensive to manufacture.

These being among the objects of the present invention, other and further objects will become apparent to those skilled in the art, from the following descriptions and drawings relating thereto in which:

FIG. 1 is a cut-away partially sectioned view in side elevation illustrating the detonating device in the normal position prior to ejection of the projectile;

FIG. 1*a* is a cut-away sectioned view in side elevation illustrating the detonating device prior to detonation as the projectile is being ejected;

FIG. 2 is a cut-away partially sectioned view in side elevation of an infra-red flare package showing the relationship of the detonating device of this invention thereto;

FIG. 3 is an exploded view in perspective illustrating the relationship of the component parts of the detonating device;

FIG. 4 is a sectional view in side elevation of a slide member thereof;

FIG. 5 is an end view of the slide member of FIG. 4;

FIG. 6 is a view in side elevation of a firing pin thereof;

FIG. 7 is an end view of the firing pin illustrated in FIG. 6;

FIG. 8 is a view in side elevation of a collet member thereof;

FIG. 9 is an end view of the collet member illustrated in FIG. 8;

FIG. 10 is a sectional view in side elevation of a retainer plug thereof;

FIG. 11 is an end view of the retaining plug illustrated in FIG. 10;

FIG. 12 is a view in side elevation of a primer retainer; and

FIG. 13 is an end view of the primer retainer illustrated in FIG. 12.

By way of generalization for a better understanding of the detailed description to follow, the embodiment of the detonating device of this invention has been illustrated in the drawings as applied to an infra-red flare projectile. A projectile of this type is quite frequently used in aerial photography and may be readily ejected from an aircraft by a fluid force, preferably compressed air. It is in coordination with the ejection of the projectile in which the novelty of the detonating device of this invention is found. The fluid force used to eject the projectile from the aircraft is also utilized as one of the two forces required to actuate the detonating device.

Detonating Device Structure

Referring now to the drawings, more specifically to FIGS. 1, 1*a*, 2 and 3, the detonating device of this invention is indicated generally by the numeral **10** and is illustrated as installed in a projectile **12**.

The detonating device **10** is made up of four major components, a housing **14**, a slide member **16**, a collet **18** and a firing pin **20**. The housing **14**, preferably formed from steel, is cylindrical in contour and provides a central portion **22** having an internal diameter substantially less than the internal diameter at **24** of end portions **25** and **26**. Shoulders **28** and **31**, formed by the variation of internal diameters, provide travel limit stops for the collet **18** and firing pin **20** as will be thoroughly understood from the operational description to follow. End portion **25** provides an internal groove **32** for receipt of a snap lock ring **34** to limit the travel of the firing pin **20** in the other direction after it has been installed. The other end portion **26** provides internally threaded portion **36** at its extremity for receipt of an externally threaded plug member **38** which is relief flattened at **38***a* for the free passage of air.

The slide member **16** is an inertial member and referring more specifically to FIGS. 4 and 5, is preferably formed from a stainless steel and provides a guide flange **40** at one end having four equally spaced tips **42** which mate in sliding contact with the internal surface of end portion **26** of housing **14** and define between their exhaust ports **42***a* for air pressure developed between the piston **58** and the slide members **16**. A cylindrical body portion **44** of the slide member, outside diameter thereof substantially reduced from the internal diameter of center por-

tion 22 of the housing, has the extremity thereof beveled as at 46. The slide member has the internal portion thereof bored to form three sections of varied concentric internal diameters. In upper section 48, at the end of the slide member having the flange portion thereon, has the largest internal diameter to engage therein the retaining plug 38. A center portion 50 has an internal diameter substantially reduced from the internal diameter of upper section 48 and a lower section 52 has an internal diameter substantially reduced from the internal diameter of center section 50. The shoulder formed between center section 50 and lower section 52 is bevelled as at 54.

Referring now to FIGS. 6 and 7, the firing pin 20, preferably formed from stainless steel, provides an elongated cylindrical portion 56 telescopically guided by the slide member and with an enlarged flange or piston portion 58 integrally formed at one end. The cylindrical portion 56 has a portion 60 adjacent the extremity thereof substantially reduced in diameter with the shoulder formed therebetween bevelled as at 62. The outer extremity of portion 60 forms a conical tip 63 which engages the primer as will be described later. The outside diameter of cylindrical portion 56 is substantially less than the internal diameter of section 52 of slide member 16 to permit reciprocation of the firing pin therein.

Referring now, more specifically to FIGS. 8 and 9, the collet 18, preferably formed from stainless steel, is substantially cylindrical in contour and provides a base portion 64 having a plurality of spring fingers 66 extending up from and integrally formed therewith. A shoulder 68 is formed between the base portion 64 and finger 66 which seats on an internal shoulder 70 of the retainer plug 38. Each of the spring fingers are designed to have a thickness so that if they are disposed in the center section 50 of the slide member the cylindrical portion 56 of the firing pin will readily slide therebetween and if disposed in the smaller internal diameter lower section 52 the portion 60 of the firing pin 20 will readily slide but prevents the firing pin from movement past the shoulder 62. The advantages and function of this dimensional relationship between the slide member 16, the collet 18 and the firing pin 20 will be more clearly understood as the description continues.

Assembly of the Detonating Device

Referring now to all the drawings and more specifically to FIG. 3, the housing 14 is formed to the proper length which will vary, depending on the type of projectile to be used, so that the extremity of the end portion 24 will preferably be at the same elevation as the outer surface of the projectile. The collet 18 is positioned within the retainer plug 38 with shoulder 68 of the collet engaging internal shoulder 70 of the plug 38. A primer 72, being any suitable conventional primer, is positioned within the base portion 64 of the collet and secured therein by a retainer 74, best illustrated in FIGS. 12 and 13. Retainer 74, having a slot 76 across the end thereof, threadably engages in the plug 38, to hold the primer in position and also provide a central opening 78 therethrough for passage of the explosive charge to ignite the powder of the projectile. The plug 38 is then secured into the end portion 26 of the housing by threadably engaging the threads 36 therein.

The slide member 16 is then slid into the housing, through end portion 24, with spring finger 66 entering into the lower section 52 thereof as the slide member seats on the plug 38. To retain the slide member in the seated position as just described, compression spring 30 is inserted into the housing, encircling the slide member and has one end bearing against the under surface of the flange portion 40.

The firing pin 20 is then inserted with the end portion 60 sliding within the lower section 52 of the slide member 16 with the extremities of the spring fingers 66 positioned therebetween. The firing pin will be limited in its inward movement as the ends of the spring fingers engage the should 62 while at the same time the other end of compression spring 30 will seat against the piston portion 58. The snap lock ring 34 is then disposed in groove 32 to prevent removal of the firing pin to complete the assembly.

The assembled detonator is then mounted in the projectile and secured in position by a perforated cover plate 82 which may be suitably secured to the outer surface of the projectile by any suitable means such as holding screws (not shown).

Operation of the Detonating Device

The detonating device having been properly installed in the projectile, a plurality of the projectiles are positioned in a suitable fluid pressure operated ejecting mechanism. As the projectiles are positioned for ejection, the component parts of the detonating device, as just described, are positioned as shown in FIG. 1.

As the fluid force, preferably air pressure, is released from the ejecting mechanism to eject the projectile, the pressure will act on the entire exposed end surface of the projectile as illustrated by the several arrows in FIG. 1. As the projectile starts to accelerate, the inertia of slide member 16 will force it in a rearwardly direction compressing spring 30. When slide member 16 has moved rearwardly to a point where the internal shoulder 54 thereof passes the extremities of spring fingers 66, the fingers will expand outwardly against the internal surface of section 50 of the slide member. The firing pin is now free to move on through the slide member and the air pressure of ejection acting against the piston portion 58 will drive the firing pin forward as shown in FIG. 1*a*; the tip portion 63 striking the primer 72 with sufficient force to cause detonation.

From the foregoing operation description it is now obvious that to effect detonation of the projectile by the detonating device of this invention, two variables must be present and acting simultaneously, namely acceleration of the projectile to cause the slide member to move rearwardly to release the firing pin and pressure acting on the piston portion of the firing pin to drive it forward into contact with the primer. Moreover, given a predetermined ejection pressude, by varying the weight of the slide member 16 with respect to the effort of the spring 30 the time at which the detonation occurs during acceleration can be varied to some degree.

To those skilled in the art, it is readily apparent how the objects and advantages of the detonating device of this invention are attained and that accidental detonation of the projectile during storage, shipment, handling and assembly is virtually impossible since the combination of the two required variables will never occur together in the magnitude required to set off the device unless actually ejected as described.

Throughout the specification and drawings, various constants have been set forth for the purpose of illustration. These constants may be varied, especially if compensatory changes are made in other parts of the device. Although a preferred embodiment of the invention has been shown and described herein, various uses, modifications and changes may be made without departing from the spirit and substance of the invention, the scope of which is commensurate with the appended claims.

I claim:

1. A detonating device for projectiles ejected by a fluid under pressure comprising:

a housing defining a cylinder receiving a portion of said fluid under pressure,

a primer secured within the housing,

a piston driven by ejecting fluid under pressure having a firing pin and being slidable in said cylinder from a retracted position to a position striking the primer with the firing pin to start the primer,

latch means normally holding the piston and firing pin in said retracted position,

inertia means movable from its resting position responsive to acceleration of said housing in a direction axially of said cylinder for actuating said latch means to release said piston and firing pin for engagement with said primer as driven by the ejecting fluid under pressure, and resilient means disposed between the piston and the inertia member to urge said piston and inertia member to their respective resting position.

2. A detonating device for projectiles ejected by a fluid under pressure comprising:

a housing defining a cylinder open at one end to said fluid under pressure,

a piston comprising a head slidable in said cylinder adjacent said one end to be driven towards the other end by fluid under pressure and a rod having a shoulder extending towards said other end and terminating in a firing pin,

a primer secured within the other end of the housing in alignment with said rod,

stop means for engaging said shoulder and normally urged out of said engagement,

inertia means in its resting position normally holding said engaging means in engagement with said shoulder and under acceleration of said housing movable towards said piston head to release said engagement,

and means interconnecting said piston and inertia member to urge said piston away from said primer and said inertia means to maintain its resting position whereby said fluid under pressure accelerates said housing to move said inertia means to release said shoulder releasing means and to drive the piston when so released into engagement with said primer to effect an ignition of the projectile.

3. A detonating device for projectiles ejected by fluid under pressure comprising:

a housing defining a cylinder open at one end, to said fluid under pressure,

a piston in said housing comprising a head adjacent said one end slidable in said cylinder and a rod driven by said head having a shoulder extending away from said one end and terminating in a firing pin,

a collet secured within the housing having a spring finger extending along said rod and releasably engaging said shoulder in sliding relationship therewith,

a primer secured in the other end of said housing in alignment with said rod, an inertia member disposed within the other end of the housing and slidably engaging said rod and collet in mutually supported relationship with one end thereof in sliding relationship with the housing and with its other end in sliding relationship with said piston and finger at said shoulder,

and bias means disposed between said piston and inertia member yielding to inertial movement of said inertia member to release said engagement between said finger and shoulder,

said firing pin being driven by the fluid under pressure against said piston into contact with the primer as the projectile is accelerated by said fluid under pressure whereby ignition of the primer is effected immediately after said projectile is set in motion by said fluid under pressure.

4. A detonating device for projectiles ejected by a fluid under pressure comprising:

an elongated housing defining a cylinder open at both ends,

piston means having a head slidable in said cylinder at one end thereof and a rod extending away therefrom,

a collet supported in said housing remote from said piston and having a plurality of spring fingers thereon extending along said rod in mutually supported relationship,

a primer secured in alignment with said collet and rod by a retaining member having an opening therethrough,

said piston having a shoulder thereon engaged by said fingers and said rod terminating in a firing pin adapted to engage said primer,

inertia means movable under acceleration of said housing from a position maintaining said engagement between said fingers and shoulder to a position releasing said engagement,

and yielding means disposed between said piston and inertia means to maintain them in spaced relationship until said fluid under pressure accelerates the projectile to thereby move said inertia means and drive the firing pin into contact with the primer to effect ignition of the projectile.

5. A detonating device for projectiles ejected by a fluid under pressure comprising:

a housing defining cylinder exposed to fluid under pressure at one end,

a primer secured within the housing,

a piston slidable in said cylinder subjected to said pressure and having a firing pin driven thereby to strike the primer,

latch means normally holding the firing pin out of engagement with said primer,

inertia means freely slidable in said cylinder and responsive to acceleration of said housing by said fluid under pressure for releasing said latch means and said firing pin,

and means interengaging the piston and the inertia member urging them in opposition to said fluid pressure and acceleration, respectively.

6. A detonating device for projectiles ejected by a fluid under pressure comprising:

an elongated housing defining a cylinder open at one end to said fluid under pressure,

an inertia member movable in said housing towards said one end and comprising a slide element having an opening therethrough with the portion thereof adjacent said one end having a reduced internal diameter,

a collet having an open end secured within the other end of the housing having a plurality of spring fingers at its other end normally defining an internal diameter substantially equal to said reduced diameter, said fingers extending in sliding relationship, through a portion of said opening and being deflected inwardly by said reduced diameter of said portion,

a primer secured at said open end of the collet in alignment with said opening,

a firing pin disposed within the other end of the housing having a piston portion thereof exposed to said fluid under pressure and disposed in sliding relationship with the cylinder, said firing pin having a portion telescoping in sliding relationship within said slide element and an end portion of reduced diameter defining a shoulder abutting said depressed fingers and a portion slidable within said fingers,

and bias means between said inertia member and said firing pin maintaining spaced relationship therebetween until said fluid under pressure accelerates the projectile to cause said inertia member to move in a direction opposite the direction of ejection to release said spring fingers to clear said shoulder and thereby release the firing pin to respond to said fluid under pressure and be driven thereby into contact with the primer to effect actuation of the projectile.

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