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2,737,890

SAFETY UNIT FOR EXPLOSIVE DEVICES

Filed Nov. 9, 1942

2 Sheets-Sheet 1

FIG. 1

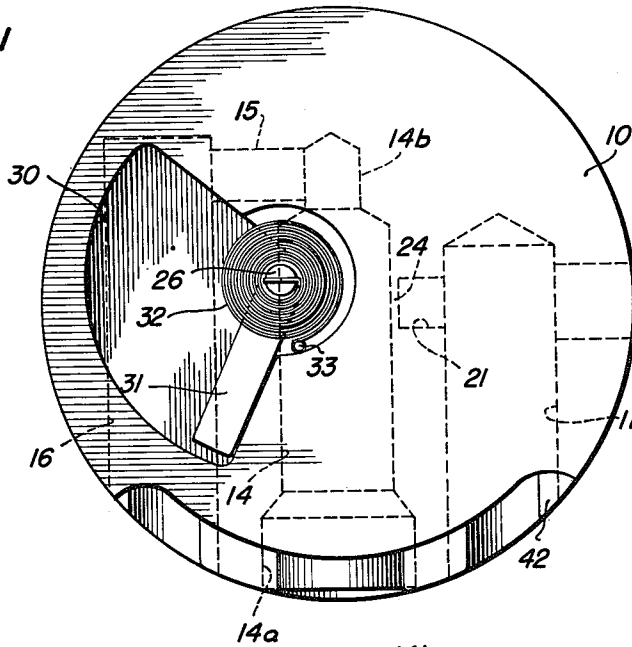
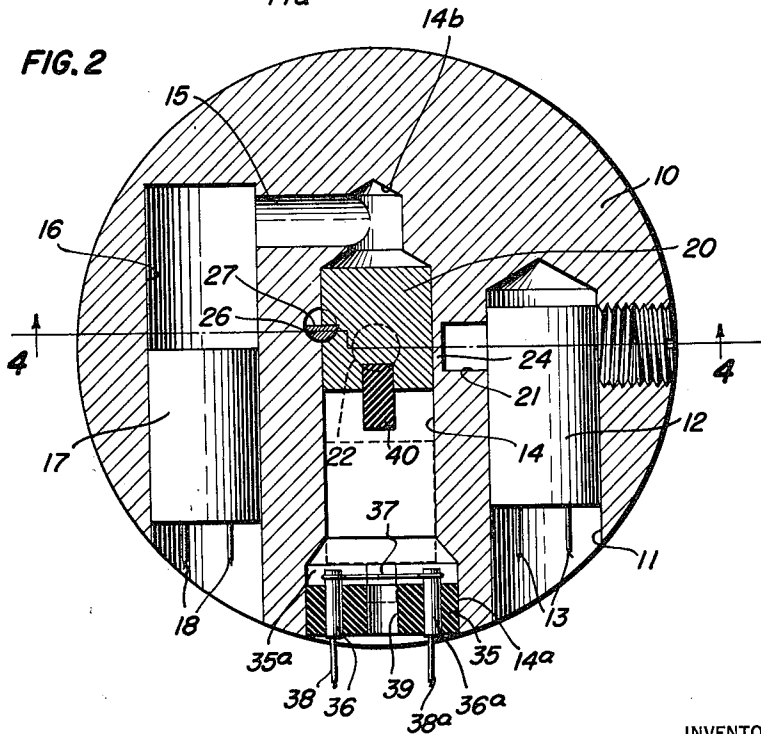


FIG. 2



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FIG. 3

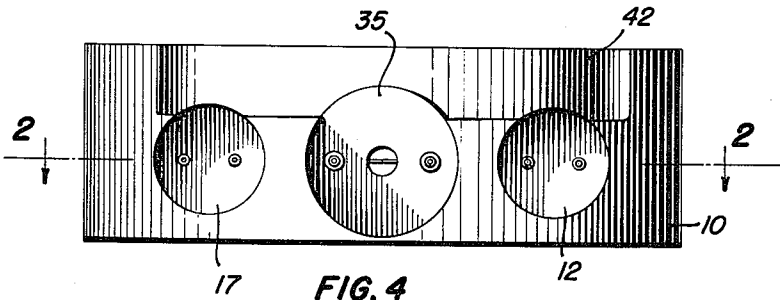


FIG. 4

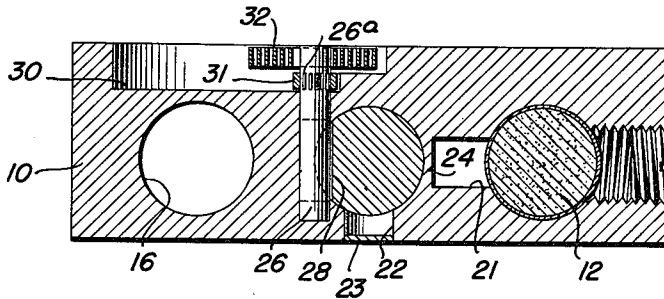


FIG. 5

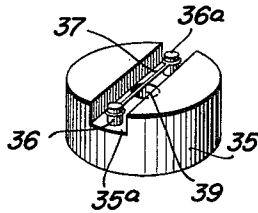


FIG. 7

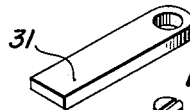


FIG. 6

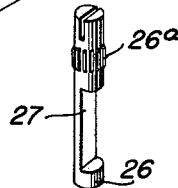
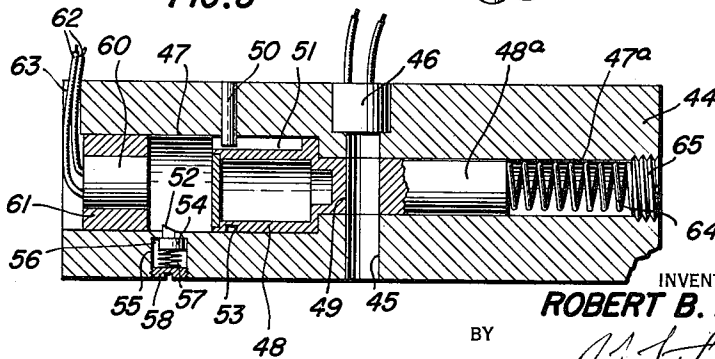


FIG. 8



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SAFETY UNIT FOR EXPLOSIVE DEVICES

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8 Claims. (Cl. 102—70.2)

This invention relates to devices for use in safeguarding the firing of explosive charges and has particular reference to a novel safety device for this use which is simple in construction and positive and reliable in operation. The new safety device may be used to particular advantage in explosive projectiles and, therefore, will be described in that connection, although it will be understood that the invention is applicable to other explosive devices as well.

Explosive projectiles as commonly made include safety means for preventing accidental firing of the main charge, as in handling the projectile. Such safety means generally comprise a safety element which acts as an obstruction in the firing train between the charge and the means for initiating explosion of the charge, whereby the projectile is normally unarmed, and when the projectile is fired it is automatically armed by rendering the safety element inoperative. Heretofore, the arming of the projectile has usually been accomplished by mechanical means responsive to centrifugal force or the force of set back and acting directly to cause relative movement between the safety element and the firing train. The mechanical means used for this purpose usually require a considerable number of moving parts and are not always positive in action because they generally depend entirely upon centrifugal force or the force of set back for their actuation.

One object of the present invention resides in the provision of a novel safety device for explosive projectiles which is operable, after the projectile is fired, to arm the detonating element through the action of a fluid pressure. A safety device made in accordance with the invention comprises a body designed to fit in the projectile casing and having a chamber for receiving the detonator, a passage leading from the chamber through which the detonator fires the booster or other charge, and a cylinder communicating with the passage. A plunger in the cylinder normally blocks the passage to secure the charge against firing by the detonator but is movable by a fluid pressure to an inoperative position to clear the passage. Preferably, the fluid pressure is derived from an explosive device, which may have a time delay action, located in a chamber communicating with the cylinder. With this construction, the plunger may be held positively in its unarmed position by a catch, or the like, until the projectile has been fired and is ready to be exploded, whereupon the plunger is moved quickly and with considerable force to the armed position and held there by application of the fluid pressure. Since the fluid pressure exerts a large force on the plunger, the latter may be relatively heavy so that it is more effective as a safety element.

Another object of the invention resides in the provision of a novel safety device for explosive projectiles in which the safety element for preventing firing of the charge by the detonator is held in the unarmed position by positive locking means responsive to set back and also by centrifugal force, and is held in the armed position by centrifugal force after the projectile is fired. In one form

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of the device, the safety element is a plunger normally held in its unarmed position on one side of the axis of rotation of the projectile by a locking member. Preferably, the locking member has an arm which acts under centrifugal force, when the projectile is fired, to move the member to an inoperative position for releasing the plunger, but the force of set back holds the arm against a friction surface to prevent movement of the locking member. Thus, when the projectile is fired, the locking member and the centrifugal force on the plunger hold the plunger in the unarmed position, and when the force of set back is relieved sufficiently, the arm moves the locking member to release the plunger which is then held only by centrifugal force. The plunger may then be moved to its armed position on the opposite side of the axis of rotation by the action of a fluid pressure thereon and is held in the armed position by the fluid pressure and centrifugal force. The arm may be provided with a spring or other biasing means to prevent accidental movement of the locking member and release of the plunger in handling the projectile. It will be evident that with the new device, accidental explosion of the projectile in the bore or near the gun after it is fired is effectively prevented because the plunger is held in the unarmed position immediately after firing both by centrifugal force and by the locking member which, in turn, is held in its locking position by set back. The plunger is moved to its armed position only on actuation of the locking member by centrifugal force when the force of set back is relieved, and by application of the fluid pressure to the plunger.

Still another object of the invention is to provide a safety device for explosive projectiles in which the safety element, in the form of a plunger, is moved to its armed position to clear a passage between the detonating element and the explosive charge and also to break a short circuiting member in a firing circuit for the detonating element, whereby accidental explosion of the projectile is effectively prevented before the plunger reaches its armed position.

These and other objects of the invention may be understood by reference to the accompanying drawings, in which

Fig. 1 is a plan of one form of the new safety device for use in a projectile;

Fig. 2 is a horizontal sectional view of the device shown in Fig. 1, on the plane 2—2 of Fig. 3;

Fig. 3 is a side view of the device shown in Figs. 1 and 2;

Fig. 4 is a sectional view on the plane 4—4 in Fig. 2;

Fig. 5 is a perspective view of the short circuiting element and its support shown in Fig. 2;

Figs. 6 and 7 are perspective views of the locking member and its arm, respectively, shown in Figs. 2 and 4, and

Fig. 8 is an axial sectional view of another form of the safety device.

Referring to Figs. 1 to 7, inclusive, the device there shown comprises a metal body 10 of cylindrical form designed to fit closely into a projectile casing. A bore 11 extends inwardly from the cylindrical surface of the body and receives a detonating element 12, which may take the form of a squib fired electrically through wires 13. Parallel to the bore 11 is a cylinder 14 with its axis extending through the axis of rotation of the body in the projectile, the cylinder being enlarged at its outer end and having a reduced portion 14a at its inner end. A passage 15 connects the reduced end of the cylinder with a bore 16 extending inwardly from the periphery of the body generally parallel to the cylinder. The bore 16 receives an explosive device 17, which may be a squib designed to be fired electrically through wires 18.

The cylinder 14 contains a safety element 20 in the form of a plunger normally held in an unarmed position

at the inner end of the cylinder. In its unarmed position, the center of gravity of the plunger is on one side of the axis of rotation of the body in the projectile, and the plunger is in line with a radial passage 21 and an axial outlet port 22 through which the explosion of the detonator 12 is communicated to the booster or other charge. Preferably, the outlet port 22 is closed by a relatively thin, frangible wall 23, Fig. 4, and the radial passage 21 is closed by another frangible wall 24, the walls 23 and 24 being sufficiently strong to withstand the pressure from the explosion of squib 17 and thereby confine the pressure within the cylinder.

The plunger 20 is normally held positively in its unarmed position to block the outlet port 22 from passage 21, and to this end there is provided a locking member in the form of a pin 26 rotatable in a bore parallel to the port 22 and in the body 10. The bore for the locking pin intersects the cylinder 14, and the pin is formed intermediate its ends with a cutaway portion 27 which is normally engaged in a recess 28 in the plunger. The flat surface formed by the cutaway portion 27 contacts a wall of the recess 28 to prevent movement of the plunger, but when the locking pin is rotated substantially 90° in the bore, the flat surface 27 moves out of the recess and releases the plunger.

The locking pin 26 projects into an arcuate recess 30 in the upper face of the body and has a knurled portion 26a near its upper end. An arm 31 secured to the knurled portion of the pin is disposed in the recess 30 adjacent its bottom surface, the arm fitting tightly on the knurling 26a to prevent relative movement of the arm and the locking pin. A flat coil spring 32 is connected at its inner end to the locking pin and at its outer end to a detent 33 in the recess 30. The spring urges the arm 31 and the pin 26 to the position for locking the plunger, as shown in Figs. 1 and 2.

An insulating plug 35 fits closely in the enlarged end of the cylinder and supports a pair of terminals 36 and 36a which project into a groove 35a in the inner face of the plug. Between the terminals 36 and 36a in the groove is a thin wire 37 connected through the terminals and through wires 38 and 38a into a firing circuit (not shown) for the detonator 12, whereby the wire 37 acts as a short circuiting element for preventing electrical firing of the detonator. Adjacent the wire 37, the plug is formed with a recess 39 for receiving a cylindrical insulating member 40 on the adjacent face of the plunger. It will be understood that the plug 35 is held in the cylinder by the inner wall of the projectile casing in which the body 10 fits, and that this inner wall also closes the outer ends of the bore 11 and 16.

In the operation of the safety device, the plunger 20 is held in its unarmed position (Fig. 2) by the locking pin 26, and the locking pin, in turn, is held in its locking position by the spring 32 which prevents accidental movement of the pin in the handling of the projectile. In the event that the squib 17 should be fired accidentally, the projectile remains unarmed because the locking pin prevents movement of the plunger under the pressure communicated thereto through the passage 15. Also, if the locking pin should be rendered inoperative for any reason, the projectile remains unarmed because the plunger, due to its relatively tight fit in the cylinder, does not move until it is subjected to the pressure resulting from firing the squib 17. It will be evident that the possibility of simultaneous accidental firing of squib 17 and turning of the locking pin 26 is exceedingly remote. If the detonator 12 should be fired accidentally, it cannot explode the projectile because the plunger 20 in its unarmed position prevents the explosion from reaching the outlet port 22 from passage 21. Even if the plunger should be released accidentally by the locking pin and move against the short circuiting element 37, the detonator 12 cannot be fired to explode the projectile because the short circuiting element is broken only when the plunger

is subjected to considerable pressure through explosion of the squib 17.

When the projectile is fired from the gun, the centrifugal force resulting from its rotation supplements the locking pin 26 in holding the plunger in the unarmed position. Accordingly, even if the locking pin should accidentally become inoperative, the plunger would be prevented from arming the projectile. Centrifugal force also acts to move the arm 31 to the opposite end of slot 30 against the spring 32. However, the force of set back resulting from firing the projectile causes the arm to engage with considerable force the bottom of the recess, which acts as a friction surface to prevent movement of the arm by centrifugal force. When the force of set-back is relieved, centrifugal force swings the arm against spring 32 through substantially 90° so as to move the locking pin out of the plunger recess 28 and release the plunger. The plunger is then held in its unarmed position only by its centrifugal force.

The squib 17 is preferably of the delay-action type so that closing of its firing circuit at the instant of firing the projectile, as by means of a set back switch (not shown), does not explode the squib until the projectile has traveled a safe distance. When the squib 17 explodes, the pressure from the explosion acts through passage 15 on the plunger 20 which, having been released by the locking pin 26 through centrifugal force, is moved outwardly with considerable force to its armed position, as shown in dotted lines in Fig. 2. As a result, the insulating member 40 breaks the short circuiting element 37 so that the detonator may be fired by the circuit including wires 13. The plunger is held in its armed position not only by the pressure from the explosion of squib 17 but also by the action of centrifugal force on the plunger, since the latter is now on the opposite side of the axis of rotation of the projectile.

The firing circuit for the detonator may be controlled by a suitable switch (not shown), such as a switch responsive to proximity of the target. When the detonator is fired, with the plunger in the armed position, the pressure from the explosion breaks the thin wall 24 and is transmitted through the cylinder to the outlet port 22 where it breaks the wall 23. The explosion is thus communicated to the booster or other charge and fires the charge.

The safety device shown in Fig. 8 comprises a cylindrical body 44 having an axial bore 45 which is enlarged at its upper end to receive an electrically fired detonator 46. A cylinder 47 extends diametrically through the body so as to intersect the bore 45, and a plunger 48 in the cylinder has an extension 48a in a reduced portion 47a of the cylinder. When the plunger is in its innermost position, an opening 49 in its extension is aligned with the bore 45, but when the plunger is in its outermost position, the extension 48a blocks the bore. Rotation of the plunger in the cylinder is prevented by a pin 50 engaged in a groove 51 in the piston.

The plunger is normally held in its outermost position by a detent 52 engaged in a recess 53 in the plunger. The detent fits closely in an opening in the cylinder wall and projects from a disc 54 slidable in a recess 55, the disc having a cutaway portion 56 adjacent the outer wall of the recess. The detent is normally forced outwardly by a spring 57 engaged at one end with the disc and at the opposite end with a plug 58. The force of setback incident to firing the projectile causes the disc 54 to move outwardly against spring 57, and when the detent clears the upper wall of recess 55, centrifugal force moves the detent and the disc outwardly so that they are held in their retracted position by the upper wall of the recess, thereby releasing the plunger.

One end of the cylinder is closed by a time delay squib 60 held in a collar 61 and fired electrically through wires 62 received in a groove 63 in the body. The plunger is normally urged against the collar 61 by a spring 64

disposed between the inner end of the plunger and a plug 65 in the other end of the cylinder.

In operation, the plunger is held by the spring 64 in its unarmed position so that the extension 48a blocks the axial bore and prevents an accidental explosion of the detonator 46 from being communicated through the bore to the booster or other charge. The spring and the detent 52 secure the plunger against accidental displacement from its unarmed position. When the projectile is fired from the gun, the force of set back causes the detent to withdraw into recess 55 where it is held by centrifugal force. Accordingly, when the squib 60 is fired, the resulting pressure in the cylinder 47 forces the plunger inwardly with considerable force against the spring 64 and holds the plunger in the armed position. In the event that the detonator 46 should fail to explode before the projectile finishes its flight, the spring 64 returns the plunger to its unarmed position. It will be observed that before the squib 60 is fired, the center of mass of the plunger is at the left of the axis of rotation, as seen in Fig. 8, so that centrifugal force also holds the plunger in its unarmed position. However, when the plunger is moved to its armed position by explosion of squib 60, the center of mass of the plunger is shifted to the right of the axis of rotation so that centrifugal force supplements the pressure in cylinder 47 in holding the plunger in its armed position.

The new safety device is compact and sturdy in construction. The plunger safety element is held in its unarmed position by positive locking means when the projectile is being handled, and also by centrifugal force when the projectile is fired from the gun. In addition, movement of the plunger to its armed position requires explosion of the time delay squib (17 or 60) and release of the locking means, either by the force of set back, as in the Fig. 8 form, or by centrifugal force after the force of set back is relieved, as in the Fig. 1 form. It will be evident that with the device shown in Fig. 1, the projectile is rendered bore-safe not only by the delay action of squib 17 but also by the force of set back which prevents movement of the locking pin 26 by centrifugal force.

While the invention has been described with reference to certain preferred examples thereof which give satisfactory results, it will be understood by those skilled in the art to which the invention pertains, after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention, and it is intended, therefore, to cover in the appended claims all such changes and modifications.

The invention herein described 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.

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

1. A safety device for use with an explosive charge and a detonating element, which comprises a body having a passage through which the detonating element fires the charge, and a cylinder communicating with the passage, a plunger movable in the cylinder and operable in one position to block the passage and secure the charge against firing by the detonating element, the plunger being movable to an inoperative position to clear the passage, and an explosive device in the body in communication with the cylinder for subjecting the plunger to fluid pressure to move the plunger to its inoperative position.

2. For use in a projectile having an explosive charge and a detonating element, a safety device which comprises means for securing the charge against firing by the detonating element, said means being normally in an operative position with its center of gravity on one side of the axis of rotation of the device and being movable to an inoperative position on the opposite side of the axis

of rotation, and means for moving said first means to its inoperative position against the centrifugal force of said first means.

3. For use in a projectile having an explosive charge and a detonating element, a safety device which comprises means for securing the charge against firing by the detonating element, said means being normally in an operative position with its center of gravity on one side of the axis of rotation of the device and being movable to an inoperative position on the opposite side of the axis of rotation, and means for locking said movable means in its operative position in response to setback and releasing the movable means when the force of setback is reduced, and means for moving said first means to its inoperative position against the action of centrifugal force thereon when said first means is released by the locking means.

4. A safety device for use with an explosive charge and a detonating element, which comprises a plunger normally disposed between the charge and the detonating element for securing the charge against firing by said element, the plunger being movable to an inoperative position in which said element is operable to fire the charge, means for moving the plunger to its inoperative position, a member for short circuiting a firing circuit for the detonating element, and a member on the plunger for breaking the short circuiting member when the plunger moves to its inoperative position.

5. A safety device for a projectile having an explosive charge and a detonating element, which comprises means normally in an operative position for securing the charge against firing by the detonating element, said means being movable to an inoperative position in which the detonating element is operable to fire the charge, a member normally locking said movable means in its operative position, means responsive to centrifugal force for moving the locking member to release said movable means, means responsive to setback for holding the locking member in its operative position against movement by the centrifugal means, and means for moving said first means to its inoperative position when said first means is released by the locking member.

6. A safety device for a projectile having an explosive charge and a detonating element, which comprises a body having a passage through which the detonating element fires the charge, a plunger movable in the body and operable in one position to block the passage and secure the charge against firing by the detonating element, the plunger being movable to an inoperative position to clear the passage, a member normally locking said movable means in its operative position, means for biasing the locking member toward its locking position, an arm on the locking member operable by centrifugal force to move said member against the action of the biasing means to an inoperative position to release said movable means, a friction surface on the body engageable with the arm in response to setback for holding the locking member in its inoperative position against the action of the arm, and means for moving the plunger to its inoperative position when the plunger is released by the locking member.

7. A safety device for a projectile having an explosive charge and a detonating element, which comprises a body having a chamber for the detonating element, a passage from the chamber through which said element fires the charge, a cylinder communicating with the passage, and a second chamber communicating with the cylinder, a plunger in the cylinder operable in one position to block the passage and secure the charge against firing by the detonating element, the plunger being movable to an inoperative position wherein said element is adapted to fire the charge, an explosive device in said second chamber for subjecting the plunger to fluid pressure to move it to its inoperative position, and frangible means in said passage normally separating the cylinder from the first

chamber and from the charge and being operable to withstand the pressure from said explosive device, the frangible means being adapted to break under the pressure from detonation of said element.

8. A safety device for a projectile having an explosive charge and a detonating element, which comprises a body having a chamber for the detonating element, a passage from the chamber through which said element fires the charge, and a cylinder intersecting the passage, a plunger in the cylinder normally blocking the passage to secure the charge against firing by the detonating element, the plunger having an opening therein, an explosive device in the cylinder for subjecting the plunger to pressure to move it to an inoperative position wherein said opening is aligned with the passage, and means normally locking the plunger in its blocking position and operable in response to set back to release the plunger.

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