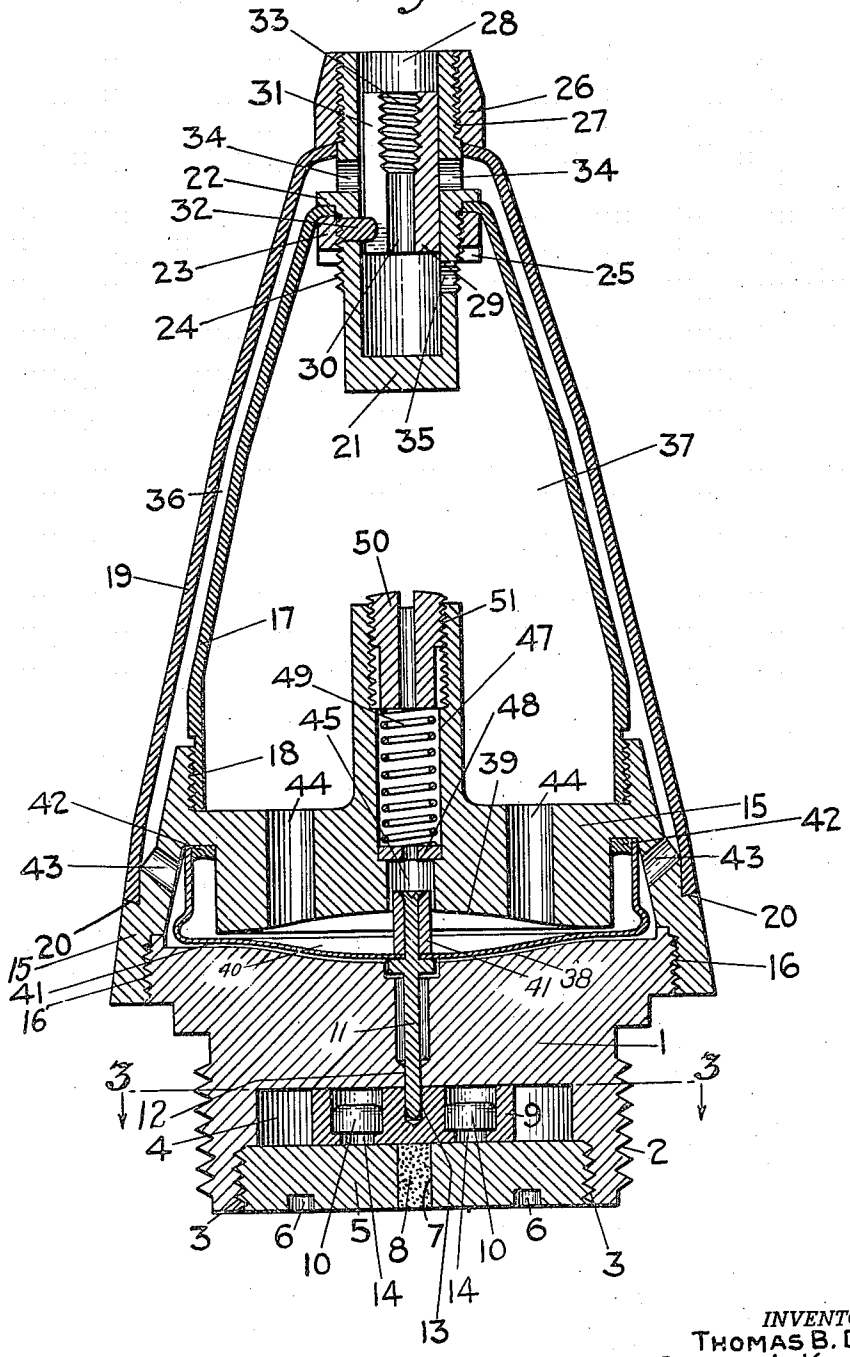
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FUSE

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Fig. 1




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Fig. 2

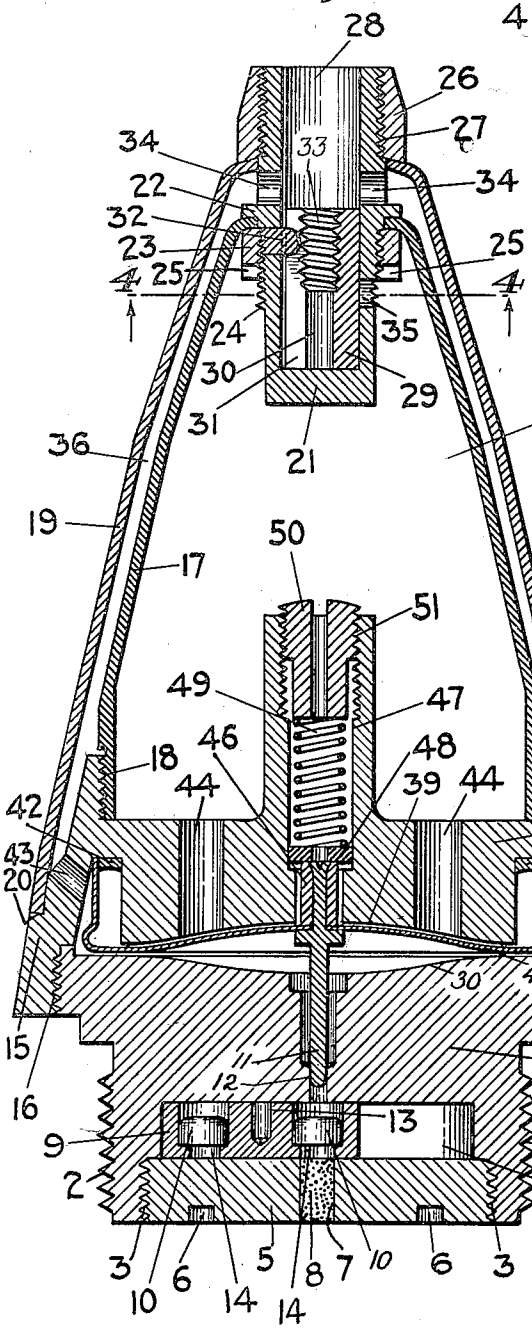



Fig. 3

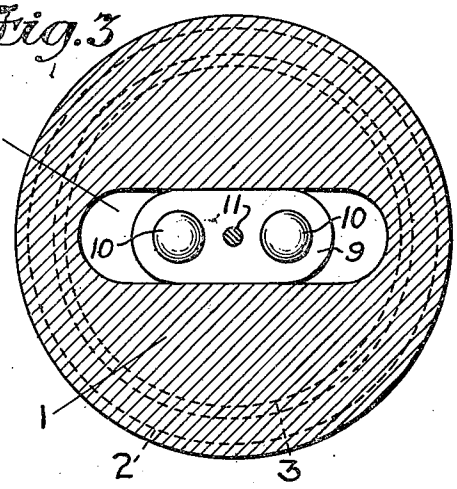
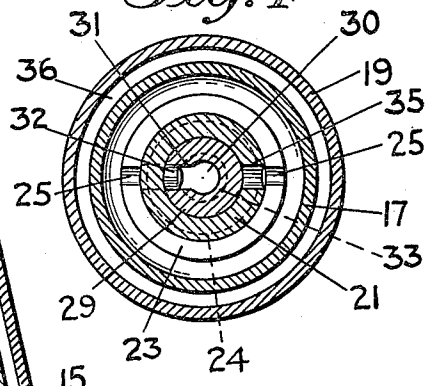



Fig. 4




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Fig. 6

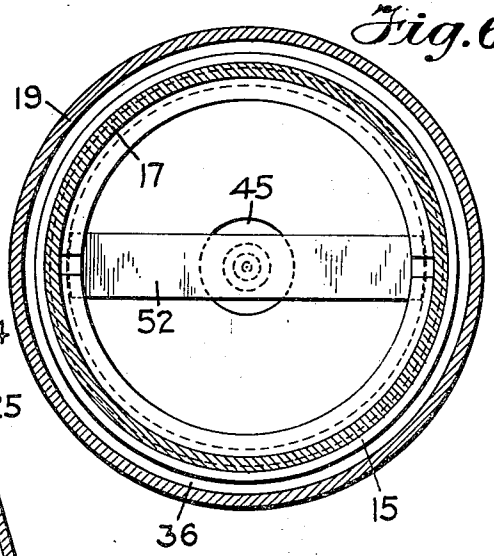
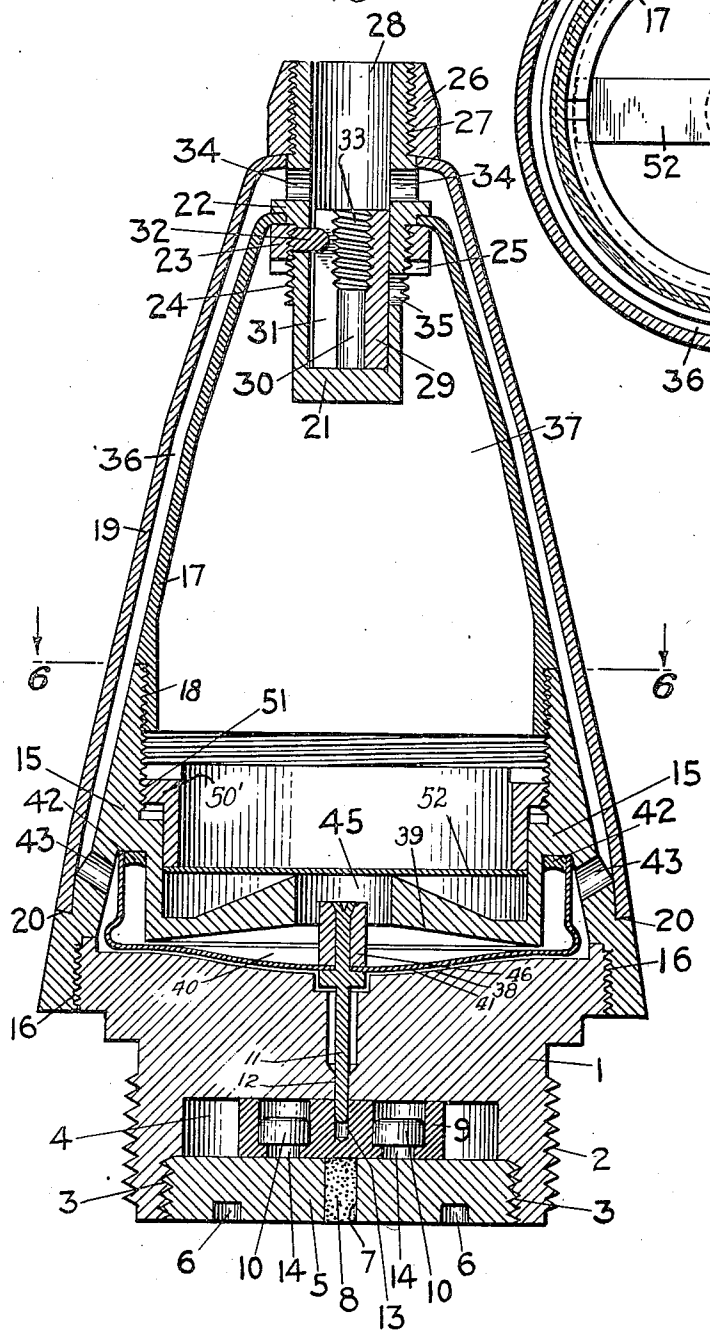



Fig. 5




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Patented Feb. 6, 1945 2,368,747

# UNITED STATES PATENT OFFICE

2,368,747

## FUSE

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Application August 31, 1940, Serial No. 354,966

6 Claims. (Cl. 102—70)

This invention relates to fuses for projectiles and more particularly to fuses for detonating a projectile at a predetermined point in its flight.

The object of the invention is to provide a fuse for a projectile which functions upon the projectile being retarded to a velocity corresponding to the predetermined point in its flight.

Another object of the invention is to provide such a fuse in which a predetermined difference between the air pressure on the nose of the fuse due to its velocity and an air pressure set in a sealed chamber within the fuse causes the fuse to function by its action on a member to which the firing hammer is permanently secured.

Another object of the invention is to provide such a fuse in which the firing caps are held in an inoperative position until after the projectile has been fired.

Another object of the invention is to provide such a fuse, including an adjustment for calibrating or standardizing the differential pressures or forces under which the fuse will be actuated.

Other objects of the invention will be apparent from a consideration of the specification and drawings in which:

Fig. 1 is a vertical cross-sectional view of an embodiment of the invention, showing the relation of the parts of the fuse before the fuse has been set to function at a predetermined range;

Fig. 2 is a view similar to Fig. 1, but showing the fuse set to function at a predetermined range and after the projectile has been fired;

Fig. 3 is a horizontal, cross-sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a horizontal, cross-sectional view taken on line 4—4 of Fig. 2;

Fig. 5 is a vertical, cross-sectional view, similar to Fig. 1, of a modification of the invention; and

Fig. 6 is a horizontal, cross-sectional view taken on line 6—6 of Fig. 5.

In many of the fuses in use heretofore a powder train leading to the detonating charge in the projectile is ignited at the time the projectile is fired and burns to the detonating charge of the projectile in an interval of time depending upon the point of ignition of the powder train. These fuses not only required that there be placed in the fuse itself a considerable amount of powder, which must be manufactured with great care that the rate of propagation of the flame be known and constant, but their construction has been such that they also required that the powder train be assembled in the fuse at the factory, with attending dangers during assembly, shipment and storage.

To overcome these disadvantages the present invention provides a fuse which may be manufactured, shipped and stored without any powder or detonating caps therein. The loading of the fuse with powder and the insertion of the firing caps are such simple operations that they may be done just before securing the fuse to the projectile.

The fuse of the present invention is fired by a firing pin which is moved to strike the firing cap by the force of air in a chamber, which is charged to a predetermined pressure, acting on one side of a diaphragm to which the firing pin is attached. Movement of the diaphagm is opposed and prevented until the projectile has reached a predetermined point in its flight by an air pressure, acting on the other side of the diaphragm, created at the nose of the projectile by its movement through the atmosphere.

It is well known that the pressure on the nose of the projectile varies with the velocity of the projectile and the conditions of the atmosphere, and as the velocity of the projectile varies with the time of flight and the angle of elevation, the nose pressure at any predetermined range may be calculated for the various sizes of projectiles and initial velocities. With these data, which are available in easily interpretable tables and curves, the pressure to which the air chamber is charged for a selected detonating range is determined. When the projectile has reached the desired range, the nose pressure will have been reduced to such a value that it will no longer overcome the air pressure in the chamber and the diaphragm will be moved, causing the firing pin to strike the firing cap.

In practice it has been found that a difference in pressure of ten pounds on the two sides of the diaphragm was necessary to force or snap the diaphragm over from one position to another. Thus, if it is desired to detonate the projectile at a range having a corresponding nose or velocity pressure of seventy-five pounds per square inch, the air chamber would be charged to a pressure of eighty-five pounds per square inch.

To provide against accidental striking of the firing caps by the firing pin before the projectile is fired, the fuse is assembled with the diaphragm in its snapped-down position with the firing pin engaging a bore in the central portion of the frame or block holding the firing caps. When the projectile is fired, the nose pressure due to

the initial velocity of the projectile overcomes the pressure of the air in the chamber and snaps the diaphragm to its up position, drawing the firing pin out of engagement with the firing cap frame. This disengagement allows the frame, under the action of centrifugal force due to the rotation of the projectile, to move outward in its cavity into a position such that one of the firing caps is in alignment with the firing pin. The firing cap is then in a position to be struck by the firing pin when the diaphragm is snapped down under the force of the air in the chamber, that is, when the nose pressure has decreased to a value corresponding to the nose pressure at the point at which it is desired to detonate the projectile.

It is realized that other fuses have been disclosed whose functioning depends upon balancing the nose air pressure, due to the movement of the projectile, against the reaction of springs, air, or centrifugal forces set up by the masses of certain parts of the fuse. In these other fuses the opposing forces act on a detent which holds a firing hammer in a safe position until the desired balance or relation of forces is reached when the detent is moved and the hammer is released. The hammer is then moved by centrifugal force or springs to strike the firing cap. In the present invention the firing hammer is directly activated by the controlling forces, thus adding to the safety, simplicity and positive action of the fuse.

Referring to the drawings and particularly to Fig. 1, 1 represents the base of the fuse which is adapted to be secured by threads 2 to the nose of the projectile (not shown). In the lower face of base 1 is bored a cylindrical cavity having threaded walls 3 and a cavity 4, the latter being generally rectangular in cross-section but with curved ends. Plug 5 is screwed into the walls 3 by means of a wrench cooperating with holes 6. In the central portion of plug 5 is bore 7 in which is placed ignition powder 8, which is in communication at its lower end with the detonating powder in the projectile (not shown).

Between the upper face of plug 5 and the upper face of cavity 4 slides frame or block 9, which carries two firing caps 10. Until the projectile is fired, frame 9 is held in its position in the center of cavity 4 by firing pin 11 which slides in bore 12 in base 1 and engages a bore 13 in the center portion of frame 9. When firing pin 11 is moved upward, as will be hereinafter described, frame 9 is free to move outward under the action of centrifugal force to one end or the other of cavity 4, when one of the firing caps 10 will be in alignment with the lower end of firing pin 11. Holes 14 in frame 9 are provided as passageways for the flame of the firing cap 10 to pass to the powder 8, when frame 9 is in its firing position, as shown in Fig. 2. These passageways may be filled with powder if desired.

The central portion of the fuse is a core 15 secured to the base 1 by screw threads 16. Core 15, among other functions, provides a base and support for the inner side walls 17 secured to core 15 by screw threads 18 and the outer side walls 19 which fit into a sloping shoulder 20 on core 15. The upper ends of the inner side walls 17 are closed by nose member 21 which is hollow and cylindrical in shape. Member 21 is closed at its lower end and has a shoulder 22 in its central portion. Shoulder 22 and nut 23, screwed on threads 24, engage the inturned upper ends of walls 17 and make an air-tight joint therebetween. Nut 23 has radial slots 25 cut in its lower surface for applying a socket or spanner wrench. The upper ends of the outer walls 19 are secured to member 21 by a nut 26, which engages threads 27, and bears down on the inturned ends of walls 19. The lower surface of nut 26 is cut with a slight slope downwardly and outwardly. The sloped ends are provided on the outer side walls so that the clamping action of the nut 26 will tend to draw the walls in to make a tight joint which, however, need not be absolutely air-tight as will hereinafter appear.

In the bore 28 of member 21 slides a cylindrical valve 29 having an axial bore 30 and a longitudinal slot 31. Slot 31 engages pin 32 secured in the side walls of member 21 to prevent valve 29 from turning about its axis as it slides in bore 28. Threads 33 in the upper portion of bore 30 are provided to fit a tool for removing valve 29 from bore 28, if desired. Ports 34 are cut in the walls of member 21 on a level between the upper ends of walls 17 and walls 19 and a port 35 is cut in the walls of member 21 below the level of nut 23.

It will thus be seen that an air space 36 is formed between walls 17 and 19, which is open at its upper end to the atmosphere through ports 34, groove 31, and bore 28, when valve 29 is in the position shown in Fig. 1. Air space 36 is open to the atmosphere through ports 34 and bore 28 when valve 29 is in the position shown in Fig. 2. It will also be seen that an air chamber 37 is formed by the inner walls 17, member 21, and core 15, which chamber is open to the atmosphere through port 35, bore 30, and bore 28, when valve 29 is in the position shown in Fig. 1 and is closed from bore 30 and the atmosphere when valve 29 is in the position shown in Fig. 2.

The upper surface of base 1 is downwardly curved as at 38 and the lower surface of core 15 is upwardly curved as at 39 to form a cavity 40 therebetween. In this cavity is placed a cup-shaped diaphragm 41. The upper or open end of diaphragm 41 is secured to core 15 by any suitable means such as a ring of solder 42. Diaphragm 41 is made of any suitable spring metal and is adapted to snap under a differential pressure on its two sides from one position to another, such as its down position shown in Fig. 1 and to its up position, shown in Fig. 2. The under side of diaphragm 41 is in communication with air space 36 through ports 43 and its upper side is in communication with air chamber 37 through ports 44.

Secured through the center of the diaphragm 41 is firing pin 11, which extends upwardly through cavity 40 into a bore 45 in the core 15. A pressure head 46 is secured to the upper end of the firing pin 11 by any suitable means such as riveting. Above the bore 45 of core 15 is another bore 47 of a diameter greater than bore 45. On the lower shoulder of bore 47 rests a pressure washer 48 adapted to contact pressure head 46 when the latter is raised to the position shown in Fig. 2. The pressure washer 48 is forced downwardly by the compression of spring 49, which compression is adjustable by turning the screw plug 50 engaging threads 51 in core 15. The purpose of spring 49 and its associated pressure members 48 and 46 is to place an adjustable bias pressure on diaphragm 41 to compensate for any variations in the force required to snap individual diaphragms from one position to another, due to variations in their metal characteristics or slight variations in their form.

In the modification shown in Figs. 5 and 6, the construction is the same as that shown in Figs.

1, 2, 3 and 4, except that a different arrangement is provided for placing the spring bias on the diaphragm 41. In the modification shown in Figs. 5 and 6, core 15 is made relatively thin and of such thickness as to permit the upper face of pressure head 46 to extend above the upper face of core 15 when the diaphragm 41 is in its up position. Bore 45 is made of sufficient diameter to accommodate head 46 and at the same time provide an air passage between chamber 37 and cavity 40.

On the lower portion of threads 18 is screwed a cylindrical plug 50', threaded at 51'. A flat spring 52 of a suitable spring material is secured in slots at the lower edges of plug 50'. The spring is of such width and thickness as to exert a suitable pressure on the pressure head 46 when the latter is in its upper position. Spring 52 is narrow enough that it does not completely cover bore 45 and permits air from chamber 37 to act upon the upper face of diaphragm 41. The amount of pressure exerted on head 46 is varied by adjusting the position of screw plug 50' and hence the curvature of spring 52 when it is in contact with the upper surface of pressure head 46 when the diaphragm 41 is in its up position.

*Assembly and operation*

In assembling the fuse, diaphragm 41 is secured to core 15 by the ring of solder 42. Air at a pressure of ten pounds is then applied to ports 44, with the diaphragm in its up position, as shown in Fig. 2. The tension of spring 49 is then adjusted by moving screw plug 50 until diaphragm 41 snaps over to its down position under the pressure on its upper face of ten pounds plus the force of spring 49. Diaphragm 41 is left in its down position. The base 1 is then secured to the lower end of core 15.

The nose member 21 is secured to the upper ends of wall 17 by nut 23 clamping the ends of wall 17 against the shoulder 22. The inner side walls 17 are then screwed into the threads 18 in the core 15. Outer side walls 19 are then placed on shoulder 20 and the upper ends are secured in position by screwing down on nut 26, which engages the inturned ends of wall 19.

When it is desired to load the fuse, frame 9 with its firing caps 10 is placed in cavity 4 with the firing pin engaging bore 13. Plug 5, with powder 8 in place, is then screwed into the bottom of the base 1. The fuse is now ready to be placed on the nose of the projectile.

To set the fuse for the desired range, valve 29 is inserted in bore 28 to the position shown in Fig. 1 and air from a suitable pressure source is connected to bore 28. Air chamber 37 is then charged through bore 30 and port 35 to the pressure corresponding to the velocity or nose pressure for the desired range plus the calibrated differential pressure of say ten pounds. Air at this pressure also fills cavity 40 through ports 44. At the same time air passes through slot 31, port 34, air space 36, and ports 43 to the under side of diaphragm 41. As the diaphragm will not move except when there is a difference in pressure of ten pounds on its two sides, diaphragm 41 will remain in its down position. Upon the completion of the charging of chamber 37, valve 29 is moved down to the position shown in Fig. 2, thus sealing port 35. The projectile is then ready for firing and is in a safe condition, that is, the firing caps 10 are held in positions such that they can not be struck by the firing pin 11.

Upon the firing of the projectile, the nose pressure due to the initial velocity of the projectile acting through ports 34, air space 36, and ports 43, forces diaphragm 41 to its up position, shown in Fig. 2. The lower end of the firing pin 11 is thus withdrawn from bore 13 and frame 9 is free to move under the action of centrifugal force to its position as shown in Fig. 2, with one of the firing caps 10 in alignment with firing pin 11. The fuse is then in its armed condition.

When the projectile has reached the desired range and the nose pressure has decreased correspondingly, the pressure in chamber 37 overcomes the nose pressure and the diaphragm snaps to its down position. Firing pin 11 carried by diaphragm 41 then strikes firing cap 10, thus igniting powder 8, which in turn sets off the detonating charge of the projectile.

It is obvious that various changes may be made by those skilled in the art in the details of the embodiment of the invention disclosed in the drawings and described above within the principle and scope of the invention as expressed in the appended claims.

We claim:

1. In a fuse for projectiles, the combination of a base, a movable member normally biased in one direction, a cavity in the base, a block slidable in the cavity and including a central bore and a firing cap therein, a firing pin connected to one side of the movable member and adapted to normally engage the bore to position the block in the cavity, an air chamber charged to a predetermined pressure and in communication with the other side of the movable member, a passageway for exposing the one side of the movable member to the nose air pressure of the fuse, and spring biasing means for augmenting the effect of the chamber air pressure on the movable member, whereby the firing pin is moved out of engagement with the bore and is subsequently moved into engagement with the firing cap in accordance with the preponderance of pressures on the sides of the member.

2. In a fuse for projectiles, the combination of a movable member, a firing pin directly controlled by the movement of the member, an air chamber charged to a predetermined pressure and in communication with one side of the movable member, passageways for exposing the other side of the movable member to the nose air pressure of the fuse, spring biasing means acting on the said one side of the movable member to augment the effect of the chamber air pressure on the movable member, and means for adjusting said spring biasing means.

3. In a fuse for projectiles, the combination of a movable member alternately biased to each of two positions, a firing pin directly connected to one side of the movable member, an air chamber charged to a predetermined pressure in excess of atmosphere and formed in part by the other side of the movable member, a second air chamber formed in part by the one side of the movable member, the fuse having an opening in the nose, a passage connecting the opening to the second air chamber, and a spring acting on the said other side of the movable member to augment the effect of the pressure in the first mentioned air chamber on the movable member when the member is biased to a position toward the first mentioned air chamber, whereby the member is moved to the said position when the effect of the pressure in the second air chamber exceeds the effect of the pressure in the first mentioned air

chamber and the member is moved to a position toward the second air chamber when the effect of the air pressure in the first mentioned air chamber and the spring exceeds the effect of the pressure in the second air chamber.

4. A fuse for projectiles comprising a base having a cavity therein, a block in the cavity free to slide and having on one face a locking recess and a firing cap, the base having an axial bore communicating with the cavity, a flexible diaphragm alternately biased to each of two positions supported upon the base, a pin carried by the diaphragm in the bore of the base and adapted to engage both the locking recess and the firing cap in different positions of the block, a sealed pressure chamber formed in part by the face of the diaphragm away from the block charged to a pressure in excess of atmosphere and so constructed and arranged that the force exerted by the pressure will normally maintain the pin engaged in the locking recess, and a chamber formed in part by the opposite face of the diaphragm and by the base, and a passage communicating with said last chamber and open to the velocity air pressure at the nose of the fuse to build up a pressure in said last chamber due to the velocity of the projectile for opposing the pressure in said first chamber and controlling the actuation of said diaphragm.

5. A fuse for projectiles comprising a base having a cavity therein, a block slidable in the cavity and having on one face a locking recess and a firing cap, a movable member carried by the base movable between firing and retracted positions, a firing pin mounted on the movable member and adapted to engage both the recess and the firing cap in different positions of the block, spring means urging said movable member to firing position a sealed air chamber charged to a predetermined pressure in excess of atmosphere and formed in part by the face of the movable member away from the cavity and so constructed and arranged that the force exerted by the pressure will normally maintain the pin engaged in the locking recess, the fuse having an opening in the nose, a second air chamber formed in part by the face of the movable member toward the cavity and in part by the base, and a passage connecting the second air chamber to the opening to build up a pressure in said last chamber due to the velocity of the projectile for opposing the pressure in said first chamber for controlling the actuation of said movable member in accordance with the pressure differential therebetween.

6. A fuse for projectiles comprising a base having a cavity therein, a block slidable in the cavity and having on one face a locking recess and a firing cap, a movable member carried by the base movable between firing and retracted positions, a firing pin mounted on the movable member and adapted to engage both the recess and the firing cap in different positions of the block, spring means urging said movable member to firing position an air chamber formed in part by the face of the movable member away from the cavity and so constructed and arranged that the force exerted by the air pressure in said chamber will normally maintain the pin engaged in the locking recess, the fuse having an opening in the nose, a second air chamber formed in part by the face of the movable member toward the cavity and in part by the base, a passage connecting the second air chamber to the opening in the nose of the fuse to build up a pressure in said last chamber due to the velocity of the projectile for opposing the pressure in said first chamber for controlling the actuation of said movable member in accordance with the pressure differential therebetween, a port connecting the first mentioned air chamber to the passage for charging, and a valve member in said passage for controlling the port.

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