Nov. 7, 1944. T. B. DOE ET AL 2,362,121

FUSE

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Fig. 1

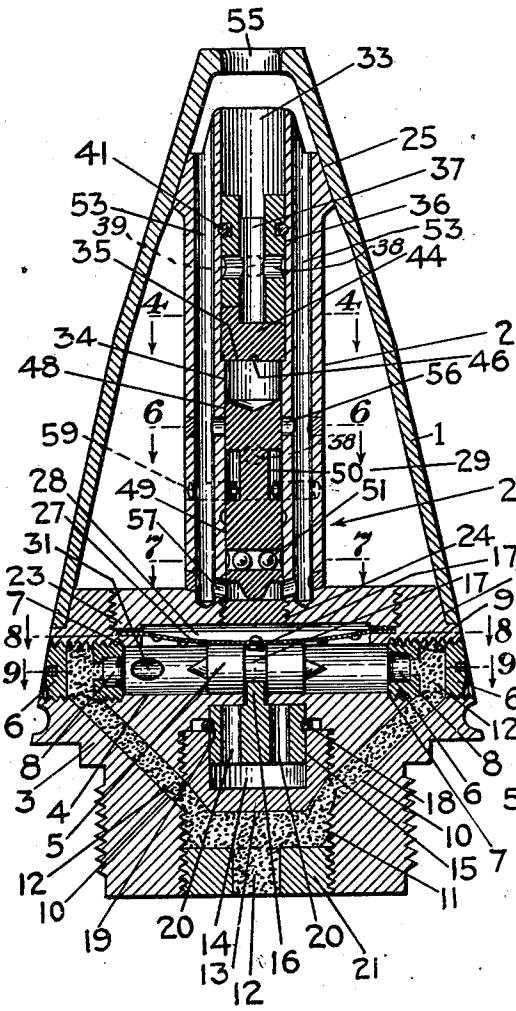
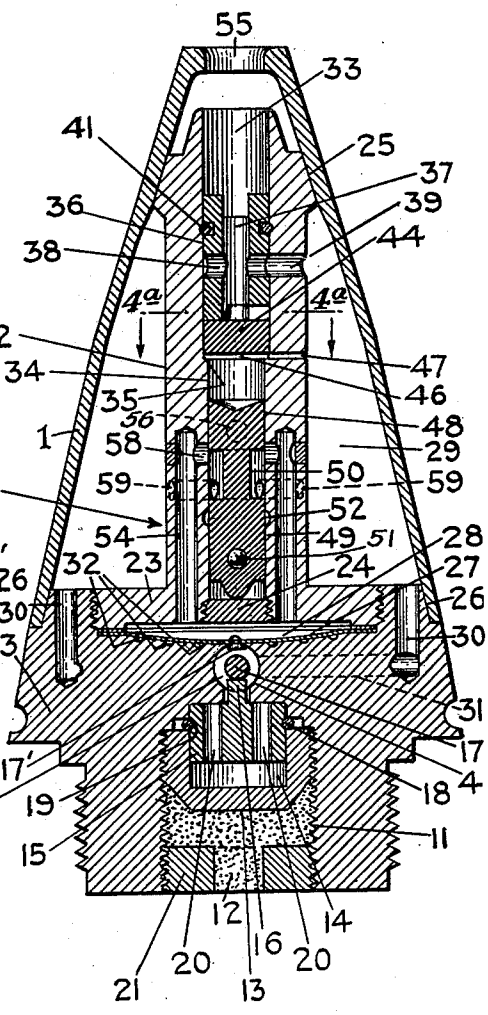


Fig. 2



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Fig. 3

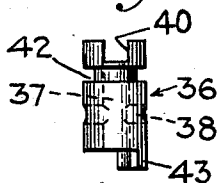


Fig. 4

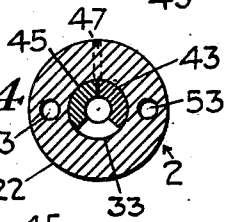


Fig. 4a

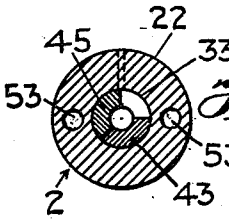


Fig. 5

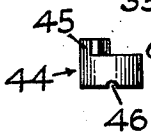


Fig. 6

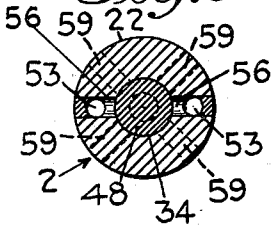


Fig. 7

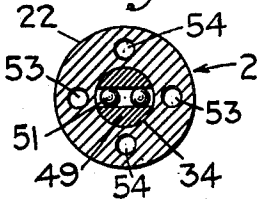


Fig. 8

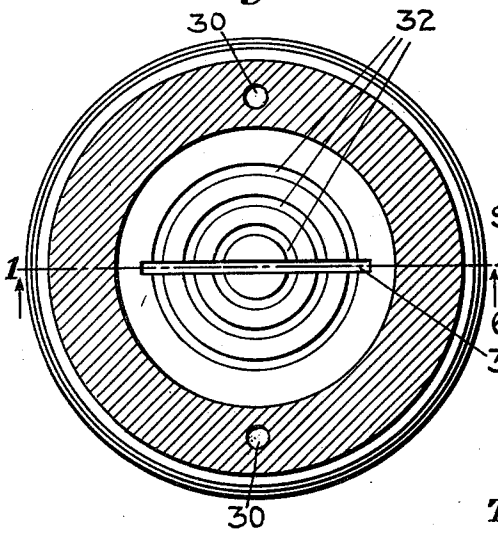
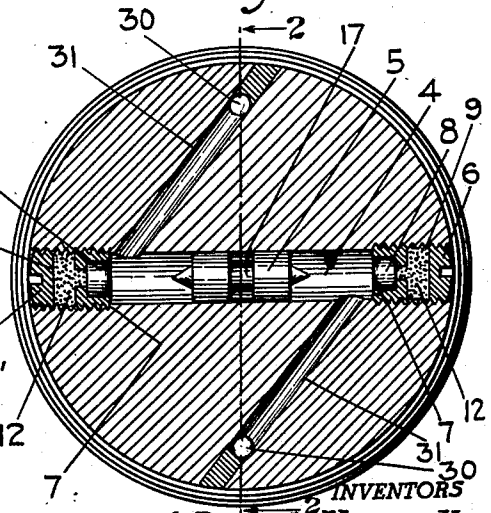


Fig. 9



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UNITED STATES PATENT OFFICE

2,362,121

FUSE

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Application August 8, 1940, Serial No. 351,893

6 Claims. (Cl. 102—70)

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

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

Another object of the invention is to provide a fuse for a projectile in which a predetermined difference in pressure between the air pressure on the nose of the fuse and a predetermined air pressure set in a sealed chamber within the fuse causes the fuse to function.

Another object of the invention is to provide a fuse for a projectile in which the firing pin or hammer, which is held in an inoperative condition until the projectile has reached a predetermined point in its flight, is released when the set air pressure predominates by a predetermined value.

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 taken on line 1—1 of Fig. 8;

Fig. 2 is a view similar to Fig. 1 but taken at right angles thereto, on line 2—2 of Fig. 9;

Fig. 3 is a view in elevation of a cross passage valve;

Fig. 4 is a horizontal, partial cross-sectional view taken on line 4—4 of Fig. 1;

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

Fig. 5 is a view in elevation of a stop;

Fig. 6 is a horizontal partial cross-sectional view taken on line 6—6 of Fig. 1;

Fig. 7 is a horizontal partial cross-sectional view taken on line 7—7 of Fig. 1;

Fig. 8 is a horizontal cross-sectional view taken on line 8—8 of Fig. 1; and

Fig. 9 is a horizontal cross-sectional view taken on line 9—9 of Fig. 1.

In many of the fuses in use heretofore a powder train leading from a firing cap 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 on the point of ignition of the powder train. These fuses not only require that there be placed in the fuse itself a considerable amount of powder, which must be manufactured with care that the rate of propagation of the flame be known and constant, but their construction has been such that they also require that the powder train be assembled with the fuse at the factory, with the 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 on the projectile.

The fuse of the present invention is fired by a firing pin or firing hammer which is moved by centrifugal force acting upon the hammer mass, the hammer being held in a fixed position by a detent until the desired time of detonation. This detent is pulled out of engagement with the hammer when the projectile has reached a selected point in its flight.

It is well known that the air pressure on the nose of a projectile varies with the velocity of the projectile and the conditions of the atmosphere through which it passes and that the velocity of the projectile varies with the time of flight and the angle of elevation until the projectile has reached its maximum height in the trajectory. Data for the various sizes of projectile and initial velocities are well known and are available in easily interpretable tables and curves.

To release the detent there is provided an opening in the nose of the fuse which is placed in communication with one side of a diaphragm after the projectile has left the gun, the other side of which diaphragm is in communication with an air chamber in the fuse in which has been sealed air at a selected pressure. The detent is connected to the diaphragm and releases the hammer when the nose air pressure is reduced to an amount such that the diaphragm is moved under the pressure of the air in the sealed chamber. The required pressure in the sealed chamber is determined by the range at which it is desired that the projectile be detonated and the difference in pressure on the two sides of the diaphragm that is necessary to snap it over from one position to another. With the type of diaphragm used in one construction, a difference of pressure of ten pounds per square inch was found necessary to snap over the diaphragm from one position to another. Thus if it is desired to detonate the projectile at a range corresponding to a nose pressure of seventy-five pounds per square inch, the sealed air chamber would be charged to a pressure of eighty-five pounds per square inch.

It will therefore be seen that when the projectile has reached the desired range, the diaphragm will be snapped over and the firing

hammer will be released from its restrained position. The hammer will then move outward against the firing cap under the action of centrifugal force created by the rotation of the shell about its central axis.

It is realized that other fuses have been disclosed whose functioning depends upon the balancing of the nose air pressure due to the velocity of the projectile against the reaction of springs or the centrifugal force due to the masses of certain parts of the fuse. These mechanical parts are subject to disarrangement or sticking which causes unreliability in their movement. It will be apparent at once that the present invention has overcome the disadvantages inherent in these previously disclosed arrangements.

To insure against the firing of the fuse after it has been charged and before the projectile has been fired, there is provided a safety inertia element to lock the firing hammer in a fixed position.

Referring to the drawings and particularly to Figs. 1 and 2, 1 represents the conical walls of the fuse secured to the core 2 in any conventional manner. In base 3, forming the lower part of core 2, is a cavity 4 in which slides a double ended firing hammer 5. At each end of cavity 4 are hollow screw plugs 6 which bear against shoulders 7 in base 3 and which hold firing caps 8 so positioned as to be struck by hammer 5. Passages 9 in screw plugs 6 communicate with passages 10 in the base 3 which lead to a threaded cavity 11 in the base 3 of the fuse. These passages and cavity are filled with powder 12.

In the upper part of cavity 11 is a screw plug 13 having a cavity 14 in which slides an inertia member 15 in which is a lug 16 engaging a reduced portion 17 of hammer 5. Inertia member 15 is held in its engaging position by a split wire ring 18 engaging groove 19 in the inertia member 15. Groove 19 is made deep enough to prevent the inertia member 15 from moving under the shocks of assembly, loading and handling of the fuse, but shallow enough that member 15 will be released from engagement with hammer 5 upon the firing of the projectile. Inertia member 15 has two parallel passages 20 therein to equalize the pressure on the upper and lower surfaces thereof, and to permit unrestricted movement under the effect of acceleration due to firing.

In the lower part of cavity 11 is a hollow screw plug 21 the inner and upper surfaces of which, together with the walls of cavity 11 and the lower surface of plug 13 form a space for powder 12. Powder 12 is in communication at the bottom of the fuse with the detonating charge of the projectile (not shown).

The upper part of core 2 consists of a member made up of a hollow cylindrical portion 22 and a flange portion 23. A threaded plug 24 closes access to the interior of cylinder 22. Cylinder 22 is secured air-tight to the inner surfaces of the walls 1, as at 25, and flange 23 is screwed into base 3. Walls 1 have an air-tight joint with the base 3, as at 26.

A diaphragm 27 is secured between shoulders at the lower outer edges of flange 23 and in the base 3. As already pointed out the diaphragm is of the snap type, that is, it is slightly dished and is of such mechanical properties that by the application of a predetermined minimum effective or differential force to one side or the other it may be snapped from curvature in one direction to curvature in the other direction. The diaphragm is placed in the fuse with its convex side toward the base 3 and on this side is secured a detent or head 17' by suitable means such as riveting or soldering. The detent 17' engages the reduced portion 17 of the hammer 5 and thereby holds it until the diaphragm is snapped to the reverse curvature as will be explained later.

The upper face of diaphragm 27 and the lower face of flange 23 form a small chamber 28. The outer surfaces of cylinder 22, the inner surfaces of walls 1 and the upper surface of flange 23 form a large chamber 29 which is in communication with the under surface of diaphragm 27 by passages 30 and 31, cavity 4, and grooves 32 in base 3. The grooves 32 are concentric with the axis of the core and intersect a straight radial groove 32'. (See Fig. 8.)

The bore of cylinder 22 is of two diameters, bore 33 in the upper portion and bore 34 in the lower portion. Bore 33 is slightly greater than bore 34. Shoulder 35 is formed where the two bores meet.

In bore 33 is cross-passage valve 36, shown in elevation in Fig. 3. Valve 36 is cylindrical in shape with a longitudinal bore 37 in communication with a cross bore 38, which cooperates with a port 39 in the walls of cylinder 22, opening into chamber 29. The axial rotation of valve 36 is adjusted by means of a tool (not shown) fitting into slot 40. The valve is held in its longitudinal position by split wire ring 41 fitting into a groove in the inner walls of cylinder 22 and a deep groove 42 in the outer surface of valve 36. In the lower portion of valve 36 is an arcuate lug 43 shown in cross-section in Figs. 4 and 4a.

Just below valve 36 and abutting on the shoulder 35 is a solid stop member 44, shown in elevation in Fig. 5, whose outer diameter is such that it has a driving tight fit with bore 33. On the upper surface of stop 44 is an arcuate lug 45 which, cooperating with lug 43, limits the axial rotation of valve 36. In the lower face of stop 44 is a groove 46 which cooperates with passage 47 in the walls of cylinder 22 to connect chamber 29 with bore 34.

In bore 34 is a spool-like valve consisting of an upper cylindrical portion 48, a lower cylindrical portion 49 both of which are of a diameter sufficiently less than that of bore 34 to permit axial movement of the valve, as will be explained later. Between these cylindrical portions is a reduced portion 50. In the lower portion 49 is a transverse cavity containing two balls 51. On the lower end of the valve is an extension which limits the downward movement of the valve and at the same time permits easy access of air to the bottom of the valve. The balls 51 are adapted to hold the valve in its upper position by their cooperating with groove 52 in the walls of bore 34 when the valve is moved to its upper position and the balls are moved outward under the action of centrifugal force due to rotation of the projectile when it is fired.

In the walls of cylinder 22 are two pairs of passages 53 and 54. Passages 53 are in communication with opening 55 in the nose of the fuse, at their upper ends, with ports 56 in their central portion which ports lead to bore 34, and with ports 57 at their lower ends which ports lead to the lower end of bore 34. Passages 54 are in communication with bore 34 at their upper ends through ports 58 and are in communication at their lower ends with chamber 28. In the walls of cylinder 22 are radial passages 59 which are

so positioned along cylinder 22 as to be opposite the lower portion of reduced portion 50 when the valve is in its lower position, as shown in Figs. 1 and 2.

It will thus be seen that when the spool-like valve is in the position shown in Fig. 2, chamber 29 is in communication with chamber 28 by passages 59, ports 58 and passages 54. When the spool-like valve is in its upper position, passages 53 are in communication with chamber 28 by ports 56, the reduced portion 50 of the valve, ports 58, and passages 54.

Operation

With the fuse assembled as shown in Fig. 2, with the cross bore 38 in communication with port 39 it is set to detonate the projectile at a selected point in its trajectory by connecting the opening 55 in the nose of the fuse to a suitable source of air under pressure and charging chamber 29 through valve 36, cross bore 38 and port 39, to a pressure, say ten pounds greater than the nose pressure on the fuse due to the velocity at the selected point in the trajectory. Air enters from chamber 29 to the top of the spool-like valve through passage 47 forcing it down so that chamber 29 is in communication with chamber 28 through passages 59, the reduced portion 50 of the valve, ports 58 and passages 54. Air also enters through passages 30 and 31 to cavity 4 where it is in communication with the lower side of diaphragm 27 through the grooves 32 and 32'. The valve 36 is then turned from the position shown in Fig. 2 to that shown in Fig. 1 thus sealing chamber 29. The fuse is then disconnected from the air charging source.

When the projectile is fired the initial nose pressure acting through passages 53 and ports 57 forces the spool-like valve upward thus placing the nose pressure on the upper surface of diaphragm 27 through ports 56, reduced portion 50 of the valve, ports 58, and passages 54. At the same time lug 16 is withdrawn, due to the inertia of the member 15, from engagement with the reduced portion 17 of hammer 5.

When the projectile has reached the selected point in its trajectory and the fuse nose air pressure due to the velocity of the projectile has been reduced to ten pounds less than the pressure in chamber 29, the pressure in chamber 29 acting through passages 30 and 31, cavity 4, and grooves 32 and 32', snaps over the diaphragm 27, to a curvature the reverse of that shown, this action pulls detent 17' with it and out of engagement with the hammer 5. Hammer 5 is then free to be moved outwardly under centrifugal force into contact with one or the other of firing caps 8. Upon the firing of caps 8, powder 12 is ignited which sets off the detonating charge in the projectile.

It will be understood 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 core and a firing cap therein, a firing hammer slidable in the core and adapted to strike the firing cap, a diaphragm in the core, a detent connected to the diaphragm for holding the hammer in a fixed position, a chamber adapted to be charged to a predetermined air-pressure and in communication with one side of the diaphragm, an opening in the nose of the fuse, a bore in the core extending axially from the opening and in communication with the chamber through a port, valve means in the bore for controlling the port, a second axial bore in the core, a passage in the core in communication at its upper end with the opening and at an intermediate point with the second bore through a port, a second passage in the core in communication with the second bore through a port and with the other side of the diaphragm, a third passage providing communication between the second bore and the chamber, and a second valve means in the second bore for controlling the two said ports associated therewith and the said third passage, whereby in one position the second valve means places the second passage in communication with the chamber through the said third passage and in another position places the first two of said passages in communication with each other.

2. In a fuse for projectiles, the combination of a core and a firing cap therein, a firing hammer slidable in the core and adapted to strike the firing cap, a diaphragm in the core, a detent connected to the diaphragm for holding the hammer in a fixed position, a chamber adapted to be charged to a predetermined air-pressure and in communication with one side of the diaphragm, an opening in the nose of the fuse, a bore in the core extending axially from the opening and in communication with the chamber through a port, valve means in the bore for controlling the port, a second bore in the core, a passage providing communication between the chamber and the said second bore, a second passage in the core in communication at its upper end with the opening and at its lower end and at an intermediate point with the second bore through ports, a third passage in the core in communication with the second bore at an intermediate point through a port and with the other side of the diaphragm, a fourth passage providing communication between the chamber and the upper end of the second bore, and a second valve means in the second bore operable in a downward direction by the air-pressure communicated from the chamber through the fourth passage and operable in an upward direction by the air-pressure communicated from the second passage through the port at its lower end, said second valve means controlling the intermediate ports whereby in its lower position the third passage is in communication with the chamber through the first mentioned passage and in its upper position the second and third passages are in communication with each other.

3. In a fuse for projectiles, the combination of a core and a firing cap therein, a firing hammer slidable in the core and adapted to strike the firing cap, a diaphragm in the core, a detent connected to the diaphragm for holding the hammer in a fixed position, a chamber adapted to be charged to a predetermined air-pressure and in communication with one side of the diaphragm, an opening in the nose of the fuse, a bore in the core extending axially from the opening and in communication with the chamber through a port, valve means in the bore for controlling the port, a second bore in the core, a passage in the core in communication at its upper end with the opening and at an intermediate point with the second bore through a port, a second passage in the core in communication with the second bore through a port and with the other side of the diaphragm, a third passage providing communi-

cation between the second bore and the chamber, a second valve means in the second bore controlling the two said ports associated therewith and the said third passage whereby in one position the second valve means places the second passage in communication with the chamber through the said third passage and in a second position places the first two of said passages in communication with each other, and means for holding the second valve means in its second position when moved to that position.

4. In a fuse for projectiles, the combination of a core and a firing cap therein, a firing hammer slidable in the core and adapted to strike the firing cap, a diaphragm in the core, a detent connected to the diaphragm for holding the hammer in a fixed position, a second detent slidable in the core, yieldable means for holding the second detent normally in engagement with the hammer, inertia operated means adapted to overcome the yieldable means upon the firing of the projectile and to move the second detent out of engagement with the hammer, a chamber adapted to be charged to a predetermined air-pressure and in communication with one side of the diaphragm, an opening in the nose of the fuse, a bore in the core extending axially from the opening and in communication with the chamber through a port, valve means in the bore for controlling the port, a second bore in the core, a passage in the core in communication at its upper end with the opening and at an intermediate point with the second bore in the core, through a port, a second passage in communication with the second bore through a port and with the other side of the diaphragm, a third passage providing communication between the second bore and the chamber, and a second valve means in the second bore controlling the two said ports associated therewith and the said third passage whereby in one position the second valve means places the second passage in communication with the chamber through the said third passage and in a second position places the first two of said passages in communication with each other.

5. In a fuse for projectiles, the combination of a core and a firing cap therein, a firing hammer slidable in the core and adapted to strike the firing cap, a diaphragm in the core, a detent connected to the diaphragm for holding the hammer in a fixed position, an air chamber adapted to be charged to a predetermined pressure and in communication with one side of the diaphragm, an opening in the nose of the fuse, a bore in the core extending axially from the opening and in communication with the chamber through a port, valve means in the bore for controlling the port, a stop in the bore adapted to limit the motion and indicate the position of the valve means, a second bore in the core, a passage in the core in communication at its upper end with the opening and at an intermediate point with the second bore through a port, a second passage in the core in communication with the second bore through a port and with the other side of the diaphragm, a third passage providing communication between the second bore and the chamber, and a second valve means in the second bore controlling the two said ports associated therewith and the said third passage whereby in one position the second valve means places the second passage in communication with the chamber through the said third passage and in another position places the first two of said passages in communication with each other.

6. In a fuse for projectiles, a firing cap having a hammer associated therewith, a detent for normally holding said hammer, a movable member for positioning said detent, said member having two opposing faces one of which forms a part of the walls of a first chamber adapted to be charged to a selected pressure, a second chamber formed in part by the second face of said member, valve means normally positioned to interconnect the said chambers, an opening in the nose of the fuse for obtaining a pressure due to the velocity of the projectile, means actuated by the pressure due to the initial velocity of the projectile for shifting said valve means to seal the first chamber at the selected pressure and to connect said opening to said second chamber for applying the velocity pressure thereto, said movable member being operable to release said detent from said hammer in response to a predetermined pressure differential resulting from a reduction in the pressure in the second chamber due to the decrease in the velocity of the projectile.

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