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H. W. SPOONER
FUSE FOR PROJECTILES

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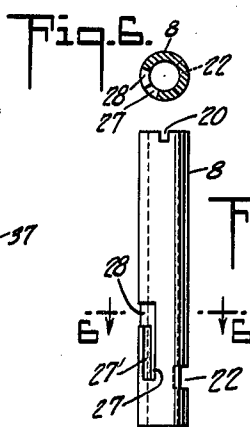
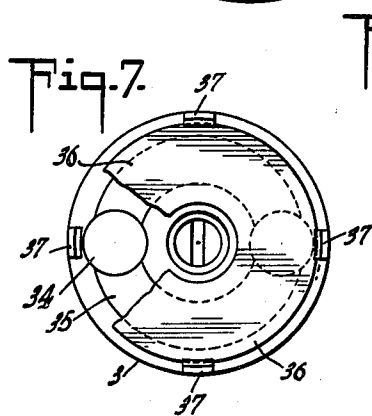
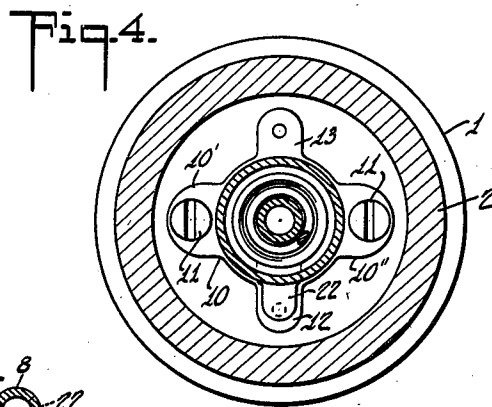
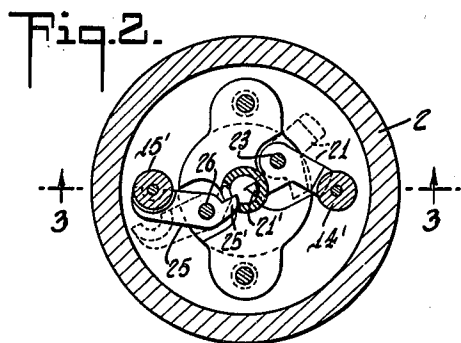
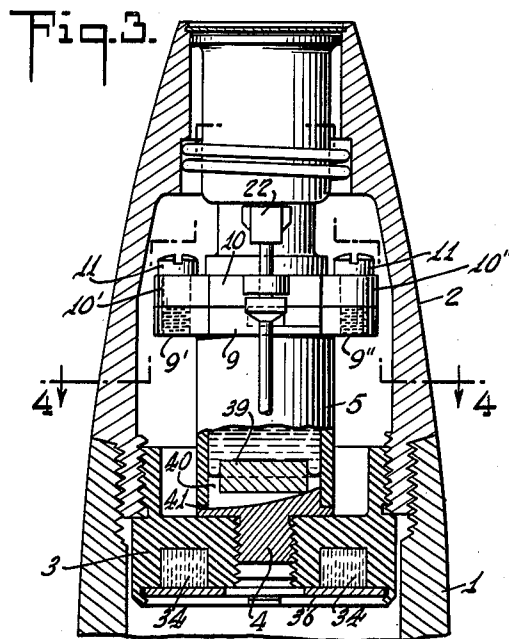
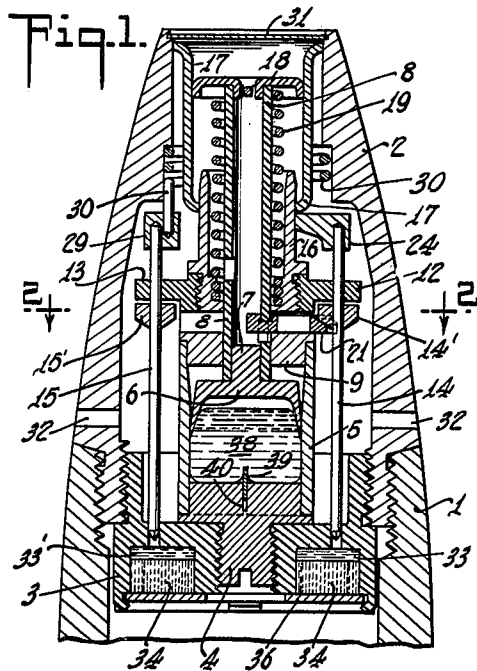


Fig. 5.

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FUSE FOR PROJECTILES

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5 Claims. (Cl. 102—71)

This invention relates to fuses for anti-aircraft projectiles, and particularly to that type of projectile known as the delayed-arming, self-exploding shell, wherein there is provided, in addition to a percussion element, means to prevent the shell from exploding in the bore of the gun, together with means to detonate the shell somewhere near the peak of its trajectory if it misses its target.

The objects of the invention are to provide greater simplicity, through a considerable reduction in the number of parts involved as compared with fuses of this type heretofore known; to insure ruggedness, through elimination of delicate parts; to provide increased safety in handling and transportation; to permit a reduction in size and weight; to improve balance, through the distribution of the parts symmetrically about the axis; and to concentrate the weight of the parts as near the axis of the fuse as possible. Some of these features combine to insure greater accuracy in the flight of the projectile. A further object of the invention is to provide a construction adaptable to projectiles of small calibre, as well as to the larger calibres of anti-aircraft artillery.

Two of the functions of the fuse are governed by the movement of a piston in a cylinder—this movement being controlled in part by the escape of fluid from the cylinder. In this construction I utilize the various properties of mercury, such as its high specific gravity, its fluid condition at all ordinary temperatures, its high surface tension, its extremely low viscosity, its ability to flow through a very small aperture when under slight pressure, its low capillarity and the fact that it does not wet the sides of the container.

In the accompanying drawing, in which like numbers represent like parts in the various figures,

Fig. 1 is an enlarged sectional view along the axis of the fuse;

Fig. 2 is a sectional view taken on the line 2—2 in Fig. 1;

Fig. 3 is a view taken on the line 3—3 in Fig. 2, showing some parts in section and others in elevation;

Fig. 4 is a sectional view taken on the line 4—4 in Fig. 3;

Fig. 5 is an elevation of the piston rod;

Fig. 6 is a sectional view of the piston rod taken on line 6—6 in Fig. 5;

Fig. 7 is a bottom view of the under side of the fuse base.

In Figs. 1 and 3 the numeral 1 indicates the body of the shell, into which the housing or body 2 of the fuse is threaded. A base 3 for supporting the principal elements of the fuse is threaded into housing 2, and base 3 is in turn tapped axially to receive the threaded shank of cylinder

base 4, which projects upward from base 3 and is snugly fitted to cylinder 5, the lower end of which is pressed down against a flange or shoulder extending outwardly from cylinder base 4.

The bore of cylinder 5 tapers slightly outward above its working portion, i. e., above the normal position of the working edges of piston 6, for the purpose of facilitating assembly, as piston 6 is made slightly larger in diameter than the working portion of cylinder 5 and compressed slightly to enter it. This insures a sufficiently snug fit to prevent leakage of mercury, and to facilitate this construction, piston 6 is made of slightly elastic material such as cellulose acetate. The upper portion of piston 6 is formed into a round shank 7, and to this is fitted piston rod 8 in the form of a cylindrical tube, which is guided in an axially placed hole in cylinder head 9, which is snugly held, as by a press fit, in the upper enlarged bore of cylinder 5.

Cylinder head 9 is provided with two diametrically opposed flanges, 9' and 9'', and superimposed on cylinder head 9 and fastened thereto by screws 11 in a flanged member 10, with corresponding flanges 10' and 10'', and having also two diametrically opposed flanges 12 and 13, disposed at right angles to flanges 10' and 10''. Flanges 12 and 13 are drilled to form guides for two firing pins, 14 and 15 respectively; firing pin 14 being the percussion pin, and firing pin 15 being controlled by the time element and herein-after referred to as the timing pin. Both these pins are guided at their lower ends in holes provided therefor in base 3, in alignment with the guide holes in flanges 12 and 13 so that the firing pins are parallel with each other and to the axis of the fuse, as well as being equidistant therefrom. Threaded into flanged member 10 is a round tubular bushing 16, concentric with the axis of the fuse. The upper cylindrical surface of bushing 16 acts as a guide for the lower end of a cup-shaped percussion piston 17, the upper end of which is guided in a cylindrical hole provided therefor in housing 2. Piston 17 in turn acts as a guide for a bushing 18, which is concentrically mounted on the upper end of hollow piston rod 8, which is thus maintained in concentric axial alignment with the fuse body. A helical extension spring 19 is secured at its lower end to bushing 16 by means of a screw thread, and its uppermost convolution is bent diametrically across itself so as to fit into notches 20 in the top of piston rod 8. When free, spring 19 is close wound, but when the fuse is assembled the spring is stretched under predetermined tension to exert a constant downward pressure upon piston rod 8, which is normally prevented from moving downward by a detent 21, provided with a lug 21' extending into piston rod or tube 8 through a notch 22 shown in Fig. 5 and indicated

by dotted lines in Figs. 2 and 6. Detent 21 is partly enclosed in a recess in cylinder head 9 and rotatably pivoted on a pin 23 projecting from the cylinder head. The extending lug 21' of detent 21 is provided on its upper side with an arc-shaped notch, into which the wall of piston rod 8 is entered, and in which the piston rod is normally held securely by the downward pressure thereon of spring 19. Detent 21 extends beyond the periphery of cylinder head 9 and under a flanged portion 14' of percussion pin 14, thus preventing downward movement of the percussion pin as long as the notch in lug 21' is engaged by the piston rod. The upper end of percussion pin 14 is provided with a dog 24, which for convenience of construction is a separate part having a hole into which the pin is snugly fitted. Dog 24 extends on one side toward bushing 16 and has an arc-shaped recess that surrounds bushing 16 sufficiently to prevent the dog from rotating out of the path of percussion piston 17, which must engage dog 24 when it descends.

Timing pin 15 is also provided with a flanged portion 15', and is normally held in the position shown by means of a detent 25, which is partly enclosed in a recess in cylinder head 9 and rotatably pivoted on a pin 26 projecting from the cylinder head. Detent 25 extends beyond the periphery of cylinder head 9 and a portion of its outer end is recessed to engage the flange 15' of timing pin 15, thus preventing the pin from descending as long as detent 25 remains in the position shown in solid lines in Fig. 2. A lug 25' integral with detent 25 extends toward the axis of the fuse and enters a longitudinal slot 27 in piston rod 8, this slot having a straight vertical face 27' formed by the wall of tube 8, and terminating in a notch 28 projecting to one side of the main portion of slot 27, as shown in Figs. 5 and 6. The upper end of timing pin 15 is fitted into a hole provided therefor in coupling 23, and another hole in this coupling engages the end of a helical compression spring 30, which is held under predetermined compression in a cylindrical space provided therefor in housing 2, the upper convolution of spring 30 abutting against a shoulder formed by enlarging the bore of housing 2 at that point. Thus spring 30 exerts a continuous downward pressure on timing pin 15, which is prevented from descending by the detent 25.

A thin sealing disc 31 is engaged by an annular groove at the nose of the fuse, and serves to keep out dust or foreign matter which might impair the action of the fuse, and at the same time serves a purpose which will be explained hereinafter. Two or more radial holes 32, placed in pairs diametrically opposite each other to preserve balance, are provided in the thicker part of housing 2, and serve as impellers to expel part of the air in the lower portion of the fuse after the projectile has been fired from the gun and is rotating rapidly. Holes 32 also serve as a means for engaging a spanner to tighten the thread fastening the fuse to the shell.

Immediately below the firing pins 14 and 15 are primers 33, 33' located in holes provided therefor in base 3, and below the primers are detonators 34 in the same holes.

Contained in cylinder 5 between its base 4 and piston 6 is a predetermined quantity of mercury 38 which nearly fills the space thus provided, leaving a small space for air. When the shell is fired the rifling in the gun causes it to rotate at high velocity, but the inertia of the mercury would

tend to prevent its rotation until this inertia is overcome by friction against the cylinder walls, which is inherently low. To accelerate the rotation of the mercury I provide a vane or impeller 39 securely fixed in a groove 40, which is machined in base 4 in such a manner as to provide a small aperture 41 between the lower edge of cylinder 5 and the bottom of groove 40. The surface tension of the mercury normally prevents it from entering this groove, but as soon as sufficient centrifugal force has been built up by the rapid rotation of the mercury caused by impeller 39, the mercury enters groove 40 and begins to escape through aperture 41. At the same time the mercury takes the form of a hollow cylinder and its pressure is exerted upward against piston 6. As soon as sufficient pressure has been thus built up to overcome the downward pressure on piston 6 exerted by spring 19, piston 6 rises until it strikes cylinder head 9. This movement is sufficient to disengage the wall of piston rod 8 from the notch in lug 21' of detent 21, which, being thus freed, is acted upon by centrifugal force and caused to rotate into the position shown in dotted lines in Fig. 2, where it is no longer interposed to prevent downward movement of percussion pin 14. The fuse is now armed, and ready to detonate the shell if it strikes a target. It is highly desirable that the fuse be not only "bone-safe"—incapable of exploding the shell in the bore of the gun—but that it should also travel a hundred yards or thereabouts before arming. This interval may be predetermined by providing a proper relationship between the speed of rotation of the shell, the dimensions of cylinder 5, the tension on spring 19 and the length and height of impeller 39.

After the action described in the foregoing paragraph causes the fuse to arm, the shell continues in flight and the air in the space inside the fuse and below percussion piston 17 is gradually exhausted and reduced in pressure. If the shell strikes its target, disc 31 at the nose of the fuse is instantly crushed in and strikes piston 17, forcing it downward against dog 24 which in turn forces percussion pin 14 into the primer 33, which explodes the detonator 34. This action is accelerated by the admission of air into the space above percussion piston 17, as the differential in air pressure above and below the piston acts upon its effective area to force it downward.

If the shell misses its target, it continues upward, but during its flight mercury escapes through orifice 41, gradually diminishing in volume and correspondingly decreasing the upward pressure on piston 6, which pressure is thus overcome by the downward pressure on the piston caused by spring 19, causing the piston and its rod to descend. Thus lug 25' of detent 25 is caused to traverse the slot 27 in piston rod 8, but the detent is held in fixed position against rotation as long as lug 25' bears against the side wall 27' of the slot. When the piston has descended to the bottom or near the bottom of the cylinder, lug 25' passes beyond the restraining side wall 27' and enters the enlarged notch 28, which interposes no further impediment to the rotation of detent 25, and, being thus freed to turn, the detent is acted upon by centrifugal force and caused to assume the position shown in dotted lines in Fig. 2, where it no longer restrains timing pin 15 against downward movement. Pressure of spring 30 against the timing pin now forces it downward into primer 33, causing detonation as described above.

While I have described my invention in minute detail, especially with reference to a specific embodiment thereof, it is not to be construed that I am limited to the design shown in the drawing, for, from the information herein disclosed, a variety of similar devices could be designed by those skilled in the art without departing from the spirit of the invention as embodied in the following claims.

What I claim is:

1. A delayed-arming percussion fuse for self exploding projectiles, consisting of a cylinder mounted axially in the fuse, fluid contained in the cylinder, an orifice in the cylinder wall permitting the escape of the fluid when the fluid is subjected to pressure, a piston movable axially in either direction in the cylinder and acted upon by pressure of the fluid set up by centrifugal force; a tubular piston rod fastened to the piston and provided with a notch and also provided with a longitudinal slot having an enlarged opening at one end; a primary pivoted detent engaging the notch in the piston rod; a primer, a primary percussion pin normally restrained by the primary detent but free to move against the said primer after the detent has been disengaged from the piston rod and swung, by centrifugal force acting thereon, out of the path of the primary percussion pin; a plunger arranged to depress the primary percussion pin against its associated primer; a secondary primer and a secondary firing pin adjacent thereto; a secondary detent engaging the secondary firing pin and also engaging the slot in the said tubular piston rod; means to depress the piston rod and piston after they have been disengaged from the primary detent engaging the notch in the piston rod; means to allow the secondary detent to be disengaged from the slot in the piston rod consisting of an enlarged opening in the said slot to permit the detent, when acted upon by centrifugal force, to emerge from the slot at a predetermined point in the travel of the said piston rod and simultaneously to swing out of the path of the secondary firing pin, and means to depress the said firing pin against the secondary primer.

2. A delayed-arming fuse for projectiles comprising a cylinder mounted axially within the fuse, fluid contained in the cylinder, a piston normally confining the fluid in the cylinder and movable in either direction axially within the cylinder, a tubular piston rod attached to the piston, a notch in the wall of the piston rod, a pivoted detent having a hook projecting through the notch in the piston rod and engaging the wall thereof, a percussion pin engaged by the detent when the detent engages the wall of the piston rod, but arranged to be disengaged from the detent when the detent is swung outwardly through centrifugal force, and a vane or impeller disposed substantially radially within the cylinder, fixed thereto, and surrounded by the fluid, for the purpose of imparting rotary motion to the fluid when the fuse is rotated, thus building up hydrostatic pressure due to centrifugal force to act upon the piston and cause it to move outwardly, disengaging the detent; the said vane or impeller being so proportioned as to impart to the fluid sufficient hydrostatic pressure due to centrifugal force to raise the piston and piston rod and release the detent at the end of a given period after the fuse has been caused to rotate at a predetermined rate.

3. A fuse for projectiles comprising a cylinder concentrically held within the fuse, mercury within the cylinder, a piston within the cylinder and confining the mercury, a piston rod attached to the piston; a detent engaging the piston rod and being engaged thereby, the said detent being adapted to restrain the piston from moving downwardly toward the head end of the cylinder, and further adapted to be operated by centrifugal force to disengage it from the piston rod; a spring acting upon the piston to force it downwardly when the said detent has been disengaged from the piston rod, an orifice permitting discharge of the mercury from the cylinder, a primer, a firing pin adjacent to the primer and restrained by the said detent until the detent has been disengaged from the piston rod, means to cause the firing pin to be depressed against the primer when the fuse strikes a target, and means to cause the mercury to rotate when the fuse and cylinder are revolved, thus building up hydrostatic pressure in the mercury due to centrifugal force and causing the mercury to lift the piston and release the said detent.

4. A fuse for projectiles comprising a cylinder concentrically held within the fuse, mercury within the cylinder, a piston within the cylinder and confining the mercury, a piston rod attached to the piston, a detent engaging the piston rod in such a manner as simultaneously to prevent movement of the piston toward the head end of the cylinder or movement of the detent away from the piston rod until the piston rod has been moved in the direction opposite to the head end of the cylinder, the said detent being further adapted to be operated by centrifugal force to disengage it from the piston rod; a primer, a firing pin adjacent to the primer and restrained by the said detent until the detent has been disengaged from the piston rod; means to depress the firing pin against the primer when the fuse strikes a target; and means to cause the mercury to rotate when the fuse and cylinder are revolved, thus building up hydrostatic pressure due to centrifugal force and causing the mercury to force the piston and rod outwardly of the cylinder and to release the said detent from engagement with the piston rod.

5. A delayed-arming fuse for projectiles of the self-exploding type, comprising a concentric cylinder, liquid contained therein, a piston superimposed on the liquid, a piston rod attached to the piston, a spring acting upon the piston rod to force the piston downward in the cylinder, a percussion pin, a detent engaging the percussion pin and the piston rod and arranged to be released therefrom by centrifugal force when the piston has been moved upwardly; a timing pin, a detent engaging the timing pin and the piston rod and arranged to be released therefrom by centrifugal force when the piston has descended a predetermined distance in the cylinder; means fixed within the cylinder to cause rotation of the liquid when the fuse and cylinder are rotated, thus creating hydrostatic pressure in the liquid due to centrifugal force for the purpose of lifting the piston against the counteracting pressure applied by the spring, and means to permit the escape of the liquid from the cylinder at a predetermined rate to allow the spring to force the piston downward.