April 14, 1925.

C. P. WATSON

1,534,011

PERCUSSION FUSE

Filed Sept. 22, 1921

2 Sheets-Sheet 1

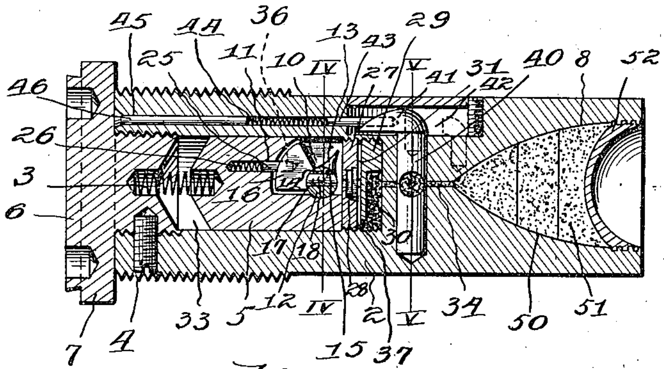

Fig. 1.

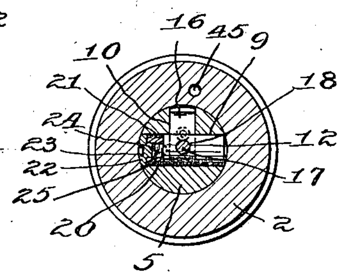

Fig. 4.

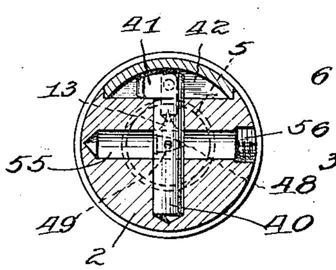

Fig. 5.

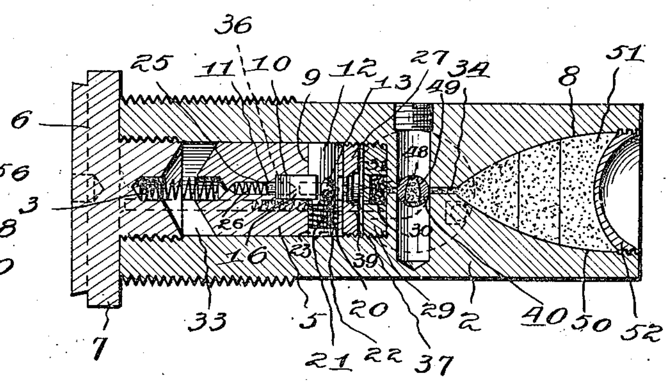

Fig. 2.

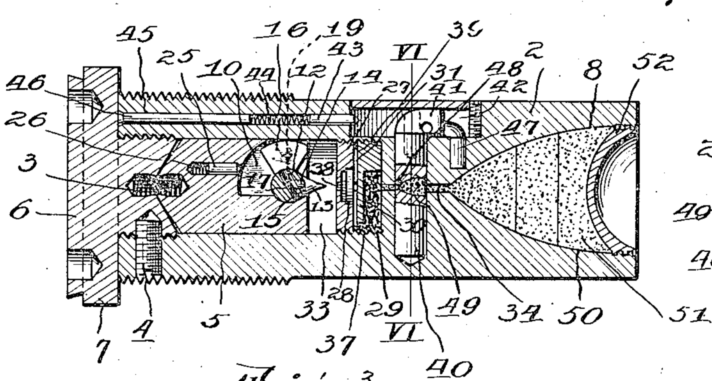

Fig. 3.

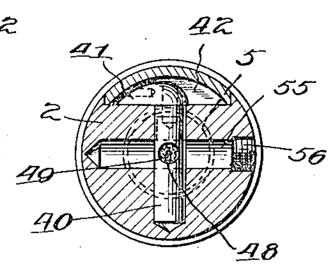

Fig. 6.

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PERCUSSION FUSE

Filed Sept. 22, 1921 | 2 Sheets-Sheet 2

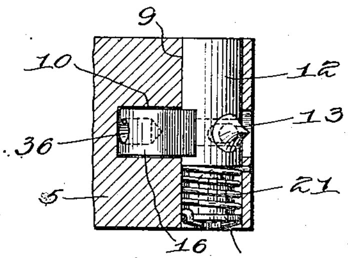

Fig. 7.

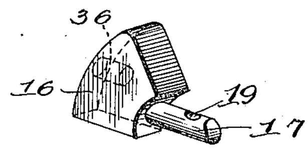

Fig. 8.

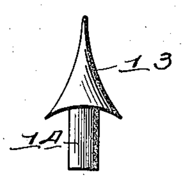

Fig. 9.

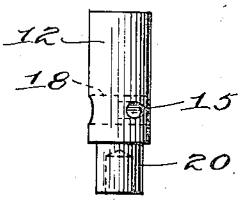

Fig. 10.

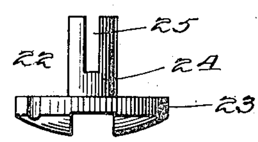

Fig. 11.

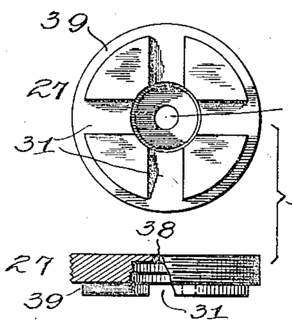

Fig. 12.

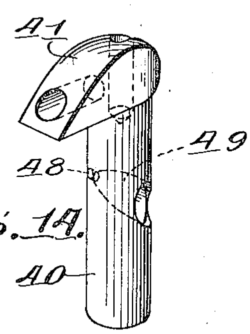

Fig. 14.

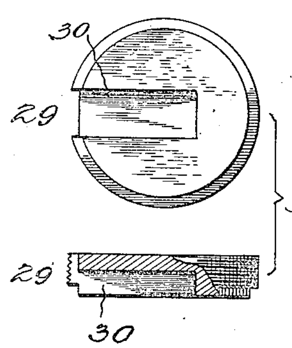

Fig. 13.

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Patented Apr. 14, 1925. **1,534,011**

UNITED STATES PATENT OFFICE.

CHARLES P. WATSON, OF YORK, PENNSYLVANIA.

PERCUSSION FUSE.

Application filed September 22, 1921. Serial No. 502,385.

To all whom it may concern:

Be it known I, Charles P. Watson, a citizen of the United States, residing at York, in the county of York and State of Pennsylvania, have invented certain new and useful Improvements in Percusssion Fuses, of which the following is a specification.

My invention relates to detonating percusion fuses used in connection with ordnance projectiles and has for its object to improve the same in construction and operation, as will be hereinafter pointed out.

In the accompanying drawings in which the preferred form of my invention is illustrated—

Figure 1 is a central longitudinal section of a fuse in unarmed condition.

Fig. 2 is also a central longitudinal section of the fuse taken on a plane at right angles to that on which Fig. 1 is taken.

Fig. 3 is a central longitudinal section on the same plane as is Fig. 1, showing the parts of the fuse in armed condition.

Fig. 4 is a transverse sectional view taken on the line IV—IV of Fig. 1.

Fig. 5 is a transverse section on the line V—V of Fig. 1.

Fig. 6 is a transverse section on the line VI—VI of Fig. 3.

Fig. 7 is a broken sectional view showing in elevation the firing pin mechanism on a large scale.

Fig. 8 is a detached perspective view of the eccentric weight associated with the firing pin.

Fig. 9 is a detached enlarged view of the firing pin.

Fig. 10 is a detail view in elevation of the supporting rocking pin or shaft that carries the firing pin.

Fig. 11 is a detail view of the adjusting means for the tension spring of the firing pin.

Fig. 12 illustrates in plan and broken edge view the plug or disc that carries the primer.

Fig. 13 illustrates in plan and broken edge view the plug or disc that carries the delay powder train.

Fig. 14 is a detail perspective view of the oscillating bolt that intercepts the channel of communication between the primer and the booster charge.

The fuse represented in the drawings is of the base type adapted to be screwed into the rear end of a projectile. It has a body 2, externally screw-threaded for engagement with the projectile. This body is preferably formed from cylindrical stock metal, cut to proper length and bored out internally to form a forward chamber 8 for the booster charge, and a rear chamber 33 in which are located the several functioning mechanical elements of the fuse, the two chambers being connected by a channel of communication 34.

The chamber 33 is open toward the rear end and is internally screw-threaded to receive a closing plug 6, which is formed with a flange 7 adapted to abut against and extend beyond the edge of the body portion 2 when the plug is screwed tightly in place, so that it constitutes the rear end flange of the fuse considered as a whole. The two parts, 2 and 6, of the fuse body or casing, are held together by a locking pin 4.

Within the chamber 33 is mounted the hammer block or movable plunger 5 that carries the firing pin. This plunger is preferably formed of a cylindrical piece of metal that fits the walls of the chamber 33 fairly closely, and is of a length somewhat less than that of the chamber, so that it is free to move longitudinally therein as the fuse functions, first toward the rear when it sets back upon the firing of the projectile from a gun, and later toward the front upon impact of the shell with the target. Between the rear end of the hammer block 5 and the closing plug 6 is located a coiled spring 3 the ends of which are seated in sockets formed therefor respectively in the hammer block and closing plug.

The spring tends to normally hold the hammer block in its forward position as indicated in Figs. 1 and 2. The rear end wall of the cavity 33, which is formed by the inner end of the closing plug 6, is of conical shape. The rear end of the hammer block is also of conical shape but with walls that slope more sharply than do those of the closing plug, this being best illustrated in Fig. 3. When the hammer block sets back, upon the firing of the shell carrying the fuse from a gun, the tapering end of the hammer block comes into violent engagement with the tapering recessed end of the plug 6, and, since these surfaces are not parallel with each other, the edges of the apertures in which the spring 3 is seated are deformed and closed somewhat, resulting in pinching the spring, which is now compressed to such a degree as to render it dead. The spring then acts to hold the hammer block in retracted position during the flight of the shell.

Through the forward portion of the hammer block is a transverse cylindrical opening 9 and with this communicates a slot 10, to the rear of which slot, and opening thereinto, is a longitudinal recess 11.

12 designates a transverse pin, carrying the firing point 13 and mounted so as to be free to oscillate in the hole 9. For convenience in construction the firing point is formed separate from the transverse pin carrying it, being formed with a stem 14 adapted to be set into a recess 15 formed therefor in the pin 12. The head of the firing point is formed with a substantial shoulder surrounding the stem 14 and bearing against the periphery of the pin 12. This construction makes a firing pin for a fuse that may be easily and cheaply manufactured, is of simple construction, and possesses great strength.

An eccentric weight 16 is also carried by the oscillating pin 12. Like the firing point it is separate from the pin, being formed with a stem 17 that fits into a recess 18 formed therefor in the oscillating pin 12. The stem 14 of the firing point intersects the stem 17 of the eccentric weight and enters a recess 19 formed in the stem 17, thus interlocking these parts. It will be understood that the stems of the firing pin and eccentric weight fit the recesses in which they are seated very tightly. The eccentric weight lies within the slot 10 formed in the forward end of the hammer block.

The weight 16 and the firing point are in such angular relationship to each other that when the parts of the fuse are in safety or unarmed position as indicated in Figs. 1 and 2, the weight lies to the rear of the oscillating supporting pin 12, at the axial center of the fuse, while the firing point 13 is to one side of the central axial line, lying entirely within the slot 10. But when the parts are in the armed position as represented in Fig. 3, as will be presently described, the firing point lies in the central longitudinal axis of the fuse, extending beyond the forward end of the hammer block, and the eccentric weight is to one side of the said central line, lying, however, within the recess 10, but in the forward instead of the rear part thereof.

In order to hold the firing point and the parts which are associated and move therewith in safety or unarmed position under all circumstances except when the shell carrying the fuse is fired from a gun, I employ a locking pin 25 adapted to enter a recess 36 in the weight 16, where it is normally held by a spring 26.

The oscillating transverse pin 12 is reduced near one end, as represented at 20, where it is surrounded by a spring 21, one end of which is secured to the plunger or hammer block as is represented at 61, Fig. 7, while its other end is connected with an adjusting device 22, carried by the pin 12, by which the tension of the spring may be varied. A convenient adjusting means for the spring consists of a short, headed bolt 24 firmly seated in the end of the transverse pin 12 so as to normally turn therewith, but supported in such manner that it may be adjusted, with reference to the pin 12. One end of the spring 21 is secured to this adjusting bolt 24,—as by being seated in a recess 60, Figs. 7 and 11, formed in the edge of the head 23 of the bolt,—so that when the latter is turned in one direction the spring is more tightly coiled, and hence the force with which it acts on the oscillating pin 12 is increased, whereas when the adjusting bolt is turned in the other direction the tension of the spring is relieved. The spring 21 is so arranged that its tension tends to move the oscillating pin 12 and the parts which it carries into the unarmed or safety positions indicated in Figs. 1 and 2.

The fuse herein illustrated is of the kind in which the firing point is moved from safety to armed position during the flight of the shell after it leaves the gun, the oscillation of the shaft 12, to carry the firing point from safety to armed position being caused by centrifugal force, generated by the rotation of the shell in its flight, acting upon the eccentric weight 16 and causing it to move from the position shown in Fig. 1 to that indicated in Fig. 3. As has been stated, the spring 21 acts upon the oscillating transverse pin to hold the parts in safety position and it is not until after the centrifugal force acting upon the eccentric weight 16 is greater than the force of the spring that the fuse will arm, and this centrifugal force is determined by the number of revolutions per minute given to the shell and to the fuse it carries. It is common practice in the manufacture of fuses, as an element of safety, to oppose the accidental arming of the fuse by spring action. Heretofore, it has been the custom to select a spring of supposedly proper tension and after placing it in the fuse subject the latter to the number of revolutions per minute specified for the arming of the fuse. If the spring selected be too stiff the fuse does not arm, while on the other hand, if it be not stiff enough it will arm too soon. The functioning of the parts in arming under such tests is noted, and if the spring be found to be either too weak or too strong, it is removed and another substituted therefor. This is a tedious and expensive procedure; and it is one of the objects of my invention to make it unnecessary, and this I accomplish by the means last described, namely, the spring 21 acting on the oscillating pin carrying the firing point and tending to hold it with a certain force in normal unarmed position, combined with means for adjusting the tension of such spring. In making and testing a fuse provided with my invention, a spring 21 is put in position and the bolt 24 adjusted so as to give, in the estimation of one making the test the proper tension to the spring. The fuse is then subjected to the spinning test and if the tension of the spring be found to be too great the adjusting bolt is turned in one direction, or if too little, it is turned in the other direction. In this way the spring can be accurately and rapidly adjusted and regulated without the necessity of removing it from the fuse after it is once put in place.

In order to render the torsion pin 22 easily adjustable I provide it with a head 23 shaped to have a screw driver or other tool applied thereto. The stem portion 24 of the adjusting bolt is seated in a central opening formed in the end of the oscillating pin 12. This stem is split at its end as indicated at 25′ in order to insure good frictional engagement between the adjusting bolt and the oscillating supporting pin or shaft 12.

The forward portion of the recess 33 in the fuse body, the portion in advance of the hammer block 5, is internally screw-threaded as indicated at 37, to support two disks or thing plugs,—a primer plug 27, Fig. 12, and a timing plug 29, Fig. 13. The former lies just in advance of the hammer block and has in its forward face a recess to receive and carry a primer or percussion cap 28. The primer plug or disk is centrally perforated at 38 in order to permit the firing point 13 to act upon the primer cap 28. A set of flash passages 31 are formed in the primer plug 27 radiating from the recess in which the primer cap is located. These passages open into a peripheral groove or flash passage 39. In the timer plug or disk 29 is formed a groove or passage 30 in which is placed a train of black or slow burning powder, one end of which communicates with the flash passage 39 from the detonating cap and the other end with the channel of ignition 34^a.

In order to interpose a safety barrier between the chamber carrying the booster charge and the chamber 33 in which is the primer, so as to prevent a premature firing of the charge or charges in the chamber 33 from setting off the booster charge, I arrange an oscillating bolt 40 in the body of the fuse, intercepting the channel of communication. This bolt is mounted in a seat formed therefor in the fuse body, and is formed with a diametric perforation 48 that, by proper oscillation of the bolt is adapted to be brought into line with the channel of communication, under conditions that will be presently described, and thus put the chambers 8 and 33 into direct communication with each other. The oscillating bolt is provided at one end with an eccentric head 41, lying in a recess 42 formed in the fuse body. Under normal safety conditions the head of the oscillating bolt lies to the rear as represented in Figs. 1 and 2, where it is held by a bolt or locking pin 43 acted upon by a spring 44. When in this safety position the diametric perforation through the oscillating cut off bolt is out of line with the channel of communication, and hence the latter is closed, cutting off communication between the chambers 8 and 33. The spring and locking bolt last referred to occupy a recess 45 in the body of the fuse. This recess is preferably formed by longitudinally perforating the body 2 to permit the insertion of the bolt and spring from the rear, after which the perforation is closed by a pin 46 held in place by the flange 7 of the closing plug 6. The oscillating bolt is released upon the firing of the gun, but remains in the position indicated in Figs. 1 and 2, that is, with its eccentric head 41 extending to the rear approximately parallel with the longitudinal axis of the fuse, so long as the shell carrying the fuse is violently accelerated, that is, while in the bore of the gun and for a short time thereafter. Then, however, when this acceleration ceases, centrifugal force due to the rotation of the shell and fuse, acting upon the eccentric head 41 of the oscillating bolt, causes it to assume the position indicated in Figs. 3 and 6 where it is transverse to the longitudinal axis of the fuse. This movement of the arm or head 41 oscillates the bolt 40, bringing its diametric perforation into line with the channel of communication. A stop pin 47 arrests the eccentric head 41 in proper position to cause the perforations 48 and 34 to register.

The transverse diametric perforation through the oscillating bolt is enlarged toward the front, the inner walls being preferably of an ellipsoidal curvature. The enlarged cavity thus formed is preferably loaded with a small charge of detonating explosive, which charge is commonly known as the detonator that is fired at the small end of the chamber by the flash coming from the chamber 33 through the passage 34^a.

I have discovered that when a charge of a detonating explosive is loaded into a cavity the walls of which are of ellipsodial or parabolic shape the effectiveness of the charge is very materially increased. The reasons for this as I believe are that the detonating waves of force, produced by the explosion or detonation of the charge, are, by the walls of the chamber in which the charge is placed, reflected forward or toward the open end of the chamber, and as this end is toward the booster chamber 8 the detonating waves of force are all, or very largely, diverted in this one direction.

I also form the chamber 8 with walls of ellipsoidal or parabolic curve shape as indicated at 50, and I do this for the same purpose as I shape the enlargement 49 of the diametric perforation through the oscillating bolt 40. The walls 50 of the chamber 8 direct the detonating waves of force in a forward direction toward the cavity of the shell, and into and against the exploding charge which it carries, thus very much intensifying the effect of the booster charge. The booster charge is preferably formed of a series of compressed pellets 51 shaped to conform to the cavity in which they are loaded.

I close the open enlarged end of the booster cavity 8 by means of an arched plug or shield 52 of sufficient strength to hold the booster charge in place under all conditions of accident or service to which the fuse may be subjected until the moment when it is to be fired upon impact with the target.

The recess 42 in which lies the eccentric head of the oscillating cut-off bolt 40 is closed by a plate 53.

When the fuse is loaded and its parts locked in safety relationship they occupy the positions represented in Figs. 1, 2, 4 and 5. The firing point is then within the cavity 10, where it is locked by the retaining bolt 25, and therefore cannot act upon the primer whatever be the movement of the hammer block as a whole within the fuse body. Likewise the oscillating bolt 40 is locked in safety position by the bolt 43, and hence communication between the chambers 8 and 33 of the fuse is cut off, making it impossible for a premature explosion of the primer cap or the delay powder charge located in the chamber 33, or the detonating charge in the chamber 49 of the oscillating bolt 40 to fire the booster charge of the fuse. Before the fuse is loaded and finally assembled the tension of the spring 21 is adjusted so as to hold the firing pin in safety position with a force that will yield to opposing centrifugal force acting on the weight 16 only when the fuse is rotated at a determined number of revolutions per minute. This is an additional element of safety as it maintains the firing pin in unarmed position even should the locking pin or bolt 25 fail to function and the fuse at the same time be subjected to rapid rotation about its longitudinal axis, such as would be produced should the shell carrying the fuse roll down an inclined plane. Should a loaded fuse be dropped and strike upon its base it might happen that the locking bolts 25 and 43 would move to the rear sufficiently to release both the firing point and the oscillating cut-off bolt. But the force of inertia which would cause such movements of the retaining bolts would at the same time act upon the eccentric weight 16, and the eccentric head 41, and tend to maintain these in the safety positions indicated in Fig. 1, so that even should these parts be unlocked as described there would be no tendency for them to move to armed positions, but on the other hand there would be an added force acting on them to retain them in safety positions.

The carrying pin 12 for the firing point, and the oscillating cut-off bolt 40, are both strongly supported when in their respective seats so that no jar or shock to which the fuse may be subjected, short of the impact on armor plate of the fuse and shell, will be able to deform these parts or cause them to bind or stick in their bearings. Hence these parts are always in condition to function when released.

When a shell carrying a fuse such as I have described is fired from a gun the sudden and violent forward movement imparted to the shell causes all the movable parts of the fuse, including the hammer block and the locking pins or bolts 25 and 43, to set back, due to inertia. These parts are held in their set back positions, so long as acceleration of the speed of the shell takes place, that is, during its entire passage through the bore of the gun and for a distance of some feet after it leaves the muzzle thereof. Bore safety is thus insured.

Covering the period of time when acceleration of the shell ceases and retardation thereof begins, the moving parts of the fuse are in equilibrium, as to inertia, but are subjected to full centrifugal force, for the shell is now rotating at maximum velocity. Centrifugal force acting upon the weight 16 causes it to move from the position shown in Fig. 1 to that indicated in Fig. 3, and this movement carries the firing point into armed position in line with the opening 38 in the primer disk 27. Centrifugal force acting on the head 41 oscillates the cut-off bolt 40 and brings the diametric opening through it into register with the channel of communication. The parts now occupy their armed positions, illustrated in Fig. 3, which are held during the flight of the shell and until impact thereof with the target or other object. Upon such impact the hammer block moves violently forward within the fuse and the firing point pierces the primer cap, exploding it. The flash from the cap issues through the passages 31 and ignites the powder train in the timing plug or disk 29. This powder train is of such nature as to insure the desired delay between the firing of the percussion cap and the ignition of the detonator. The flame therefrom finally enters the diametric perforation in the oscillating cut-off bolt 40 and ignites the small detonating charge in the cavity 49, the peculiar shape of which causes the detonating waves produced by the firing of the charge therein to be directed in a forward direction and so that they act most efficiently upon the booster charge to cause a high order of detonation thereof. The walls of the cavity 8 in which this latter charge is located are shaped, as has been described, so as to reflect the detonating waves produced by the booster charge and direct them in a forward direction and into the mass constituting the explosive charge of the shell. By reflecting the detonating waves and directing them where they may act with the greatest effectiveness I am enabled to secure detonation of the bursting charge of the shell of high order, with great certainty and uniformity of result.

It will be seen that when the fuse is in armed position there are two charges of high explosive supported in cavities having walls that flare toward the front. These walls are of peculiar shape for the purposes of directing the detonating waves, as has already been described; but there are other advantages incident to the form of the cavities, which I will now state. By making them of arch shape in cross section, as shown, the supporting walls are of great strength and are not likely to give way or deform should there be side impact of the shell during flight. This is of particular advantage in connection with the relatively large cavity for the booster charge. Upon impact of the shell with the target the masses of the detonating charges, within the cavities 8 and 49, tend to move forward and become highly compressed, particularly in their forward portions, and this compression, in the case of a sensitive explosive, sometimes causes a premature detonation of the charge, and hence a bursting of the shell before it has pierced the armor of the target. With the charge cavities shaped as shown and described compression of the masses of explosive is not nearly so great as though the cavities were of inverted shape, that is, with the smaller end toward the front; and is also very considerably less than where the charge cavities are cylindrical in shape. Therefore the danger of premature explosions due to the compression of the detonating charges in the fuses is reduced. This is of particular advantage in connection with the charge carried in the cavity 49.

Upon impact of the shell the safety bolts 25 and 43 move forward and come respectively behind the eccentric weight 16 and the eccentric head 41 holding these parts in armed or functioning positions. While it is not at all likely that the parts referred to would, upon impact, tend to move from armed to safety position, the arrangement just described positively insures against such a possibility.

It is entirely feasible to use an arrangement like the spring 21 and the tension controlling pin 22 in connection with the oscillating cut-off bolt 40. However, I do not under ordinary conditions consider this to be essential and the arrangement shown is simpler and cheaper.

The spring 21 could be arranged to positively move the part that it controls to armed position, instead of having it operate to retard such movement as is shown and as has been described. Such an arrangement might be desirable in connection with fuses used in trench mortar bombs where rotation of the projectile is very slow and centrifugal force incident to such rotation might not be depended upon to cause the arming of the part with which the spring is associated.

55 indicates a perforation extending part way through the fuse body 2 preferably at right angles to and intersecting the seat for the oscillating bolt 40. A plug 56 closes the outer end of this aperture. The perforation 55 constitutes a chamber into which gases of combustion could expand should there be a premature detonation of the charge carried by the oscillating bolt 40, the cavity 49 communicating with such chamber when the bolt is in safety position and the fuse unarmed.

I have herein employed the term "channel of communication" to define that passage which is between the primer 28 and the inner end of the chamber 8. This channel of communication is divided, by the oscillating bolt 40 that acts as a safety barrier, into two parts, a channel of detonation, 34, located between the detonator and the booster, and a channel of ignition, 34[a], between the chamber 33 and the detonator. A third, and remaining, portion of the channel of communication is the diametric perforation through the oscillating bolt 40, which, in the form of invention herein illustrated, serves as the cavity in which is placed the detonator.

Both of the cavities, 8 and 49, in which are loaded detonating charges, and the walls of which are shaped to reflect and direct forwardly the waves of detonating force are formed in parts of the fuse that are rigid and strong, the surrounding walls being thick and closing the base or rear ends of such cavities, except for the passages through which the said charges are detonated, which passages are of as small size as is consistent with their proper functioning. The cavities are thus practically closed at their inner or rear ends, so that such end portions thereof (as well as the remaining portions of the cavity walls) serve as reflecting surfaces and direct forwardly the waves of detonating force which impinge thereupon and prevent them, and the gases of combustion, from passing, to any appreciable extent, to the rear, from their respective cavities.

A detonating fuse of the percussion type such as is herein described, has many striking advantages over detonating fuses that have heretofore been employed. By the use of a cavity,—enlarged toward the front and of curved shape, preferably ellipsoidal,—formed in a rigid part of the fuse and serving as a container for the detonator, it is practical to use for the latter only approximately from one-fifth to one-sixth of what has heretofore been required. The reduction in the quantity of explosive employed for the booster charge is even more marked, and this I have been enabled to reduce to one-fifth or less of that heretofore employed. As a result the detonating fuse herein described is much smaller than those heretofore employed, thus utilizing more space in the shell for the bursting charge, and not unduly weakening the base of the shell.

This detonating fuse possesses another special property in that by virtue of the properties of the curved surfaces of the containers for the detonator and booster charges it is practical to so concentrate the waves of detonation that a shell-bursting charge of high explosive may be detonated across a considerable air gap. This property of the fuse is of important military application, since it is recognized that in firing a high explosive shell against armor an air gap will be formed in the base of the shell due to the set forward of the explosive charge on the impact of the shell. Likewise an air gap may be formed at the base or rear of the booster charge due to its set forward upon impact. So, also, air gaps or hollow spaces are sometimes unavoidably left in loading fuses and explosive charges, it being impossible to prevent these conditions. The detonating fuse herein described by virtue of its ability to direct and concentrate waves of detonating force across an air gap effectively secures detonation of a high order of the booster or other explosive charge.

It has been recognized for some time that a detonator composed of fulminate of mercury may be compressed to such an extent as to render it practically non-explosive or inert to severe shocks, and when thus compressed the tendency on the part of fulminate of mercury is to burn rather than detonate upon being ignited. But in the use of a fuse employing a loading cavity for a detonator such as herein described, it has been found practicable to compress fulminate of mercury as high as 20,000 pounds per square inch and yet secure good detonation. It is very important in the loading of detonating fuses for armor piercing shells that a detonator of fulminate of mercury shall receive sufficiently high initial loading compression to withstand the shock incident to the impact of the shell against armor plate.

The novel features of the invention herein described are applicable not only to fuses employed for the detonation of high explosive shells, but also may be used in connection with bombs, torpedoes and other containers of charges of high explosive whether used for military or commercial purposes.

I do not in this case claim a fuse having a chamber into which the booster charge may be loaded from the front, an opening or seat into which the barrier bolt 40 may be inserted from the side, and a chamber for the firing mechanism and primer elements adapted to receive these parts from the rear, the construction of the fuse body being such that the assembly of the fuse parts and its loading into the said chambers or cavities may take place each independently of the other, as this subject matter is more fully described and claimed in a co-pending application bearing Serial No. 659,623 filed by me August 27, 1923. Nor do I claim in this case a fuse, the body or stock of which has a channel of detonation adapted to be intercepted by a movable barrier, such fuse being formed with an expansion chamber in proximity to the barrier and a detonator at the rear of the channel of detonation, the expansion chamber being open to the exterior so there may be inspection of the barrier after the fuse parts are assembled, and arranged to be closed by a removable plug, as these elements are also more fully described and claimed in my aforesaid application. The fuse illustrated in my said later application is a development of the fuse illustrated and described in this case and the two cases are thus closely related, and it is my purpose that the patents to be issued respectively on the two applications shall bear the same date.

What I claim is:—

1. In a fuse, the combination with an oscillating part adapted to occupy either a safety or an armed position, a bolt for holding the part in safety position, arranged to be set back to release the part upon the firing of the projectile carrying the fuse from a gun, and a spring acting on the oscillating part to control its movements after it has been freed by the set back of the locking bolt.

2. In a fuse, the combination with a functioning part arranged to be moved into armed position by centrifugal force generated by the rotation of the shell carrying the fuse, and means for retarding such operation until a determined number of revolutions per minute are attained by the shell, of means for varying at will the retarding effect of the last said means.

3. The combination stated in claim 2 including also a locking means for positively holding the functioning part in safety position arranged to be released upon firing the shell carrying the fuse from a gun.

4. In a fuse, the combination with a functioning part arranged to be moved into armed position by centrifugal force generated by the rotation of the shell carrying the fuse, and a spring for opposing the said movement and retarding it until a determined number of revolutions per minute are attained by the shell, and means for varying at will the tension of the spring.

5. The combination stated in claim 4 including also means for positively locking the said functioning part against arming movement, arranged to be released upon the shell carrying the fuse being fired from a gun.

6. In a fuse, the combination with a movable firing point arranged to occupy either a safety or an armed position and to be moved into the latter position by centrifugal force generated by the rotation of the shell carrying the fuse, means for retarding the arming of the fuse under centrifugal action until a certain determined number of revolutions per minute are attained by the shell, and means for varying at will the retarding effect of the last said means.

7. In a fuse, the combination with a firing point adapted to occupy either a safety or an armed position and arranged to be moved into the armed position by centrifugal force, a spring acting on the firing point holding it in safety position and retarding its movement to armed position until a determined number of revolutions per minute are attained by the shell, and means for varying at will the tension of the spring and its retarding effect upon the firing point.

8. In a fuse, an oscillating part turning about an axis that is transverse to the longitudinal axis of the fuse and the shell that carries it, arranged to occupy either a safety or an armed position, means for holding the said oscillating part normally in the safety position arranged to be operated to release the oscillating part upon the shell being fired from a gun, and a spring acting upon the oscillating part to control its movement after it has been freed by the release of the locking means.

9. In a fuse, the combination with a hammer block, of a transverse oscillating shaft or pin supported in the hammer block and a firing point carried by the said transverse pin, the firing point being separable from the pin and having a stem seated in an aperture in the pin.

10. A firing pin for a fuse, comprising a transverse shaft constituting an oscillating support, a separate firing point having a stem seated in an aperture provided therefor in the transverse oscillating shaft, and an eccentric weight separate from the transverse oscillating shaft and formed with a stem seated firmly in a hole provided therefor in the shaft, the weight being arranged to be acted upon by centrifugal force when the shell carrying the fuse is in rotation to move the firing point into armed position.

11. The combination stated in claim 10, having the stems of the separate weight and the separate firing point interlocking with each other when such stems are respectively seated in the holes provided therefor in the oscillating shaft.

12. In a fuse, a functioning element arranged to occupy either a safety or an armed position, a transverse oscillating shaft or pin carrying the said functioning element a coiled spring surrounding the shaft or pin and having one of its ends secured fast, and a tension device to which the other end of the spring is secured supported by the oscillating shaft or pin, and adjustable relative thereto to vary the tension of the spring, the spring being arranged to act upon the oscillating shaft or pin with a force determined by the adjustment of the spring.

13. In a fuse, a functioning element arranged to occupy either a safety or an armed position, a transverse oscillating shaft or pin carrying the said functioning element, a coiled spring surrounding the shaft or pin and having one of its ends secured fast, and the other end connected with the oscillating shaft or pin and arranged to hold it with the said functioning element in unarmed position, an eccentric part carried by the oscillating shaft or pin arranged to be acted upon by centrifugal force due to the rotation of the fuse to move the shaft or pin to armed position when the rotation of the fuse attains a certain speed, and a tension regulating device carried by the oscillating shaft or pin, through which the spring is connected therewith, and by which the tension of the spring may be varied at will.

14. In a fuse, the combination of a hammer block, an oscillating pin supported transversely in the hammer block and carrying a firing point and also an eccentric weight, the latter adapted to be acted upon by centrifugal force due to the rotation of the fuse to move the firing point into armed position, a spring coiled about the oscillat-

ing pin and having one end connected with the hammer block, and a tension regulating device with which the other end of the spring is connected, supported by the oscillating pin and adjustable relative thereto whereby the tension of the spring may be varied, the spring being arranged to exert its force to hold the oscillating pin with the firing point in safety postion.

15. A detonating fuse formed with a chamber for a booster charge and another chamber in which are located the primer and the movable functioning elements that fire the primer, these chambers being connected by a channel of communication, the forward portion of which constitutes the channel of detonation and the rear portion a channel of ignition, a movable bolt supported in the fuse body at the junction of the said channels of ignition and detonation, interrupting the channel of communication and arranged to constitute a closing barrier at this place when moved to safety position, and having a passage through it arranged to register with and constitute part of the channel of communication when the bolt is moved to armed position, and a detonator that is fired by the primer through the channel of ignition, and is located to the rear of the said channel of detonation.

16. The combination stated in claim 15 having the detonator supported in a cavity in the movable barrier bolt.

17. The combination stated in claim 17 having the walls of the cavity in which is located the detonator shaped to reflect and concentrate the detonating waves produced by the explosion of the detonator and direct them through the channel of detonation and into the chamber containing the booster charge.

18. In a detonating fuse formed with a chamber to receive a booster charge and another chamber in which are located the primer and the movable functioning parts that fire the primer, these chambers being connected by a channel of communication, a rotatory bolt supported in the fuse body so as to intercept the said channel and to constitute a closing barrier betwen the chambers when moved to safety position, the bolt having a diametric passage through it arranged to register with and constitute part of the channel of communication when the bolt is rotated to assume armed position and a detonator supported in the diametric passage through the rotatory bolt.

19. A fuse such as described in claim 18, having the cavity through the rotatory barrier bolt shaped to reflect the detonating waves, produced by the detonation of the charge therein, in a direction toward the channel of detonation leading to the chamber carrying the booster charge.

20. A detonating fuse having a chamber for a booster charge and another chamber in which are located a primer and the functioning mechanism for firing the primer, a channel of communication between the said chambers, a movable safety barrier for closing the said channel except when the fuse is armed, a detonator for firing the booster charge, which detonator is fired by the primer, the detonator being located in a cavity constituting part of the channel of communication, and the walls of which cavity are shaped to reflect and concentrate the waves of detonating force and direct them forwardly through the said channel and into the booster charge.

21. A detonating fuse, comprising a body in one end of which is a chamber for the booster charge, the walls of such chamber converging at the rear inner end thereof so as to close the cavity except for a channel of detonation, and being of a curvature to direct the waves of detonating force, produced by detonation of the booster charge, forwardly and into the bursting charge of the shell to which the fuse is applied, and automatically operating means for detonating the booster charge.

22. A detonating fuse, comprising a body in one end of which is a chamber for the booster charge the walls of which chamber converge at the rear, so as to close the chamber, except for a channel of detonaticn leading to the chamber, and being curved to direct and concentrate the waves of detonating force, produced by the detonation of the booster charge, into the bursting charge of the shell to which the fuse is applied.

23. A detonating fuse comprising a body in one end of which is a chamber for a detonating charge, the walls of which chamber converge at the rear so as to close the chamber except for a channel through which the charge may be detonated, and being of a curvature to direct the resulting waves of detonating force forwardly and out of the chamber.

24. A detonating fuse comprising a body in one end of which is a chamber for a detonating charge, the walls of which chamber converge at the rear so as to close the chamber except for a channel through which the charge may be detonated, and being of a curvature to reflect and concentrate the resulting waves of detonating force forwardly and out of the chamber.

25. A detonating fuse comprising a body in one end of which is a chamber for a detonating charge, the walls of such chamber being of ellipsoidal curvature.

26. A percussion fuse, having a body formed with a chamber the rear wall of which is conical, a plunger or hammer block located in the said chamber having its rear

end conical, the angle of the conical end of the hammer block being sharper than the angle of the conical end of the chamber in which it is located, and a coiled spring interposed between the hammer block and the rear end of the fuse body, its ends being seated in recesses formed therefor in the fuse body and the hammer block, the edges of the said recesses being adapted to be deformed and caused to grip the compressed spring upon the set back of the hammer block when the shell carrying the fuse is fired from a gun.

27. A percussion fuse having a body formed with a chamber open toward the rear and arranged to contain the primer and the functioning parts that fire the fuse, a safety device supported in the body of the fuse, a longitudinally movable locking bolt for holding the said safety device locked in safety position, the locking bolt being movable in a longitudinal opening from the rear in the body of the fuse, a spring in the said opening acting upon the locking bolt, a pin for closing the opening from the rear and a screw-threaded plug engaging with the body of the fuse to close the chamber in which are the primer and firing parts, the said plug having a flange adapted to overlie and hold in place the pin closing the opening in which moves the said locking bolt.

28. In a percussion fuse, the combination of the fuse body in which is formed a cavity, a hammer block carrying a firing pin movable in the body, a thin disc carrying a primer, having screw-thread connection with the fuse body and located in position to have the primer struck by the firing pin, a second disc constituting a carrier for a delay powder train supported in the fuse body adjacent to and in advance of the disc carrying the primer, one end of the train being located to be ignited by the flash from the primer, and a detonating charge to be fired by the flame from the delay train.

29. The combination stated in claim 28 in which the flame passage from the primer to the end of the delay train which is first ignited is tortuous, whereby such train is not subjected to the direct blast of flame from the primer.

30. In a percussion fuse, the combination of a fuse body formed with two chambers, one to receive a booster charge and the other the firing mechanism, these being separated by a rigid partition wall through which is a channel of communication, an explosive train for firing the booster, arranged to be fired by the firing mechanism, the train being of independent explosive elements, and separable carriers for independent elements of the explosive train adapted to be inserted into and secured within the chamber in which is located the firing mechanism.

31. In a percussion fuse, the combination of a fuse body formed with chambers, one to receive a booster charge and the other the firing mechanism, the chambers being separated by a partition wall through which is a channel of communication, a removable carrier for a primer arranged to be secured within the second chamber herein referred to so as to hold the primer in position to be acted upon by the firing mechanism after the fuse is armed, and a second removable carrier for an explosive charge constituting an element of the explosive train between the primer and the booster, located between the carrier for the primer and the wall separating the two mentioned chambers in the fuse body.

32. In a detonating fuse for a high explosive shell, the combination of a booster charge and an exterior detoantor for firing it through a channel of detonation, the center of gravity of the detonator continuing approximately fixed relative to the booster charge, and a carrier for the detonator so shaped and constructed as to reflect, direct and concentrate forward through the said channel the waves of detonating force produced by the explosion of the detonator and across any air gap that may be formed incident to the assembling, or set forward of the booster charge upon impact of the shell carrying the fuse.

33. In a detonating fuse for a high explosive shell, the combination of a fixed detonator, a booster charge to be fired by the detonator, there being an uninterrupted channel of detonation between the detonator and the booster charge, means for firing the detonator including a delay element, and a carrier for the detonator so shaped and constructed as to reflect, concentrate and direct forward through the channel of detonation and any air gap that may be produced by the assembling, or set forward of the booster upon impact of the shell, and before the detonator is fired, the waves of detonating force resulting from the firing of the detonator.

34. In a detonating fuse, the combination of a rotatable member, a detonator held in such member, an explosive charge and a channel of detonation between the said member and explosive charge, the center of gravity of the detonator continuing approximately fixed relative to the explosive charge, and means provided for rotating the said member causing the detonator to be moved from a safe to an armed position in alignment with the path of detonation.

35. In a detonating fuse, the combination of an oscillating barrier bolt, a detonator held in the barrier bolt, a booster charge, a channel of detonation between the said barrier bolt and booster charge, the center of gravity of the detonator continuing ap-

proximately fixed relative to the booster charge, and means provided for rotating the said barrier bolt, causing the detonator to be moved from a safe to an armed position and in alignment with the channel of detonation.

36. In a detonating fuse for a high explosive shell, the combination of an oscillating barrier bolt, a detonator held in the barrier bolt, a booster charge, a channel of detonation between the said barrier bolt and booster charge, the center of gravity of the detonator continuing approximately fixed relative to the booster charge, and means provided for holding the said barrier bolt and detonator in safe position and for rotating them into armed position, causing the detonator to be in alignment with the channel of detonation on the set back and rotation of the shell when fired from a gun.

CHARLES P. WATSON.

Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,534,011, granted April 14, 1925, upon the application of Charles P. Watson, of York, Pennsylvania, for an improvement in "Percussion Fuses," an error appears in the printed specification requiring correction as follows: Page 8, claim 17, at the end of line 35, for the numeral "17" read *15;* and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 12th day of May, A. D. 1925.

[SEAL.]

KARL FENNING,
Acting Commissioner of Patents.