C. P. WATSON.

DETONATOR FOR ORDNANCE PROJECTILES.

APPLICATION FILED JULY 27, 1915.

1,311,104. Patented July 22, 1919.

Fig. 1

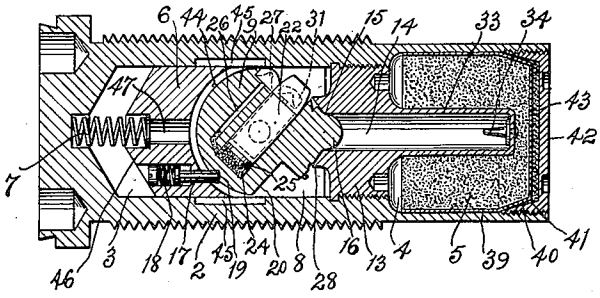


Fig. 2

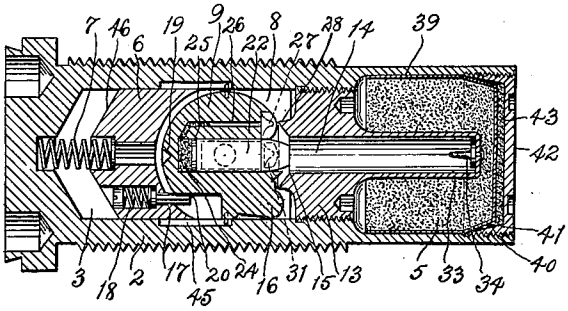


Fig. 3

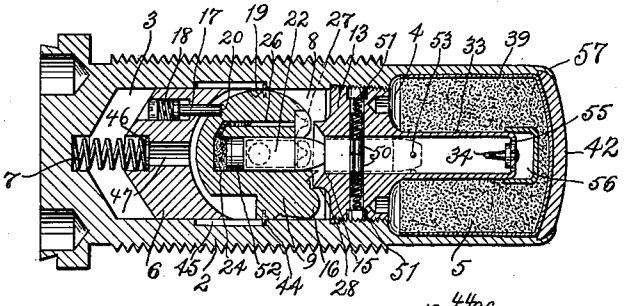


Fig. 4

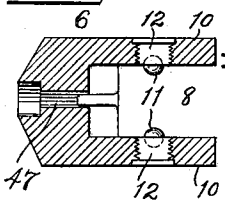


Fig. 5

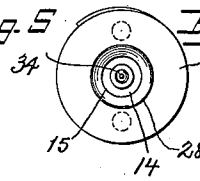


Fig. 6

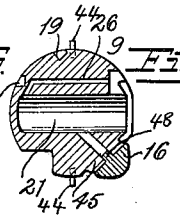


Fig. 7

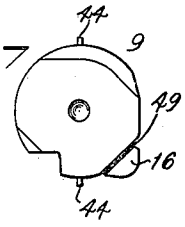


Fig. 8

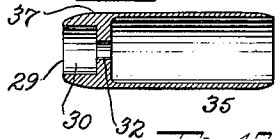


Fig. 9

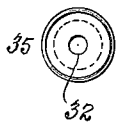


Fig. 10



Fig. 11

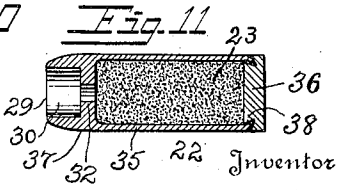
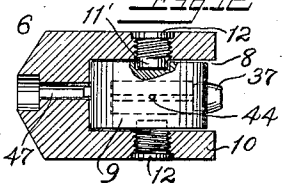


Fig. 12



Inventor

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By John S. Barker

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UNITED STATES PATENT OFFICE.

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DETONATOR FOR ORDNANCE-PROJECTILES.

1,311,104. Specification of Letters Patent. Patented July 22, 1919.

Application filed July 27, 1915. Serial No. 42,134.

To all whom it may concern:

Be it known that I, CHARLES P. WATSON, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Detonators for Ordnance-Projectiles, of which the following is a specification.

My invention relates to detonators for ordnance projectiles, it having been devised with especial reference for use in connection with projectiles loaded with high explosives; and it has for its object to render the detonator certain in its operations, safe against accidental or malicious firing, to improve the mechanism thereof, and to reduce its length.

In the accompanying drawings—

Figure 1 is a longitudinal sectional view of a detonator embodying my invention, the parts being represented in the positions they occupy when the detonator is unarmed.

Fig. 2 is a longitudinal sectional view of the detonator armed.

Fig. 3 is a longitudinal sectional view of a detonator the parts of which are in arming position, and the detonator being in some features, to be pointed out, different from the detonator illustrated in Figs. 1 and 2.

Fig. 4 is a longitudinal sectional view, detached, of the plunger.

Fig. 5 is an inner end or face view of the partition separating the two main chambers of the detonator.

Fig. 6 is a longitudinal sectional view of the turret, and embodying some features not found in the form of turret illustrated in the other views.

Fig. 7 is a side elevation of a turret, of a slightly different construction from those illustrated in the other views.

Fig. 8 is a longitudinal sectional view of the casing for the miniature projectile or capsule that carries a charge of high explosive.

Fig. 9 is a rear end view of the casing shown in Fig. 8.

Fig. 10 is a sectional view of the base piece for closing the rear end of the casing shown in Figs. 8 and 9.

Fig. 11 is a longitudinal sectional view of the miniature projectile or capsule loaded but not capped.

Fig. 12 is a longitudinal sectional view of a plunger and turret supported therein, the pivotal mounting of the latter being different from that illustrated in the other views.

Figs. 8 to 11 are drawn to a scale twice that of the other views.

In the drawings 2 indicates the shell or case of the detonator. This is preferably in the form of a steel plug of high tensile strength, exteriorly screw-threaded so as to be adapted to be screwed into the breech of a shell, and bored out to form a central chamber open at its forward end.

The walls of the case surrounding this central chamber vary in thickness at different parts, that portion at the forward end surrounding the chamber 4 being relatively thin. In this chamber, 4, is located the booster charge 5, the detonation of which ruptures the detonator and fires the main charge of explosive within the projectile.

It is the object of the mechanism contained in the case 2 to cause a certain and high order of detonation of the booster charge at the instant desired, and to absolutely prevent the accidental explosion or detonation of that charge at all other times. One of the elements of the apparatus employed to cause the detonation of the booster charge is a ponderous body located in the rear chamber, 3, of the case 2, the movements of which body are controlled, and which, when the moment for exploding the shell arrives, operates by percussion to cause the firing of a minor charge of explosive, through the detonation of which the booster charge is fired. The ponderous body is a plunger, 6, free to move in its chamber within the case 2 except when positively restrained, the inner walls of such chamber being preferably smooth and the plunger fitting them quite closely though not so tightly as to interfere with its free longitudinal movements. A spring 7 is located behind the plunger and between it and the rear wall of the case 2, and acts to normally hold the plunger in its forward position. While this spring is not essential to my invention I prefer to use it, as it prevents the plunger from moving when the shell is being handled, and, though such movements would not be attended with danger, they might awaken suspicion on the part of one handling a shell provided with my invention who was

not informed as to its construction and operation. It will be understood that the plunger 6 sets back at the instant the shell is fired from the gun, compressing the spring 7; and it is while the plunger is thus set back that the detonator is armed, that is to say, its parts come into position, rendering it possible to explode the shell upon impact thereof; and the arming is caused by the joint operation of inertia, causing the setting back of the plunger, and of centrifugal force due to the rotation given the shell by the rifling of the gun, causing movements of parts, to be described, that bring the detonator into armed condition.

In the forward portion of the plunger 6 is formed a slot 8 extending entirely through it transversely, and within which is mounted a turret 9. This turret is mounted upon bearings located in the diametrically opposite parts 10 of the plunger. I preferably use steel balls 11 as such bearings, each resting in recesses semi-spherical in shape and formed respectively in short bolts 12 screwed into the parts 10 of the plunger, and in the side walls of the turret 9.

The turret carries a body of explosive material adapted to be set off by percussion, the firing of which, either mediately or immediately, causes the detonation of the booster charge. I prefer that there should be a series of explosive charges that act in succession, the first being fired by percussion due to the operation of the ponderous body or plunger 6, and the last immediately causing the detonation of the booster charge, in order that there may be a very slight delay between the impact of the shell and the bursting thereof, and the specific arrangement of parts and explosive charges that I prefer to use will be later described.

Between the chamber 4 in which is located the booster charge, and the chamber 3 in which is placed the plunger 6 and the turret which it carries, is a partition 13, which is preferably in the form of a screw-threaded plate, perforated, as indicated at 14, to permit, at the proper moment, communication to be established between the two chambers that the partition separates, in order that the booster charge may be fired from the other chamber.

In order to insure safety the perforation 14 through the partition that separates the two chambers of the detonator should be closed gas-tight at all times except when the detonator is armed, so that should from any cause whatever the charge or charges of explosive located in the rear chamber become accidentally ignited or detonated the waves of force and the highly heated gases, engendered by such accidental firing or detonation shall not under any possibility have access to the chamber at the forward end of the detonator and the charge of explosive located therein. I therefore provide a valve for closing the opening through the partition gas-tight, so long as the detonator is unarmed, and the arrangement preferred I will now describe.

15 designates a valve seat formed in the face of the partition 13 around the perforation 14 therethrough. Against this seat sets a valve 16. This valve preferably is carried by the turret 9, relative to which it is eccentric and has a parti-spherical face finished to set somewhat into the perforation 14 and to fit the valve seat 15 gas-tight. It is carried by the turret 9, and when the latter is in its safety position and held forward by the spring 7 the valve is seated. A locking bolt 17 seated in the rear portion of the case 2 and held forward by a spring 18 engages with the turret, entering a recess 19 therein, and holds it in safety position under normal conditions. When the shell is fired from the gun this locking bolt sets back, compressing the spring 18, and releases the turret, which is then free to turn into arming position. Thereafter, when acceleration of the shell in its flight has ceased and the spring 18 operates to move the bolt forward, it enters a recess 20 in the turret, which then has been turned to arming position, and thus positively locks the parts in arming position.

The turret is balanced upon its pivotal supports 11, that is to say, any two parts thereof diametrically opposed and in a plane crossing the axis of support of the turret are of equal weight, as near as this may be in the manufacture of an article like the turret 9. It will be seen, however, that the disposition of the mass of the turret is such, since its longest diameter is through the valve 16, that, when subjected to centrifugal force while supported on its bearings 11, it will rock from the position indicated in Fig. 1 with the valve opposite the opening 14, to the position indicated in Figs. 2 and 3, where the valve is laterally to one side of such opening, which therefore becomes uncovered and free, the two chambers of the detonator thus being in communication.

In the body of the turret, and in line with the axis of the aperture 14 when the turret is turned into arming position as indicated in Fig. 2, is formed a chamber 21. Into this chamber is loaded a miniature projectile 22 carrying a charge 23 of high explosive, such as fulminate of mercury. Behind this miniature projectile is placed a charge of an explosive, 24, such as black powder. A wad 25 of raw cotton, asbestos or other suitable heat insulating material is preferably interposed between the charge of the powder 24 and the projectile. A flash passage 26 communicates with the base of the chamber 21 opposite the place where

may be readily and highly detonated by the firing charge such as may be carried by the miniature projectile 22.

44 designates shear pins carried by the turret 9. They are adapted to occupy a shallow channel in the inner wall of the case 2 when the plunger is set back and the turrent is turned to arming position. When the plunger, with the turret in arming position, is moved forward by the spring 7, after the initial set back caused by firing the projectile from the gun, the shear pins engage with the forward edge of the channel 45 and hold the parts in position with the cap 27 just back of and in line with the firing rim 28, but not in engagement therewith.

46 is a check valve covering the inner end of a passage 47 through the base of the plunger, opening into the slot in which the turret is mounted. This check valve is held in place closing the said passage, by the spring 7.

If from any cause any one or even all of the explosive charges carried by the turret,—such charges all being sensitive to shock, or to heat, or to both,—should become ignited or detonated, no serious injury would result to the detonator beyond rendering it dead, provided the turret occupied its normal position, such as represented in Fig. 1. The rear chamber 3 of the detonator in which these charges of explosive are located is in a part of the case 2 the walls of which are sufficiently strong to resist pressures due to the explosions or detonations just supposed, and provision is made, by gas passages around and through the plunger into the rear part of the chamber 3, for the expansion of the gases incident to an accidental explosion. Should such take place the flame and gases and incident waves of force instantly become reduced through expansion, and through the loss of heat which is conducted away by the surrounding metal. The pressures that would be exerted in the rear chamber of the detonator by an accidental explosion therein would operate to force the valve 16 against its seat with tremendous force, thus increasing its efficiency in preventing the passage of any of the hot gases and the detonating waves to the chamber 4. Should there be any slight passage of gas beyond the valve it would do no harm, since it would be confined within the tube 33 and hence not come into actual and immediate contact with the booster charge. Any premature or accidental explosion such as just supposed would doubtless rupture the turret, and lest that should cause an unseating of the valve 16 through pressure being applied thereto eccentrically and tilting it from its seat, I have provided for the valve easily separating from the turret so that it would be free to occupy its seat even should the turret be blown to pieces. Thus, as represented in Fig. 6 the valve 16 may be provided with a stem or projection 48 that fits into a recess formed therefor in the turret 9. In the event of the turret being disrupted through accidental explosion of the charge it carries, the valve would easily separate from the shattered turret, remaining on its seat, where it would be held by the gas pressure. Another way of providing for the separation of the valve from the turret should the latter be blown to pieces is to form a groove at the base of the valve between it and the turret, as indicated at 49 in Fig. 7.

In Fig. 3 I represent a form of the invention having some features different from anything thus far described. As shown in such figure there is a cut-off or check valve, arranged to close the runway for the miniature projectile, in addition to the valve 16. As shown this additional valve consists of a pair of bolts 50 set in recesses formed therefor in the partition 13. These plates are forced toward each other by springs 51 and under normal conditions their edges meet and they together close the runway or passage that unites the two chambers of the detonator. Under the action of centrifugal force the two parts of this valve move outward, compressing the springs 51 and opening the passage 14. This supplemental valve is a safety appliance that would be operative should the fuse become accidentally armed and when in this condition the explosive charges, or any of them, within the chamber 3 of the detonator become accidentally ignited; for in such event the supplemental valve would prevent the miniature projectile passing along the runway and hence becoming detonated in proximity to the booster charge and would confine the effects of the accidental explosion to the rear chamber 3 of the detonator.

In Fig. 3 there are also shown other features of invention the use of which improve the detonator.

Referring to this figure 52 indicates a mass of lead interposed between the miniature projectile and the charge 24. When this is employed I prefer that the miniature projectile should fit the chamber 21 in which it is seated rather loosely so that after the turret has assumed the arming position and the projectile begins to be retarded in its flight from the gun, the miniature projectile shall creep forward from its seat into the runway, due to such retarding of the ordnance projectile. In order to stop the miniature projectile before it reaches the firing pin I employ intercepting means such as the teats or projections 53 formed on the inside of the tube 33. The miniature projectile having crept forward during the flight of the shell carrying the detonator until arrested by the intercepting means 53, occupies a position with its rear portion between

the charge of black powder is located and leads to a seat for an explosive cap or primer 27. This cap, when the turret is moved into arming position, sets opposite the firing rim 28, carried by the partition 13 and preferably concentric with the aperture 14 therein. In the head of the miniature projectile 22 is a chamber 30, in which is located a percussion cap 31. This chamber communicates, through a perforation in a partition 32, with the chamber in which is located the charge of high explosive carried by the miniature projectile, and another opening, 29, through the head or nose of the miniature projectile, exploses the cap 31 from the outside.

33 indicates a tube carried by the partition 13 and extending into the booster charge 5 which is hollowed out to receive it. It is preferably integral with the partition and of a thickness that will be ruptured by the detonation of the charge of the miniature projectile. At the end of the tube is a firing pin 34. It will be seen that the walls of the aperture 14 and of the tube 33 constitute a runway through which the miniature projectile passes from its seat within the turret to the firing pin 34, the latter being so located that it enters the open end 29 of the head of the miniature projectile and engages with and fires the cap 31 thereof. In order to prevent the air confined within the tube from being compressed to an undesirably high degree by the advancing miniature projectile, I may perforate the tube as at 55 and provide an extension 56 into which the air from the tube may be driven. The extension 56 forms a closed chamber so that the air forced from the tube does not escape into the chamber 4 containing the booster charge. The end of the extension may rest against the base of the case 39 in which the booster charge is supported.

If a high order of detonation of the booster charge is to be insured it is of the utmost importance that the detonating charge 23 carried by the miniature projectile shall not be exploded prematurely, that is, before such projectile has entered the tube 33 and is thus in the midst of the mass constituting the booster charge. It is therefore necessary that great care be exercised in the manufacture of the capsule or shell constituting such miniature projectile to insure that it shall be absolutely gas-tight, sufficiently strong to withstand the shocks to which it is exposed, and capable of being readily and safely loaded with its sensitive explosive charge. I therefore preferably form it as follows, reference being made to Figs. 8, 9, 10 and 11. 35 represents a cylinder, preferably formed of mild steel, the walls of which are relatively quite thin. One end of this cylinder is left open and the edge of the walls around this open end are chamfered. 36 indicates the base of the miniature projectile. It consists of a small metal plate or disk in the edge of which is formed a groove or kerf 38 into which is forced the chamfered edge of the cylinder 35. The head 37 of the miniature projectile is preferably integral with the cylinder 35 and includes the partition 32 already referred to. In forming the miniature projectile the cylinder 35 is filled with its charge 23 before the base piece 36 is applied.

In uniting these two parts the chamfered edge of the cylinder is caused to enter the groove 38 in the base into which it is compressed with sufficient force to cause it to curl over and form a gas-tight inseparable joint. To insure that the joint shall be tight and moisture-proof, shellac or some equivalent water-repelling and quickly hardening cementing substance is employed in the joint when the cylinder and base are being united. The percussion cap or primer 31 is placed in the chamber formed therefor in the head of the miniature projectile and there secured in any suitable manner well known to those skilled in the art of applying percussion and fulminating caps.

The booster charge 5 is preferably supported in a case 39, open at its rear end and formed of thin metal, such as block tin. The closed forward end of this case tapers slightly as indicated at 40, and rests against the inner tapering flange portion 41 of the plate 42 that closes the front end of the shell 2. A cushion 43 of raw cotton or equivalent is preferably interposed between the closing plate 42 and the case 39. The booster charge is formed of a high explosive that is not sensitive to shock, such as tri-nitrotoluol. This and other high explosives adapted to be used for the booster charge do not readily detonate if subjected to too high compression. I therefore support this charge in the case 39, and compress it therein only to a moderate degree. The case itself is loosely mounted in the chamber 4 and is of such material that it will deform somewhat as it comes into engagement with the tapered part 41 of the closing end plate of the detonator, due to the shock incident to the impact of the projectile carrying the detonator. When the projectile is fired there is but little compression of the booster charge,—only such as is due to the setting back of the mass of the charge itself. When the projectile strikes there is likewise but little compression of the booster charge, as the engagement of the tapered end 40 of the case 39 with the tapering walls 41 of the closing plate of the detonator, and the action of the cushion 43, coöperate in tending to somewhat gradually slow down the movement of booster charge within the detonator case. Hence, as will be seen, the booster charge is never compressed beyond the limit where it

the parts 50 of the auxiliary or supplemental valve employed to close the runway, so that, should the rotation of the shell slow down sufficiently to so reduce the centrifugal force that the plates 50 would not be held outward thereby they will nevertheless be held in open position by the miniature projectile which lies between them. Upon impact of the shell and the firing of the charge 24 the plug of lead, 52, is projected forward and, striking the base of the miniature projectile, forces it forward past the arresting devices 53 and into engagement with the firing pin 34 by which its charge is detonated.

An advantage incident to the arrangement described is that the relatively thick mass of lead, fitting the chamber 21 closely, prevents the heat developed by the explosion of the charge 24 from being communicated to and causing the ignition of the charge within the miniature projectile. The walls of the latter are necessarily quite thin and it is conceivable that the great heat developed by the ignition of the charge 24 would cause ignition of the charge within the miniature projectile before the latter reach the firing pin 34. But with the arrangement shown this is not possible. The use of the plug 52 necessarily reduces the available length of the miniature projectile which should therefore be loaded with a correspondingly higher explosive to compensate for the diminished charge thereof which the miniature projectile will then be able to carry.

In Fig. 3 the forward end of the casing 2 of the detonator is represented as being closed by a plate 42′ the edges of which set into a groove formed in the casing wall, and a flange 57 of the latter, extending beyond said groove, being turned over the edge of the end plate to hold it in place. The closing plate 42′ is dished, its concave face being inward, and the end of the case 39 in which is packed the booster charge is shaped to conform to such face and rest against it.

In Fig. 12 I have represented a pivotal mounting for the turret 9 which has some advantages over that illustrated in the other views, being more rigid, though perhaps not so delicate. As illustrated in this view the screw bolts 12 seated in the parts 10 of the plunger have their ends, 11′, smooth and cylindrical, and adapted to fit into recesses formed therefor in the side faces of the turret, the ends of the bolts constituting the trunnions on which the turret swings.

The operation of the invention herein described may now be set forth. In Fig. 1 the parts are represented in normal positions, the detonator being then unarmed. The plunger is held forward by the spring 7, the turret is turned so that the miniature projectile 22 is not in line with the aperture 14 between the chambers 3 and 4, and the locking bolt 17 holds the turret in safety position. No condition or situation incident to handling the shell, or any accident to which it might be subjected, can be thought of that will cause the detonator to arm. For, to accomplish this, simultaneously must the plunger be set back against the action of the spring 7, in order to take the valve 16 from its seat, the locking bolt 17 be set back, releasing the turret, and centrifugal force be developed to turn the turret into arming postion; and under no known conditions, except the firing of a projectile from a rifled gun, are forces created that would cause the operations enumerated to take place simultaneously.

However, should the detonator become accidentally armed. the arrangement shown in Fig. 3 would still render the fuse safe against detonation, though internal explosions might take place which would render it dead and ineffective as a detonating fuse.

Upon a shell carrying a detonator such as described, with the parts in the position indicated in Fig. 1, being fired from a gun, the plunger 6 is violently set back, compressing the spring 7; and at the same time the locking bolt 17 is set back, freeing the turret. The rotary motion given to the shell by the rifling of the gun and communicated to the mechanism of the detonator causes the turret to swing from the safety position to the arming position represented in Figs. 2 and 3 through the action of centrifugal force, which holds the turret in this position so long as the shell is in rotation; but as soon as acceleration of the shell in its flight has ceased the spring 18 forces the locking bolt forward, and its end enters the recess 20, thus bringing into operation a positively-acting device for holding the turret in arming position. At the same time that the locking bolt comes into operation the spring 7 forces the plunger 6 forward until the shear pins 44 come into engagement with the front wall of the channels 45. where the parts are arrested and held until the projectile strikes.

Upon impact of the shell the plunger 6 jumps forward, shearing off the pins 44, and the cap 27 is brought into violent contact with the firing rim 28. The explosion of the cap causes the charge 24 of black powder to be ignited, and this operates to propel the miniature projectile from its seat in the turret through the aperture 14 and along the tube 33 until its end comes into engagement with the firing pin 34 which explodes the cap 31 in the head thereof. The firing of this cap causes the detonation of the charge 23 within the miniature projectile, and the detonation of this charge detonates the charge 5 which ruptures the detonator shell 2 and fires the main charge within the projectile.

It will be seen that the miniature projectile at the moment its charge 23 is detonated, is located in the midst of the booster charge which, as has been explained, is so loaded and supported that it will not be under undue compression, and is therefore in condition to undergo a high degree of detonation.

It will be perceived that the detonator described is short, as compared with other detonators and percussion fuses, with the result that it is located far back toward the rear of the shell and hence in the midst of that part of the explosive charge carried thereby that is subjected to the least compression. I am thus enabled to insure a high degree of detonation of the main charge of the shell for the reason that the high explosives constituting both this charge and the booster charge are not compressed beyond a degree where detonation of a high order may be easily started, at the moment when the detonation of the shell is desired.

It will be seen that the firing of the charge within the shell or projectile is caused by a stepping-up process accomplished by a series of explosions or minor detonations, and that although these follow one another very rapidly, yet an appreciable length of time occurs between impact of the projectile and the final detonation of the charge it carries. First, upon impact, the plunger has to travel forward to cause the firing of the cap or primer 27, then this has to ignite the charge of powder that propels the miniature projectile, or the lead plug 52, when this is used, causing it to travel to the end of the tube 33 where the charge it carries is detonated, the effects of this detonation have to be communicated to and detonate the booster charge, and finally, this latter must rupture the detonator and set off the main charge within the shell.

This retarding action is utilized to accurately determine the length of time after impact when the shell shall burst, because by varying the amount of the powder charge 24 the speed at which the miniature projectile moves toward the firing pin 34 may be governed and hence the length of time after impact when the charge within the miniature projectile shall be fired may be controlled.

The flash passage 26 provides a means for varying the time element between impact of the shell and its bursting. If it be left open the flash from the primer cap 27 ignites the powder charge 24 almost instantly, whereas if it be more or less filled with meal powder, which has to burn before the powder charge 24 is ignited, a greater or less length of time will elapse between impact and the bursting of the shell.

Having described my invention what I claim and desire to secure by Letters Patent is:

1. In a detonator for ordnance shells, an inclosing case, a movable body within the case for causing the firing of the detonator, a runway along which the said body travels, and a movable carrier in which the said body is supported, which carrier normally occupies a safety position with the said body out of line with the runway, and is arranged to move to an arming position with the said body in line with the runway under action of centrifugal force upon the shell being fired from a gun.

2. In an impact detonator for ordnance shells, an inclosing case, a movable body within the case for causing the firing of the detonator, a runway along which the said body travels, a movable carrier in which the said body is supported, which carrier normally occupies a safety position with the detonator-firing body out of line with the runway, and is arranged to move to a position to bring the body in line with the runway under the action of centrifugal force, and means for holding the carrier in safety position until the shell is fired from a gun.

3. In an impact detonator for ordnance shells, an inclosing case in which is located an explosive charge, a movable body within the case for causing the firing of the explosives, a runway along which the said body travels, an oscillating turret in which the said charge-firing body is supported, means for holding the turret in safety position with the said body out of line with the runway, such means being moved on the shell being fired from a gun to release the turret, and the turret being arranged to move, under the action of centrifugal force, to a position to arm the detonator.

4. In an impact detonator for ordnance shells, a case in which is located an explosive charge, a detonating capsule for firing the said explosive charge, a runway along which the detonating capsule travels to charge-firing position, a movable carrier in which the said detonating capsule is supported, which carrier normally occupies a safety position with the detonating capsule out of line with the runway, and being free to move under the action of centrifugal force to a position to bring the detonating capsule into line with the runway upon the shell being fired from a gun, and means for holding the carrier in safety position.

5. In an impact detonator for ordnance shells, a case adapted to be seated in a shell, a detonating capsule for firing the detonator, a runway along which the detonating capsule travels to firing position, and an oscillating turret in which the detonating capsule is supported adapted to be moved to safety position with the capsule out of line with the runway, and being free

to move under the action of centrifugal force to arming position with the capsule in line with the runway, and means for normally holding the turret in safety position, such means being arranged to be operated to free the turret and permit it to assume arming position on the shell being fired from a gun.

6. In an impact detonator for ordnance shells, a case adapted to be seated in a shell, a detonating capsule for firing the said detonator, a runway along which the detonating capsule travels to firing position, and an oscillating turret in which the detonating capsule is supported adapted to be moved to safety position with the capsule in line with the runway, an explosive charge located in the said turret adapted to project the detonating capsule from its seat in the turret, and means for firing the said charge arranged to act upon impact of the shell.

7. In an impact detonator for ordnance shells, an inclosing case adapted to be seated in the breech of a shell, a detonating capsule adapted to fire the said detonator, a runway along which the said detonating capsule is adapted to be moved to firing position, a plunger located in the inclosing case, a carrier for the detonating capsule supported in the said plunger and free to move therein from a normal safety position with the detonating capsule out of line with the said runway to an arming position with the detonating capsule in line with the runway, means for holding the said carrier in safety position arranged to be operated to release the carrier upon the shell being fired from a gun, an explosive charge adapted to cause the detonating capsule to be discharged from its carrier, and means operated by the movement of the plunger upon impact of the shell for causing the firing of the last said charge.

8. In a detonator for ordnance shells, an inclosing case adapted to be seated in a shell, a movable body within the case for causing the firing of the detonator, a runway along which the said body travels, a movable carrier in which the said firing body is supported, which carrier normally occupies a safety position with the said body out of line with the runway, and is arranged to move to an arming position with the said body in line with the runway upon the shell being fired from a gun, and means for closing the said runway until the detonator is armed, said means being free to be set back when the shell is fired from a gun and then movable to open the runway.

9. In an impact detonator for ordnance shells, an inclosing case adapted to be seated in a shell, a movable body within the case for causing the firing of the detonator, a runway along which the said body travels, an oscillating turret in which the said firing body is supported, means for holding the turret in safety position with the said body out of line with the runway, such means being moved on the shell being fired from a gun to release the turret, and the turret being arranged to move, under the action of centrifugal force, to a position to arm the detonator, and means for closing the runway until the detonator becomes armed.

10. In an impact detonator for ordnance shells, a case adapted to be seated in a shell, a detonating capsule for firing the said detonator, a runway along which the detonating capsule travels to firing position, a movable carrier in which the said detonating capsule is supported, which carrier normally occupies a safety position with the detonating capsule out of line with the runway, and being free to move to an arming position with the detonating capsule in line with the runway upon the shell being fired from a gun, and means for closing the runway gas-tight when the said carrier is in safety position, such means being arranged to set back when the shell is fired from a gun, and then movable to a position for opening the runway when the detonator is armed.

11. In an impact detonator for ordnance shells, a case adapted to be seated in a shell, a detonating capsule for firing the said detonator, a runway along which the detonating capsule travels to firing position, an oscillating turret in which the detonating capsule is supported adapted to be moved to safety position with the capsule out of line with the runway or to arming position with the capsule in line with the runway, means for normally holding the turret in safety position, such means being arranged to be operated to free the turret and permit it to assume arming position on the shell being fired from a gun, and an eccentric valve carried by the said turret for closing the runway when the parts of the detonator are in safety positions.

12. In an impact detonator for ordnance shells, a case adapted to be seated in a shell, a detonating capsule for firing the said detonator, a runway along which the detonating capsule travels to firing position, and an oscillating turret in which the detonating capsule is supported adapted to be moved from safety position to arming position with the capsule in line with the runway, an explosive charge located in the said turret adapted to project the detonating capsule from its seat in the turret, means for firing the said charge arranged to act upon impact of the shell, and means for closing the runway gas-tight when the parts of the detonator are in safety positions.

13. In an impact detonator for ordnance shells, a case adapted to be seated in a shell, a detonating capsule for firing the said deto-

nator, a runway along which the detonating capsule travels to firing position, and an oscillating turret in which the detonating capsule is supported adapted to be moved from safety position to arming position with the capsule in line with the runway, an explosive charge located in the said turret adapted to project the detonating capsule from its seat in the turret, means for firing the said charge arranged to act upon impact of the shell, and a valve carried by the turret for closing the runway gas-tight when the parts of the detonator are in safety positions and for opening the runway when the detonator is armed.

14. In an impact detonator for ordnance shells, an inclosing case adapted to be seated in a shell, a detonating capsule adapted to fire the detonator, a runway along which the said detonating capsule is adapted to be moved to firing position, a plunger located in the inclosing case, a carrier for the detonating capsule supported in the said plunger and free to move therein from a normal safety position with the detonating capsule out of line with the said runway to an arming position with the detonating capsule in line with the runway, means for holding the said carrier in safety position arranged to be operated to release the carrier upon the shell being fired from a gun, an explosive charge adapted to cause the detonating capsule to be discharged from its carrier, means operated by the movement of the plunger upon impact of the shell for causing the firing of the last said charge, and means for closing gas-tight the runway when the parts of the detonator are in safety positions and for opening the runway when the detonator is armed.

15. In an impact detonator for ordnance shells, a case carrying a booster charge, a movable body carrying a charge of high explosive for detonating the booster charge, a runway along which the said body travels leading toward the booster charge, a movable carrier in which the charge-firing body is supported normally occupying a safety position with the said body out of line with the runway, and being adapted to move to arming position with the said body in line with the runway, under the action of centrifugal force, a partition dividing the case into two chambers in the forward one of which is located the booster charge and in the rear one the carrier for the charge-firing body, the aforesaid runway extending through the said partition, and means for closing the runway gas-tight when the said carrier is in safety position and for opening it when the carrier is moved to arming position.

16. In an impact detonator for ordnance projectiles carrying a booster charge of high explosive, a miniature projectile carrying a detonating charge for firing the booster charge, a partition dividing the detonator into front and rear chambers, the booster charge being located in the front chamber, a carrier in which the said miniature projectile is supported located in the rear chamber of the detonator, the carrier being movable from a safety position to an arming position through the action of centrifugal force, means for normally holding the carrier in safety position, a runway leading through the partition toward the booster charge along which the miniature projectile is adapted to travel, an explosive charge for propelling the miniature projectile, firing devices operating on impact of the shell for igniting the said explosive charge that propels the miniature projectile, and a valve device for normally closing the runway, the said carrier and the valve being operated when the shell is fired from a gun, the former coming to arming position and the latter moving to open the runway.

17. In an impact detonator for ordnance shells, a case carrying a booster charge, a partition dividing the detonator case into front and rear chambers, in the former of which is located the said booster charge, a plunger in the rear chamber, an oscillating turret supported in the plunger and adapted to move, under the action of centrifugal force, from a safety to an arming position, a miniature projectile carrying a charge of high explosive for firing the booster charge supported in the said turret, a runway along which the miniature projectile is adapted to travel to booster-charge-firing position extending through the partition that separates the chambers within the detonator case, a valve carried by the oscillating turret for closing the said runway gas-tight when the turret is in safety position, an explosive charge for propelling the miniature projectile supported in the turret, and firing devices operated upon impact of the shell for igniting the last said charge.

18. In an impact detonator for ordnance shells, an inclosing case, a perforated partition dividing the case into two chambers, a booster charge located in the front chamber, a detonating capsule for firing the booster charge, a movable carrier in which the said capsule is supported, located in the rear chamber of the case and adapted normally to occupy a safety position with the capsule out of line with the perforation in the partition, and to be moved when the shell is fired from a gun to an arming position with the capsule in line with the said perforation, an explosive charge for projecting the said capsule from its carrier through the perforation in the said partition, and means acting upon impact of the shell for igniting the last said charge.

19. In an impact detonator for ordnance

shells, an inclosing case, a perforated partition dividing the case into two chambers, a booster charge located in the front chamber, a detonating capsule for firing the booster charge, a movable carrier in which the said capsule is supported, located in the rear chamber of the case and adapted normally to occupy a safety position with the capsule out of line with the perforation in the partition, and to be moved when the shell is fired from a gun to an arming position with the capsule in line with said perforation, an explosive charge for projecting the said capsule from its carrier through the perforation in said partition, means acting upon impact of the shell for igniting the last said charge, and means for closing the perforation through the partition gas-tight when the parts of the detonator are in safety positions, and adapted to open the said perforation for the passage of the detonating capsule when the shell is fired from a gun.

20. In an impact detonator for ordnance shells, an inclosing case, a perforated partition dividing the case into two chambers, a booster charge located in the front chamber, a detonating capsule for firing the booster charge, a movable carrier in which the said capsule is supported, located in the rear chamber of the case and adapted normally to occupy a safety position with the capsule out of line with the perforation in the partition and to be moved when the shell is fired from a gun to an arming position with the capsule in line with the said perforation, the said carrier being also supported so as to move forward in the detonator case upon impact of the shell, an explosive charge for projecting the capsule from the carrier through the perforation in the partition, located in the said carrier, and means acting when the said carrier moves forward on impact of the shell, for igniting the last said charge.

21. In an impact detonator for ordnance shells, an inclosing case, a perforated partition dividing the case into two chambers, a valve device for normally closing the said perforation adapted to move to open the partition upon the shell being fired from a gun, a booster charge located in the front chamber of the detonator, a detonating capsule for firing the booster charge, a carrier in which the said capsule is supported, located in the rear chamber of the case, the said carrier being supported so as to move forward in the detonator case upon impact of the shell, an explosive charge for projecting the capsule from its carrier through the perforation in the partition and into position for firing the booster charge, and means brought into operation by the forward movement of the said carrier upon impact of the shell for igniting the charge that projects the detonating capsule.

22. In an impact detonator for ordnance shells, an inclosing case, a perforated partition dividing the case into two chambers and carrying a cap-firing projection, a valve device for closing the perforation in the partition, adapted to move to uncover the perforation when the shell is fired from a gun, a booster charge located in the front chamber of the detonator, a detonating capsule for firing the booster charge, a carrier in which the said capsule is supported, located in the rear chamber of the case, the said carrier being supported so as to move forward in the detonator case upon impact of the shell, an explosive charge for projecting the said capsule from its carrier through the perforation in the partition and into position to fire the booster charge, and a primer cap for igniting the charge that projects the detonating capsule, supported by the said carrier and arranged to come into engagement with the firing projection carried by the partition when the carrier moves forward on impact of the shell.

23. In an impact detonator for ordnance shells, an inclosing case, a perforated partition dividing the case into two chambers and carrying a cap-firing projection, a booster charge located in the front chamber of the detonator, a detonating capsule for firing the booster charge, a plunger located in the rear chamber of the detonator adapted to move forward upon impact of the shell, an oscillating turret in which the said capsule is supported, mounted in the said plunger, the turret being arranged to normally occupy a safety position with the capsule out of line with the perforation in the partition, and being arranged to be moved by centrifugal force to an arming position with the capsule in line with the said perforation, when the shell is fired from a gun, an explosive charge for projecting the said capsule from its seat in the turret through the perforation in the partition and into position to fire the booster charge, and a primer cap for igniting the charge that projects the detonating capsule, supported by the turret and arranged to come into engagement with the firing projection carried by the partition when the plunger, carrying the turret, moves forward on impact of the shell.

24. In an impact detonator for ordnance shells, an inclosing case, a perforated partition dividing the case into two chambers, a booster charge located in the front chamber, a detonating capsule for firing the booster charge, an oscillating turret in which the said capsule is supported mounted in the rear chamber and arranged normally to occupy a safety position with the capsule out of line with the perforation in the partition, and to be moved when the shell is fired from a gun to an arming position with the capsule in line with said perforation, a valve for

closing the said perforation when the turret is in safety position, carried by the turret, and means for holding the valve against its seat under normal conditions, said means being arranged to set back and free the valve upon the shell being fired from a gun.

25. In an impact detonator for ordnance shells, an inclosing case, a perforated partition dividing the case into two chambers, a booster charge located in the front chamber, a detonating capsule for firing the booster charge, a plunger located in the rear chamber, a spring acting on the plunger, an oscillating turret carried by the plunger and provided with a cavity in which is supported the said detonating capsule, the turret normally occupying a safety position with the capsule out of line with the perforation in the partition and being arranged under the action of centrifugal force to move to an arming position with the capsule in line with the said perforation, a valve carried by the capsule for closing the said perforation when the turret is in safety position, means for locking the turret in safety position to free the turret when the shell is fired from a gun, and means for projecting the detonator capsule into firing position operating upon impact of the shell.

26. In an impact detonator for ordnance shells, an inclosing case adapted to be seated in a shell, a movable body within the case for causing the firing of the detonator, an oscillating turret in which the said firing body is supported arranged to normally occupy a safety position and to be moved to an arming position when the shell is fired from a gun, the said turret being also supported so that it may move forward upon impact of the shell, and shear pins carried by the turret for holding it from moving forward during the flight of the shell but arranged to yield upon impact thereof.

27. In an impact detonator for ordnance shells, an inclosing case adapted to be seated in a shell, a detonating capsule movable within the case upon impact of the shell for causing the firing of the detonator, an oscillating carrier in which the said capsule is supported arranged to normally occupy a safety position and to be moved under the influence of centrifugal force to an arming position, a plunger in which the said oscillating carrier is supported, the plunger being free to set back upon the firing of the shell from a gun, shear pins carried by the oscillating carrier, abutments with which the said pins engage, such abutments being arranged so as to be out of the paths of the shear pins as the carrier oscillates in a set back position, but in the paths of the said pins when the carrier is in its forward position, and a spring bearing against the said plunger and tending to move it forward.

28. In an impact detonator for ordnance shells, an inclosing case in which is located a booster charge, a movable body within the case for causing the firing of the said booster charge, an oscillating turret in which the said charge-firing body is supported arranged to normally occupy a safety position and to be moved to an arming position when the shell is fired from a gun, the said turret being also supported so that it may move forward upon impact of the shell, shear pins carried by the turret for holding it from moving forward during the flight of the shell but arranged to yield upon impact thereof, and means for causing the charge-firing body to be projected to position to fire the booster charge arranged to be brought into operation by the said forward movement of the turret.

29. In a detonator for ordnance shells, a case, a booster charge supported in the forward end thereof, a detonating capsule for causing the firing of the booster charge, a runway along which the said detonating capsule is adapted to move, a movable carrier in which the said capsule is supported arranged to normally occupy a safety position, and to come to an arming position upon the shell being fired from a gun, a charge of explosive material for causing the detonating capsule to be moved into position to fire the booster charge, and a plug of relatively soft metal interposed between the last said charge and the detonating capsule.

30. In an impact detonator for ordnance shells, a case in the forward end of which is located a booster charge, a detonating capsule for firing the booster charge normally supported in the rear portion of the detonator case and arranged to be projected into proximity to the booster charge where it is fired, a runway along which the said capsule moves separating the booster charge from direct communication with the passage through which the detonating capsule moves, the said runway being perforated to permit the escape therefrom of air in advance of the forwardly moving detonating capsule, and an inclosed chamber into which the said air passes from the runway.

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