E. GATHMANN.

DETONATOR FOR HIGH EXPLOSIVE SHELLS.

APPLICATION FILED MAY 11, 1917. RENEWED JULY 21, 1919.

1,340,536.

Patented May 18, 1920.

2 SHEETS—SHEET 1.

Fig. 1.

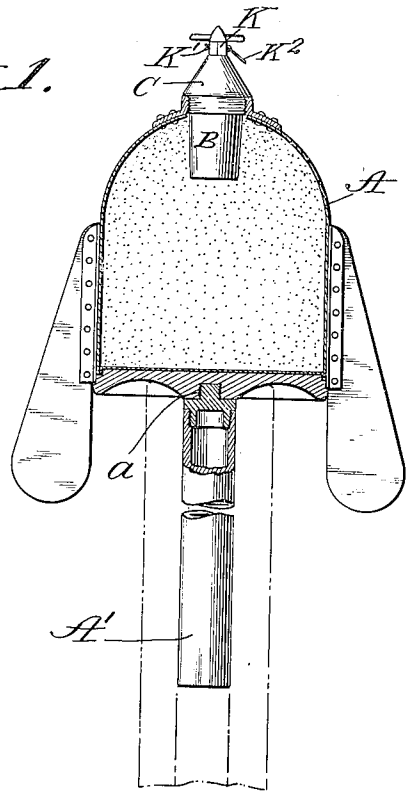
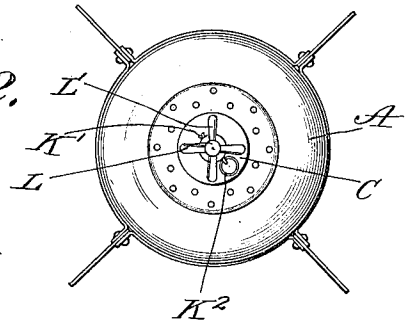


Fig. 2.



Witnesses:

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2 SHEETS—SHEET 2.

Fig. 3.

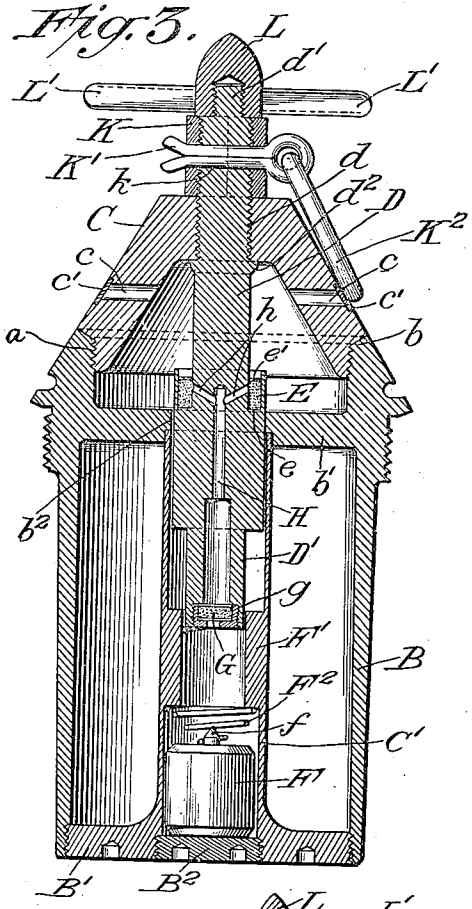


Fig. 4.

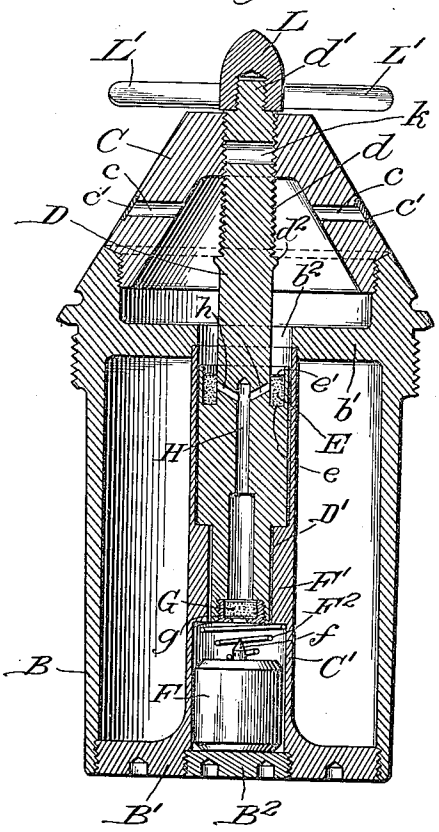
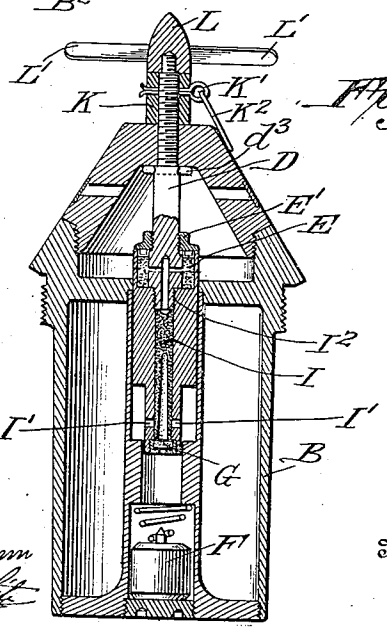


Fig. 5.



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UNITED STATES PATENT OFFICE.

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DETONATOR FOR HIGH-EXPLOSIVE SHELLS.

1,340,536. Specification of Letters Patent. Patented May 18, 1920.

Application filed May 11, 1917, Serial No. 167,956. Renewed July 21, 1919. Serial No. 312,467.

To all whom it may concern:

Be it known that I, EMIL GATHMANN, a citizen of the United States, residing at Baltimore city, in the State of Maryland, have invented certain new and useful Improvements in Detonators for High-Explosive Shells; and I do hereby declare the following to be a full, clear, and exact description of the same when taken in connection with the accompanying drawings, forming part of this specification.

This invention relates to a detonator which is primarily adapted for use in connection with shells fired from smooth-bore guns, more particularly large caliber shells carrying large charges of high explosives and of the type developed in the present war and known as "torpedo shells". Shells of this type are intended to be fired from light smooth bore guns of sub-caliber diameter relatively to the bursting chamber of the shell and with a relatively low initial velocity, whereby the guns may be mounted on relatively light mounts and on ordinary merchant marine vessels. Projecting rearwardly from the bursting chamber of the shell is a tail piece of sub-caliber diameter which enters the bore of the gun, when the shell is placed in position from the muzzle end of the gun. The firing or propelling charge is secured in a pressed cartridge case, in accordance with the usual practice, and is loaded into the gun through the breach end thereof.

The primary object of the invention is the provision of a detonator enabling shells, for example, of the type above described, to carry large charges of high explosives and to be handled with practically absolute safety before firing. A detonator constructed in accordance with the present invention prevents explosion of the bursting charge of high explosive in the shell until the latter has traveled a safe distance from the muzzle of the gun, and operates automatically to insure ignition of the charge of high explosive in the shell at the time when the charge will be effective to produce the destructive effect desired.

An armament of this character is designed mainly for protection against submarine torpedo boats. It is demonstrable that a shell of the character described is infinitely more effective than a shell of small caliber having a high initial velocity, for the reason that a large shell, when exploded in the vicinity of a submarine produces highly destructive effect, whereas a small shell, must score a direct hit, in order to produce destructive effects.

A full understanding of the invention will be attained from the ensuing detailed description when taken in connection with the accompanying drawings which illustrate a structural embodiment of the invention in a preferred form. The novel features of the invention will be particularly pointed out and specified in the claims at the end of this specification.

In the drawings:—

Figure 1 is a longitudinal sectional elevation through a high explosive shell of large caliber provided with a detonator constructed in accordance with the present improvement.

Fig. 2 is a front end elevation of the same.

Fig. 3 is an enlarged detailed longitudinal sectional elevation of the detonator showing the parts in the position they normally occupy before the shell is discharged from a gun.

Fig. 4 is a view similar to Fig. 3 but showing the parts in the positions they assume after the shell is discharged from the gun and during the flight of the shell toward its objective.

Fig. 5 is a view similar to Figs. 3 and 4 illustrating a modification.

Like characters of reference in the several figures indicate the same parts.

The shell adopted for illustrating the present improvement embodies a bursting chamber A of large caliber and carrying a large quantity of high explosive, for example, trinitrotoluol. Said shell is intended primarily to be discharged from a smooth bore gun of sub-caliber diameter relatively to the bursting chamber A and for this purpose the shell may be provided with tail piece A′ of sub-caliber diameter corresponding to the caliber of the gun, whereby the shell may be placed in position in the gun from the muzzle end of the latter. The details of construction of the shell, however, form no part of the present invention, which may obviously be embodied in many other types of shells without departure from the essential features of the invention.

At its forward end, the shell is apertured and threaded, as shown at *a*, for the insertion and retention of the priming charge cham-

ber and other parts of the detonator. The detonator includes means whereby the detonating charge will be normally held in a chamber which is of considerable strength, and, simultaneously the primer for firing the detonating charge will be held in a position out of the zone of operation of the firing hammer. The chamber is provided with vent ports leading to the exterior air, and when the detonating charge is held in said chamber, it is prevented from acting on the priming charge or charge of high explosive in the shell, should the detonating charge explode accidentally before the shell is discharged from the gun. Destructive effects of the detonating charge, in case of a premature explosion of the latter, will be prevented by the chamber in which it is confined, and the pressure created by such accidental detonation of the charge will find a ready exit to the external air. This adds an important factor of safety which is especially desirable where shells of high explosives are carried on vessels other than regularly equipped and manned war vessels.

The priming charge for setting off the charge of high explosive may be picric acid or other suitable explosive substance, and said charge is confined within a priming charge chamber B, usually in the form of a large thimble or cup, which is screwed into the aperture in the shell body and projects into the latter, in order that the priming charge may be surrounded by the high explosive material in the shell.

As shown in Figs. 3 and 4, a detonating charge chamber is provided, part of which is located within the priming charge chamber and the other part of which is exterior to the priming charge chamber and also exterior to the shell body itself. The exterior part or portion of the detonating charge chamber is formed by means of a conical cap or housing C which is screwed into a vertically projecting annular flange *b* formed on the upper end of the cup B, and said upper portion of the detonating charge chamber is separated from the priming charge chamber by a lateral flange or wall *b'* formed as a part of the cup B. The inner end of the cup is closed by a plug or bushing B' which is screwed into said inner end. The plug B' is formed with a centrally disposed hollow sleeve C' which extends axially to the flange *b'*, the upper end of said sleeve projecting into an annular recess formed in the side wall of the central aperture b^2 of the flange *b'*. The sleeve C' constitutes the inner portion of the detonating charge chamber and it will be noted that said portion of the detonating charge chamber is smaller in diameter than the exterior portion C and is surrounded by the priming charge in the chamber B. A small plug B^2 screwed into the base plug or bushing B' closes the inner end of the portion C' of the detonating charge chamber.

In accordance with the present invention, the detonating charge and the primer for firing the same are both supported by a movable carrier consisting of a shaft D extending through the exterior portion C of the detonating charge chamber and into the inner portion C' of the latter. At its outer end the shaft D is threaded, as shown at *d*, and screwed into a threaded aperture in the head or apex of the cap C. Beyond the threaded portion *d*, the shaft D is provided with a second threaded portion *d'* of reduced diameter for purposes which will hereinafter appear.

With the above set forth construction, a rotary movement of the shaft D relatively to the cap C and chamber B will effect an axial or longitudinal movement of the shaft in the detonating charge chamber and said longitudinal movement is utilized for the purpose of advancing the detonating charge from a point remote from the priming charge to a point in proximity with the latter and the primer from a point out of the zone of operation of the firing hammer to a point within said zone of operation. The detonating charge, indicated at E and usually fulminate of mercury, is positioned between the ends of the shaft D in a recess or chamber *e* formed in the shaft, and is preferably protected and pressed into place by an annular cap ring *e'* formed of thin paper reinforced with unbleached linen. A firing hammer F is positioned in the inner portion C' of the detonating charge chamber just in advance of the plug B^2, said hammer consisting of a metallic block formed with a firing pin or projection *f* adapted on forward movement of the hammer to engage the primer, as will hereinafter appear. Forward movement of the hammer F is limited by the inner edge of the thickened portion F' of the sleeve C'. A spring F^2 interposed between the thickened wall portion F' and the front face of the hammer normally holds the hammer out of engagement with the primer, and, during the flight of the shell, the action of the spring in so holding the hammer will be assisted by the natural forces acting on the shell. On impact, or when the motion of the shell is arrested, the force produced thereby overcomes the spring tension and the hammer is moved forward into firing engagement with the primer.

The inner end of the shaft D is formed with a portion D' of reduced diameter which enters the space inclosed by the thickened portion F' of the sleeve or detonating chamber wall. An ordinary primer or percussion firing cap G is located in a recess in the shaft at the inner extremity of said reduced portion, and is held in po-

sition by a cup *g* screwed into the end of the shaft and provided with a central opening whereby the firing pin *f* may strike the primer at the proper time. In the shaft D, there is formed a channel H having lateral branches *h* which connect the primer G with the detonating charge, permitting the flame produced by firing the primer G to reach the detonating charge.

Normally, the carrier or shaft D is held in the position indicated in Fig. 3. In such position the detonating charge E is located at a point remote from the priming charge in the chamber B and within the exterior portion C of the detonating chamber. At this time, the detonating charge is separated from the priming charge by the wall *b'*, which is made comparatively thick and strong as possible and also by the thick practically solid portion of the shaft D, behind the detonating charge, said wall and shaft together forming an effective barrier which prevents destructive detonating effects from reaching the priming charge, when the parts are positioned as shown in Fig. 3. Simultaneously the cap or primer G is located at a point beyond the limit of movement of the firing hammer, so that any possible movement of the hammer, due to jarring of the shell, or any other cause, would have no effect whatsoever on the primer G. As an additional factor of safety the exterior portion of the detonating charge chamber is provided with ports *c*, leading to the exterior air, but normally provided with very thin closing diaphragms or plugs *c'* which prevent access of water or dirt to the detonating charge chamber. These closures *c'* are relatively light and practically form no obstruction to the free exit of pressure from within the detonating charge chamber, especially pressure such as would be created by explosion of the detonating charge.

Preferably, locking mechanism is provided for locking the movable carrier D in the safety position above described. As shown, the carrier or shaft D is provided with a lateral slot *k* which is located outside the detonating charge chamber when the parts are in the position indicated in Fig. 3. Surrounding the shaft D, above the cap C, is a split locking ring K having holes adapted to register with the lateral slot *k*. The locking ring K may be connected to the shaft D by means of a cotter pin K' inserted through the holes in the locking ring and the lateral slot *k*. When the locking ring K is locked to the shaft D, as shown in Fig. 3, the ring K engages the outer end of the cap C and prevents inward movement of the shaft D. Just before firing the shell, the locking ring is removed, which may be accomplished by withdrawing the cotter pin K'. To assist in the withdrawing operation, the cotter pin may be provided with a ring K^2 inserted in the head of the pin.

The detonator of the present invention is intended primarily for use in connection with shells fired from smooth bore guns, as heretofore explained, and, for this purpose, provision is made whereby the air pressure acting on the shell during the flight thereof moves the carrier rearwardly to position the detonating charge in proximity to the priming charge and the primer in position for engagement by the firing hammer. Screwed into position on the threaded portion *d'* of the shaft D is a cap L provided with a plurality of laterally projecting vanes L', preferably four in number and set at quadrature with respect to the head L. During the flight of the shell, the pressure or resistance of the air will impart a rotary movement to the vanes L', thereby rotating the shaft D. As the latter is screwed into the cap C, the rotary movement causes the shaft to move rearwardly, thereby advancing the detonating charge E into the portion C' of the detonating charge chamber in proximity to the priming charge in chamber B, and also advancing the percussion cap or primer G into the zone of operation of the firing hammer F, whereby it may be engaged by the firing hammer to explode the detonating charge, on impact of the shell, as shown in Fig. 4. The wall of the portion C' of the detonating charge chamber is relatively thin, permitting the explosion of the detonating charge to readily rupture the wall and the flame to reach the priming charge in chamber B. Outward movement of the shaft D may be limited by a collar d^2 formed on the shaft and adapted to engage the inner face of the wall of portion C of the detonating charge chamber at the apex of the latter.

In some cases, it is desirable to delay the explosion of the detonating charge for an instant after the percussion cap G has been exploded by the firing hammer, for example, it may be desirable to explode the shell under water. Fig. 5 illustrates a modification which is especially adapted for this purpose. In the channel *d* of the shaft or carrier D there is inserted a delay action pellet or fuse 1 of black powder or other slow burning substance, which will prevent the flame produced by explosion of the cap G from reaching the detonating charge E immediately. The pressure produced by explosion of the cap G may be exhausted into the detonating charge chamber through vents I' formed in the shaft D. In the modified form, the shaft D is formed of two portions, an upper portion which is screwed into the lower portion, as shown at I^2. The detonating charge E may be further protected by a cap E' screwed on the upper portion of the shaft. A pin d^3 inserted through the upper

portion of the shaft takes the place of the integrally formed collar d^2, illustrated in Figs. 3 and 4.

From the foregoing it will be seen that the outer end of the shaft or carrier D forms a member of the carrier which projects through and beyond the wall of the detonating charge chamber, for coöperation with the external locking and retaining means formed by the split sleeve K and the manually releasable means or cotter pin K'. It will be further noted that when the parts are assembled as shown in Fig. 1, the priming charge chamber and priming charge therein are located on the inner side of the wall of the shell, and the detonating charge chamber is located mainly on the outer side of said wall, although its extension of reduced cross sectional area formed by the sleeve G' extends within the body of the shell and in proximity to the priming charge in the priming charge chamber formed by the cup B.

What is claimed is:—

1. A detonator for high explosive shells comprising a priming charge chamber, a movable carrier supporting a detonating charge and a primer for firing the detonating charge, a longitudinally movable firing hammer adapted on impact to fire the primer and thereby the detonating charge, said carrier being held normally in a position wherein the detonating charge is at a point remote from the priming charge and the primer is out of the zone of operation of the firing hammer, and means operable by the resistance of the air to the flight of the shell for positively moving the carrier to advance the detonating charge to a point in proximity to the priming charge and to advance the primer into the zone of operation of the firing hammer.

2. A detonator for high explosive shells comprising a priming charge chamber, a movable carrier supporting a detonating charge and a primer for firing the detonating charge, a delay action fuse interposed between the primer and the detonating charge, a longitudinally movable firing hammer adapted on impact to fire the primer and thereby the detonating charge, said carrier being held normally in a position wherein the detonating charge is at a point remote from the priming charge and the primer is out of the zone of operation of the firing hammer, and means operable during the flight of the shell for positively moving the carrier to advance the detonating charge to a point in proximity to the priming charge and to advance the primer into the zone of operation of the firing hammer.

3. A detonator for high explosive shells comprising a priming charge chamber, a movable carrier supporting a detonating charge and a primer for firing the detonating charge, a firing hammer movable longitudinally of the axis of movement of the carrier adapted on impact to fire the primer and thereby the detonating charge, means for limiting the movement of the firing hammer, said carrier being held normally in a position wherein the detonating charge is at a point remote from the priming charge and the primer is beyond the limit of movement of the firing hammer, and means operable during the flight of the shell for moving the carrier to advance the detonating charge to a point in proximity to the priming charge and to advance the primer into the zone of operation of the firing hammer.

4. A detonator for high explosive shells comprising a priming charge chamber, a movable carrier supporting a detonating charge and a primer for firing the detonating charge, a firing hammer movable longitudinally of the axis of movement of the carrier, a spring for normally holding the hammer against movement but adapted to permit movement of the hammer on impact to fire the primer and thereby the detonating charge, said carrier being held normally in a position wherein the detonating charge is at a point remote from the priming charge and the primer is out of the zone of operation of the firing hammer, and means operable during the flight of the shell for moving the carrier to advance the detonating charge to a point in proximity to the priming charge and to advance the primer into the zone of operation of the firing hammer.

5. A detonator for high explosive shells comprising a priming charge chamber, a detonating charge chamber having venting ports therein leading to the exterior air, a movable carrier supporting a detonating charge and a primer for firing the detonating charge, a longitudinally movable firing hammer adapted on impact to fire the primer and thereby the detonating charge, said carrier being held normally in a position wherein the detonating charge is at a point remote from the priming charge and in proximity to the venting ports in the detonating charge chamber and the primer is out of the zone of operation of the firing hammer, and means operable during the flight of the shell for positively moving the carrier to advance the detonating charge to a point in proximity to the priming charge and to advance the primer into the zone of operation of the firing hammer.

6. A detonator for high explosive shells, comprising a priming charge chamber, a movable carrier supporting a detonating charge and a primer for firing the detonating charge, a longitudinally movable firing hammer adapted on impact to fire the primer and thereby the detonating charge, said carrier being held normally in a position wherein the detonating charge is at a point re-

mote from the priming charge and the primer is out of the zone of operation of the firing hammer, and means including vanes driven by the resistance of the air to the flight of the shell for moving the carrier to advance the detonating charge to a point in proximity to the priming charge and to advance the primer into the zone of operation of the firing hammer.

7. A detonator for high explosive shells embodying a priming charge chamber, an elongated detonating charge chamber having ends of unequal cross sectional area and with the end of the smaller area located within the walls of the priming charge chamber and the end of the larger area exterior to the walls of the priming charge chamber, a detonating charge carrier mounted in said chamber and movable to carry the detonating charge from the end of larger area into the end of the chamber of smaller area, and a barrier normally separating the detonating charge from the priming charge, a member detachably associated with said carrier and located beyond the outer walls of said detonating charge chamber in the exterior air for operatively locking and unlocking said carrier with the detonating charge within the end of the chamber of larger area, and a mechanism for igniting the detonating charge when the shell reaches its target or objective.

8. A detonator for high explosive shells embodying a priming charge chamber, an elongated detonating charge chamber, having ends of unequal cross sectional area and with the end of the smaller area located within the walls of the priming charge chamber, and the end of the larger area exterior to the walls of the priming charge chamber, a detonating charge carrier mounted in said chamber and a member detachable from the said carrier and located beyond the outer walls of said detonating charge chamber in the exterior air for operatively locking and unlocking said carrier within the end of the chamber of larger area and a mechanism for igniting the detonating charge when the shell reaches its target or objective.

9. A detonator for high explosive shells embodying an elongated detonating charge chamber, having ends of unequal cross sectional area and with the end of the smaller area located within the walls of the shell, and the end of the larger area extending to the exterior of the walls of the shell, a detonating charge carrier mounted in said chamber, and having a member projecting beyond the outer walls of said detonating charge chamber into the exterior air with removable means coöperating therewith for operatively locking and unlocking said carrier within the end of the chamber of the larger area, a delay action fuse, and a mechanism for igniting the same when the shell reaches its target or objective.

10. The combination with a high explosive shell, of a detonator mounted at the forward portion thereof, embodying an elongated detonating charge chamber having its end portions of unequal cross sectional area, a priming charge located around the chamber portion of the smaller area, a carrier for a detonating charge movable in the detonating charge chamber from its portion of larger area to its portion of smaller area, and manually detachable means associated with the detonating charge carrier and located on the exterior of the detonator for normally locking the detonating charge carrier to hold the detonating charge within the portion of the detonating charge chamber of larger area.

11. The combination with a high explosive shell, of a detonator mounted at the forward portion thereof, embodying an elongated detonating charge chamber having its end portions of unequal cross sectional area, a priming charge located around the chamber portion of the smaller area, a carrier for a detonating charge movable in the detonating charge chamber from its portion of larger area to its portion of smaller area, and manually removable means associated with the detonating charge carrier and located on the exterior of the detonator for normally locking the detonating charge carrier to hold the detonating charge within the portion of the detonating charge chamber of larger area, and means for obtaining delay ignition of the detonating charge when the shell reaches its target or objective.

12. A detonator for high explosive shells or like bodies of the class described, comprising a priming charge chamber adapted to be firmly secured within the bursting charge chamber of the shell, an elongated detonating charge chamber having ends of unequal cross sectional area and with the end of the smaller area located within the walls of the priming charge chamber and the end of larger area exterior to the priming charge chamber, a detonating charge carrier mounted in said detonating charge chamber and movable from the larger into the smaller end thereof, a member detachably connected with said carrier and located beyond the outer walls of said detonating charge chamber in the exterior air for operatively locking and unlocking said carrier in a position normally locating the detonating charge within the end of the chamber of larger area, and a mechanism for igniting the detonating charge when the shell reaches its target or objective.

13. A detonator for high explosive shells or like bodies, embodying a priming charge chamber adapted to be firmly secured within

the bursting charge chamber of the shell, a detonating charge chamber having a part of its area remote and a part extending in proximity to the priming charge, a carrier for supporting a detonating charge in the detonating charge chamber movable from a point remote to a point in proximity to the priming charge, and detachable means located outside of the detonating charge chamber operatively engaging with a detachable member engaging said carrier and likewise located outside of said chamber for normally locking the detonating charge at a position remote from the priming charge.

14. A detonator for high explosive shells or like bodies, comprising a priming charge chamber having a priming charge therein, the said chamber being adapted to be firmly secured within the bursting charge chamber of the shell, a detonating charge chamber, a movable carrier therein supporting a detonating charge and a primer cap for firing the detonating charge, a longitudinally movable firing mechanism adapted on impact to fire the primer cap and thereby the detonating charge, and detachable means for locating and locking the carrier normally in a position wherein the detonating charge is at a point remote from the priming charge and the percussion cap is out of operative relation with the firing mechanism, said locking means being operable from the exterior of the detonator, and means consisting of a vaned member operable after said locking means have been released and during the flight of the shell for advancing the detonating charge to a point in proximity to the priming charge, and the percussion cap within operative relation of the firing mechanism.

15. A detonator for high explosive shells or like bodies, comprising a priming charge chamber having a priming charge fixedly located therein, the said chamber being adapted to be firmly secured within the bursting charge chamber of the shell, a detonating charge chamber, a movable carrier therein supporting a detonating charge and a percussion cap for firing the detonating charge, a longitudinally movable firing mechanism adapted to fire the percussion cap and thereby the detonating charge when the shell reaches a target or objective, and detachable retaining means for holding the carrier normally in a position where the detonating charge is at a point remote from the priming charge and the percussion cap is out of operative relation with the firing mechanism, said retaining means being provided with independent detachable locking means engaging therewith, and means operable from the exterior of the detonator after said locking means have been released for advancing the detonating charge to a point in proximity to the priming charge and to advance the percussion cap within operative relation to the firing mechanism.

16. A detonator for high explosive shells or like bodies, embodying a priming charge chamber adapted to be firmly secured within the bursting charge chamber of the shell, a detonating charge chamber having a part of its area remote and a part extending in proximity to the priming charge, a carrier for supporting a detonating charge in the detonating charge chamber movable from a point remote to a point in proximity to the priming charge, and detachable means consisting of a split sleeve or ring located outside of the detonating charge chamber operatively engaging with a member of said carrier likewise located outside of said chamber for normally locating the detonating charge at a position remote from the priming charge, and detachable means for operatively locking the said split sleeve or ring to the said member of the carrier located outside of said chamber.

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