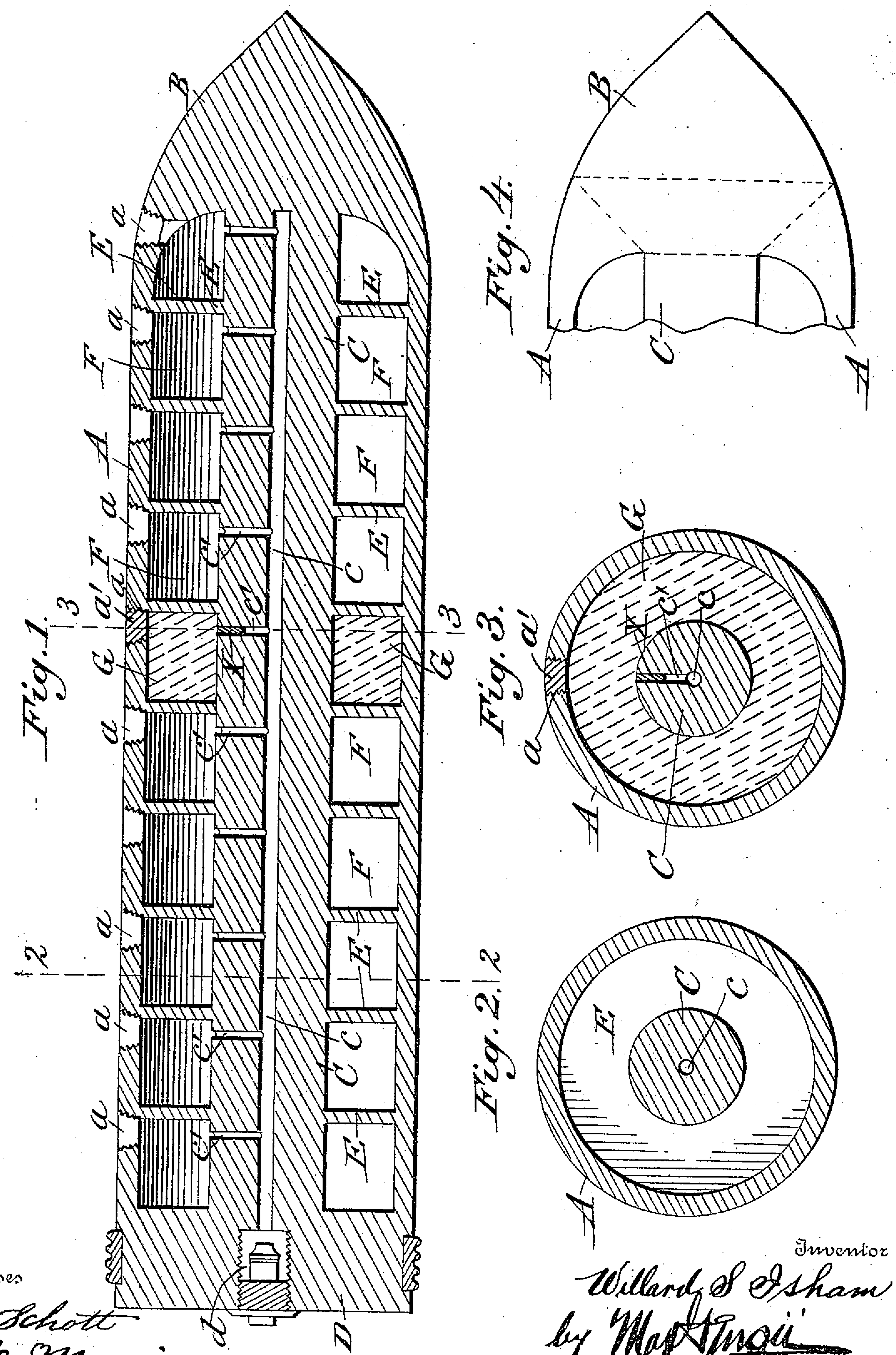
No. 622,479. Patented Apr. 4, 1899.

W. S. ISHAM.

SHELL FOR HIGH EXPLOSIVES.

(Application filed Nov. 28, 1898.)

(No Model.) 2 Sheets—Sheet 1.



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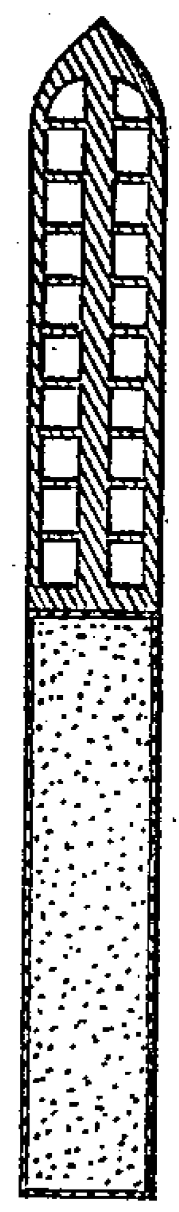

Fig. 7.

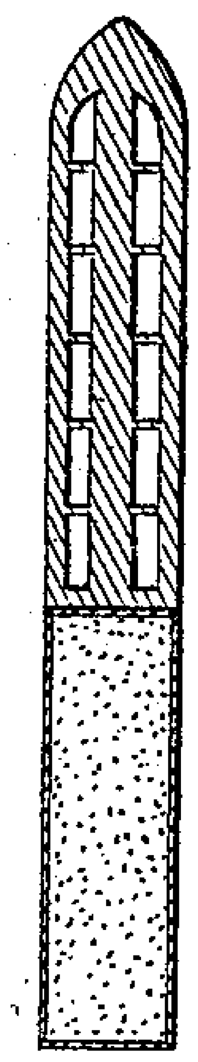

Fig. 10.

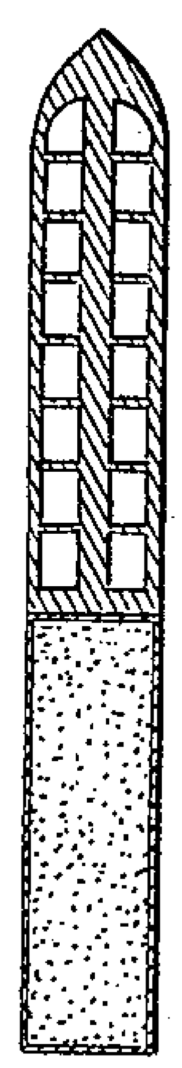

Fig. 6.

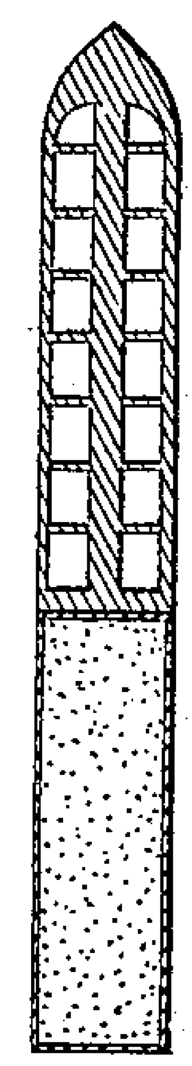

Fig. 9.

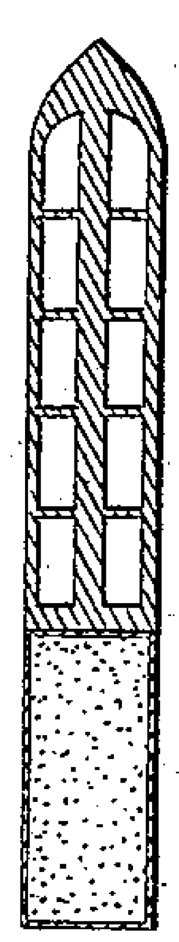

Fig. 5.

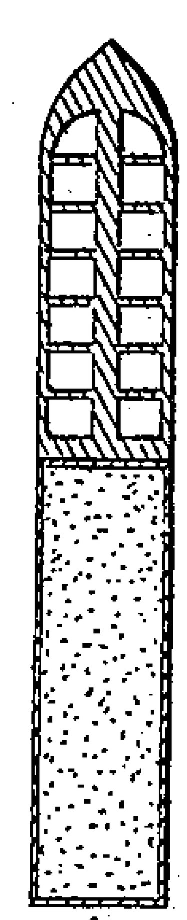

Fig. 8.

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UNITED STATES PATENT OFFICE.

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SHELL FOR HIGH EXPLOSIVES.

SPECIFICATION forming part of Letters Patent No. 622,479, dated April 4, 1899.

Application filed November 28, 1898. Serial No. 697,573. (No model.)

To all whom it may concern:

Be it known that I, WILLARD S. ISHAM, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Shells for High Explosives; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in shells, and in particular to armor-piercing projectiles intended to carry a charge of high explosives.

The object of my invention is to provide a shell which will enable a charge of high explosives to be fired from an ordinary gun in the usual manner of firing shells without danger of a premature explosion.

Another object of my invention is to provide a shell for carrying a high explosive which will be able to pierce armor, the piercing of the armor taking place prior to the explosion of the shell charge.

Many attempts have been made hitherto to construct shells by means of which high explosives could be fired from an ordinary gun in the usual way of firing shot and shell. All such attempts have been failures.

I have discovered the law relative to the pressure on the bursting charge of high explosives due to the pressure of the firing charge, and as a result of such discovery I am enabled to construct shells for high explosives of any kind.

According to the law discovered by me the maximum pressure on the bursting charge due to the inertia of said charge is directly proportional to the maximum pressure per square inch of the firing charge, to the area of the exterior base of the shell, to the weight per cubic inch of the high explosive, and to the height of the charge and is inversely proportional to the total weight of the shell, or, in algebraic language,

$$p = \frac{h\ P\ A\ w}{W},$$

when p equals maximum pressure in pounds per square inch on the high explosive, P equals maximum pressure in pounds per square inch of firing charge, A equals area of base of shell, w equals weight in pounds per cubic inch of high explosive, W equals total weight in pounds of shell loaded, and h equals maximum height of any charge in inches. Now this pressure p on the bursting charge must be less than the minimum pressure per square inch necessary to detonate the high explosive—that is, $p < D$, when D equals pressure in pounds per square inch necessary to detonate the said high explosive. Substituting, we have

$$\frac{h\ P\ A\ w}{W} < D.$$

All the factors involved in my formula are well known except h—the maximum height of the charge of high explosive. This can be deduced readily by means of the formula.

It is to be understood that h, the height of the bursting charge, is the maximum height of such charge in any one compartment or chamber measured in the direction of the longitudinal axis of the shell. Furthermore, the product P A is the total maximum pressure of the firing charge on the base of the shell, and w, the weight per cubic inch of the high explosive, may for brevity be called the "density" of such high explosive.

My invention, broadly considered, consists in a projectile provided with chambers arranged to carry charges of high explosives, none of which chambers are to receive a charge of such high explosive having a height greater than is imposed by the formula

$$\frac{h\ P\ A\ w}{W} < D.$$

It is especially important in the construction of a shell for high explosives that the chambers have their walls without joints and that the chambers be absolutely isolated from each other. Furthermore, for an armor-piercing projectile the construction should be such that the pressure due to impact shall not be transmitted to the charges. These further requirements are met by the preferred form of my invention, which therefore consists, further, in a shell embodying the features, details of construction, and combination of parts, which will first be described in conection with the accompanying drawings and then particularly pointed out in the claims.

In the drawings, Figure 1 is a longitudinal central section of a shell embodying my invention in its preferred form; Fig. 2, a transverse section of the same on the line 2 2, Fig. 1; Fig. 3, a similar view on the line 3 3, Fig. 1, showing a portion of the wall of the shell with a charging-hole and its plug; Fig. 4, a diagrammatic view illustrating the construction of the point. Figs. 5, 6, and 7 are diagrammatic views illustrating the changes that would be made in the heights of the chambers in accordance with my invention where the propelling charge is varied in size, it being assumed, for the sake of this illustration, that the pressure produced by the firing charge will always be proportional to the size of such firing charge. Figs. 8, 9, and 10 are similar views illustrating the changes that will be made in the heights of the chambers in accordance with my invention where the weight of the shell is varied, the other factors remaining constant, as will be more fully explained hereinafter.

Referring to the drawings, A is the wall of the shell; B, the nose or point; C, a pillar or column; D, a base, and E a plurality of transverse partitions, these parts all being made integral with each other in any suitable manner, so that the chambers have no communication with each other. The spaces between the partitions form charge-chambers F, arranged to receive charges which are proportioned in accordance with my formula.

It is absolutely necessary that none of the charges exceeds the limits in height imposed by my formula, and it is preferable that the chambers be also so proportioned that each charge will just fit its chamber.

Through the pillar or column C extends a main vent c, which crosses and communicates with a plurality of transverse chamber-vents c', opening into the respective chambers F. Each chamber F is provided with a charging-hole a, formed in the wall A of the shell, each charging-hole being opposite the chamber-vent c' of its respective chamber and being conical in form, as shown on an enlarged scale in Fig. 3. The charging-holes are screw-threaded and into each is screwed a plug a', which is correspondingly cone-shaped, as shown in said Fig. 3.

The base D of the shell contains a recess d, arranged to receive a fuse of any desired or usual construction, which fuses being well known to those skilled in the art need not be specifically described herein.

After the shell has been cast and before the vents are formed the chambers may be tested by hydraulic pressure one at a time through the charge-holes in order to detect defective shells. After this the main vent is drilled from the base of the shell toward the point and the recess for the fuse is formed. Then the chamber-vents are drilled by inserting a drill through the charge-holes.

A small stopper or plug is inserted into the chamber-vent before loading the chamber, as shown at X, Fig. 1. These plugs are usually, but not necessarily, of soft wood and are intended to be blown into the chambers upon the detonation of the fuse. The plugs for the charge-holes may then be screwed into place and the fuse secured in the recess at the base, thus completing the shell. In Figs. 1 and 3 the charge is shown at G.

A shell embodying all the specific features of my invention has a centrally-arranged column or pillar C, whose diameter is greater than the thickness of the wall A of the shell and whose cross-sectional area is less than the cross-sectional area of said wall A, the column extending entirely from the point B to the base D. The point of the shell is substantially conical or conoidal, the base of the cone or conoid being practically concentric with the forward end of the column or pillar C. Furthermore, the said point is so proportioned that the sides of an imaginary inverted frustum of a cone resting on the front end of the pillar and having its sides at an angle of forty-five degrees will intersect the surface of the nose or point A in a circumference lying directly ahead of the wall of the shell. By this construction the column or pillar will sustain the whole impact of the shell when first striking an armor-plate and up to the time that the cross-sectional area of that portion of the nose lying in the plane of the armor-surface is not greater than the cross-sectional area of the column or pillar. As the point penetrates deeper into the armor the pressure will be distributed between the column and the wall of the shell, the major component, however, being transmitted to the column until the nose has penetrated to such a depth that the points of intersection of the sides of said imaginary frustum and the outer surface of the shell will be beyond the plane of the outer surface of the armor, whereupon the major component of the pressure falls upon the walls of the shell. Since the strain is transmitted longitudinally to the shell-wall, it is readily resisted by the same, this being possible with a comparatively thin wall, owing to the fact that its cross-section is not weakened by joints and also because the partitions are integral with said wall, and thereby prevent bulging of the same. Moreover, the partitions brace the column in the same manner, thereby rendering it possible to make the latter of a smaller diameter than would otherwise be the case, the result being that a shell made in accordance with my construction will have a larger capacity for a bursting charge.

It will be plain that by the particular formation of the point or nose which I have described above the pressure due to impact will be transmitted at first entirely to the column, then partly to the column and shell, and finally to the shell and that this pressure will be at all times in the direction of the lengths of the said column and wall and at no time will there be any pressure from impact on the charge in the shell, except such as due to the momentum of the charge, which, being no greater than the inertia at the time of firing, (if the shell penetrates the armor or other obstruction,) will not cause an explosion of the said charge, whereby it becomes possible for the shell to pierce and pass through an obstruction before exploding, the time of explosion being controlled wholly by the fuse. It will be apparent, therefore, that the pillar is arranged to afford a continuous solid support for the initial penetrating portion of the nose. Moreover, the momentum of the pillar acts directly on the nose and assists in driving the same through the obstruction, such as armor.

With reference to so much of my invention as concerns the proportional size of the chambers or of the charges, if the chambers are not to be entirely filled, it is to be understood that a shell embodying such features is intended for charging with explosives which may be detonated by pressure. This is the sense in which the term "high explosives" is generally used and is the meaning which I attach to said term in this specification. Hence attention is directed to the fact that my formula contains as a factor D the pressure per square inch necessary to detonate the explosive charge. This is important, because this pressure varies with different high explosives, and consequently a shell which would have chambers suitably proportioned according to my formula for one kind of high-explosive charge might be inoperative for use with another kind of high explosive. It will be understood, of course, that D is well known for all high explosives.

In Figs. 5, 6, and 7 I have shown how the heights of the chambers proportioned in accordance with my invention will vary as the firing charge varies. It will be noted that the firing charges increase in size from Fig. 5 to Fig. 7, being smallest in the former view and largest in the latter view. It will also be noted that the heights of the chambers of the shells decrease from Fig. 5 to Fig. 7, being greatest in Fig. 5 and least in Fig. 7. In these three views it is assumed that the weight and diameter of the shell, the kind and quality of the high-explosive bursting charge, and the kind and quality of the firing charge remain unchanged. Furthermore, it is also assumed that the maximum pressure of the firing charge is proportional to the size of said firing charge. Of course it is to be understood that a difference in quality of powder will also cause a difference in the maximum pressure generated by such firing charge.

In Figs. 8, 9, and 10 is illustrated the manner in which the heights of the chambers will vary with the variation in the weight of the shell, such height being least in Fig. 8, where the weight of the shell is least, and greatest in Fig. 10, where the weight is greatest. In these views it is assumed that the kind, quality, and quantity of the firing charge and the kind and quality of the high-explosive bursting charge are unchanged.

As will be seen from the drawings, the difference in weight of the shell may be caused by a difference in the length of said shell, as illustrated by Figs. 8 and 9, or by a difference in thickness of walls or columns, as will be clear from a comparison of Figs. 9 and 10.

While the said views Figs. 5 to 10 are made to a scale illustrating a seven-inch shell, they are only intended as illustrative examples to make clear in a general way the gist of my invention, and it is to be understood that my invention is not restricted to the proportions therein shown nor to those changes only, the full scope of my invention being pointed out in the claims.

While I have particularly mentioned the use of the shell for piercing armor, it is to be understood that it may be used for piercing any obstruction or resistance—such as masonry, earthworks, and the like—and the term "armor" is used by me in this generic sense.

For firing dynamite or other high explosives in which nitroglycerin is a component it is highly important that the shell shall be formed integral instead of being built up of parts screwed or otherwise fastened together in a detachable manner for the following reasons: When the shell is made of such parts, the joints, no matter how well fitted, are not absolutely closed at all points, for even though water-tight there will be marginal edges which do not contact throughout. As the nitroglycerin will exude to a slight extent from the explosive charge, it will enter such joints, although of course only to an almost infinitesimal extent. Yet even such a small amount will cause the premature explosion of the shell, since at the moment of firing the joints are compressed with great force, and consequently the nitroglycerin caught therein is exploded, this in turn detonating the remaining charges of the shell.

In my construction no attention is paid to the inertia of rotation of the bursting charge, because the shell can rotate while the bursting charge is relatively stationary at the start, and there is no lateral surface for such bursting charge to press against. Thus all danger of explosion from rotation is avoided. Eventually, of course, the charge acquires a certain amount of rotary motion through friction.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. A shell for high explosives having chambers provided with bursting charges, none of said bursting charges having a maximum height equal to that obtained by dividing the product of the total weight of the shell, loaded, and the minimum pressure per square inch

necessary to detonate the high explosive, by the product of the maximum total pressure of the firing charge on the base of the shell and the density of the high explosive.

2. A shell for high explosives having chambers provided with bursting charges, none of said chambers having a maximum height equal to that obtained by dividing the product of the total weight of the shell, loaded, and the minimum pressure per square inch necessary to detonate the high explosive, by the product of the maximum total pressure of the firing charge on the base of the shell and the density of the high explosive.

3. A shell for high explosives having a plurality of non-communicating, entirely inclosed chambers provided with bursting charges, none of said bursting charges having a maximum height equal to that obtained by dividing the product of the total weight of the shell loaded and the minimum pressure per square inch necessary to detonate the high explosive, by the product of the maximum total pressure of the firing charge on the base of the shell and the density of the high explosive.

4. An integral shell for high explosives having a plurality of non-communicating entirely inclosed chambers provided with bursting charges, none of said bursting charges having a maximum height equal to that obtained by dividing the product of the total weight of the shell loaded and the minimum pressure per square inch necessary to detonate the high explosive, by the product of the maximum total pressure of the firing charge on the base of the shell and the density of the high explosive.

5. A shell for high explosives having a shell-wall, a centrally-arranged pillar within the same and integral therewith and annular compartments around the pillar.

6. A shell for high explosives having a shell-wall, a centrally-arranged pillar within the same, and a nose integral with the wall and pillar, the diameter of the pillar being greater than the thickness of the wall.

7. A shell for high explosives having a shell-wall, a centrally-arranged pillar within the same and a plurality of transverse partitions extending from the pillar to the walls and integral with the pillar and walls.

8. A shell for high explosives having a shell-wall, a centrally-arranged pillar and a nose whose base is concentric with the front end of the pillar, said parts being integral, the proportions of the point being such that an imaginary inverted frustum of a cone resting on the front end of the pillar and having its sides sloping at an angle of forty-five degrees would intercept the outer surface of the point in a circumference lying directly forward of the wall of the shell, substantially as described.

9. A shell for high explosives having a shell-wall, a central pillar, a nose and transverse partitions extending from the pillar to the wall, the pillar having a longitudinally-arranged main vent and chamber-vents opening into said main vent and into the chambers formed between the partitions, in combination with a fuse at one end of the main vent, substantially as described.

10. A shell for high explosives having a shell-wall, a central pillar, a nose and transverse partitions extending from the pillar to the wall, all the parts being integral, the pillar having a longitudinally-arranged vent and chamber-vents opening into said main vent and into the chambers formed between the partitions, the wall being provided with charging-holes, one for each chamber, each hole being opposite its corresponding chamber-vent.

In testimony whereof I affix my signature in presence of two witnesses.

WILLARD S. ISHAM.

Witnesses:
M. C. MASSIE,
ANTON A. GLOETZNER.