

June 16, 1931.

J. H. WOODBERRY

1,810,000

BOOSTER

Filed June 7, 1921

2 Sheets-Sheet 1

Fig. 1.

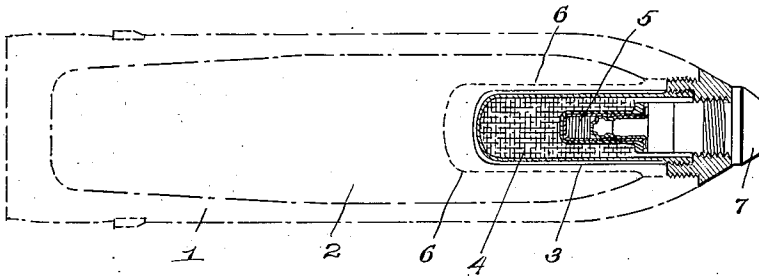
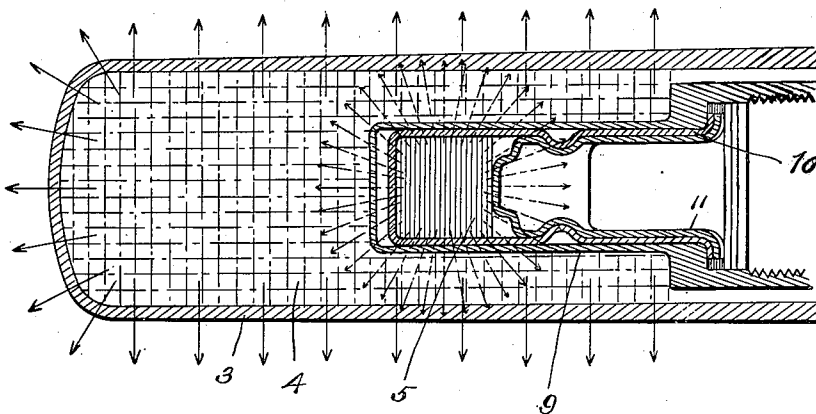


Fig. 2.



*John H. Woodberry*  
INVENTOR

June 16, 1931.

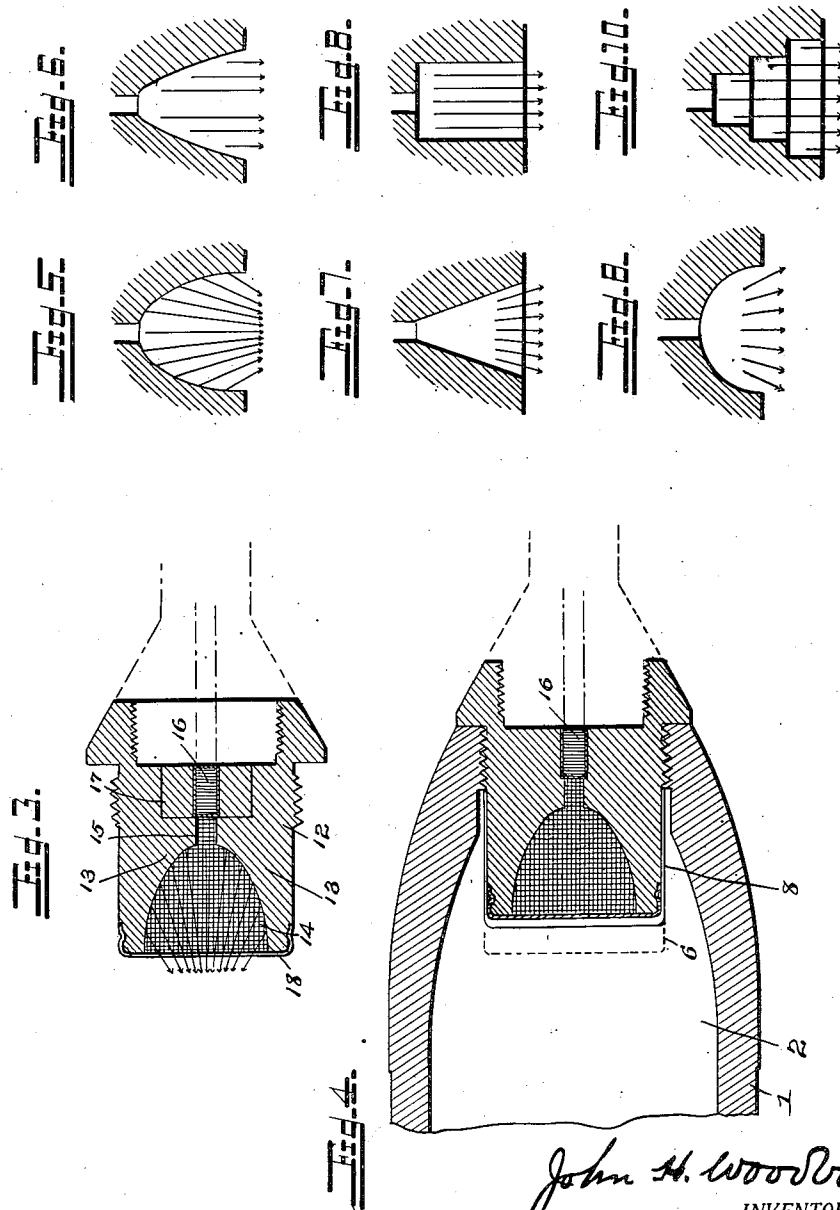
J. H. WOODBERRY

1,810,000

BOOSTER

Filed June 7, 1921

2 Sheets-Sheet 2



John H. Woodberry  
INVENTOR.

## UNITED STATES PATENT OFFICE

JOHN H. WOODBERRY, OF THE UNITED STATES ARMY, FRANKFORD ARSENAL,  
BRIDGESBURG, PENNSYLVANIA

## BOOSTER

Application filed June 7, 1921. Serial No. 475,745.

(GRANTED UNDER THE ACT OF MARCH 3, 1883, AS AMENDED APRIL 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

5 The subject of this invention is a booster intended for use in exploding shells, bombs, grenades, torpedoes and other articles of ammunition, and in blasting explosives. It is particularly adapted for use in detonating  
10 high explosives but its principles are equally applicable to explosives of a low order.

A form of the present invention wherein explosive charges are controlled is shown in my Patents 1,376,908 and 1,462,313, applications for which were filed December 10,  
15 1918.

To fully show the principles involved in my invention and to better illustrate its objects and uses, its use as applied to high explosive artillery shells will be here described sufficiently to explain its typical action.

In order to produce a detonation with high explosive shells, that is in shells loaded with explosives such as T. N. T., tetryl, amatol,  
25 picric acid, and the like, two conditions must obtain: First there must be a mechanical means for initiating the explosive, and, second, there must be means whereby this initial explosion will be accelerated and augmented  
30 until sufficient energy in the form of highly heated and highly compressed gas has been obtained to produce a sympathetic detonation of the shell charge. The first condition is obtained by means of a fuse which contains  
35 usually a primer and fulminate detonator.

In any but the minor caliber shells it has been found that the fulminate detonator of itself is not usually sufficient to produce the necessary energy to cause the shell charge to  
40 detonate without assistance. Consequently, it is necessary to augment this fulminate charge with an auxiliary charge of powerful yet easily detonated explosive. This additional explosive is commonly known as a  
45 booster charge and the container of this charge is a booster casing.

In common practice the booster casing is usually composed of a drawn, pressed or machined metal cup. The thickness of the walls  
50 and the interior shape of the cavity is deter-

mined chiefly by considerations of manufacture rather than by scientific analysis of the practice involved in securing a maximum desired effect of the booster. The size of the casing is usually determined by experiments  
55 for each particular type of shell and the amount of explosive contained in any type of booster is sufficient to cause detonation in the shell charge when the initiating charge (the  
60 detonator) is preponderant in size and strength, and the shell charge is in immediate contact with the booster casing. It is possible to obtain the first condition when the element of danger in having an excessively  
65 large charge of fulminate of mercury is disregarded or when mechanical means for separating the detonator from the booster charge is provided, but even so, the less fulminate contained in a fuse the less is the element of  
70 danger. It is seldom possible, however, to have the second condition prevail in actual practice for even though the shell charge is loaded in intimate contact with the booster casing in high velocity shells, the inertia of  
75 the shell is enormous, and the resulting set back force, due to linear acceleration in the bore is usually sufficient to further compress the shell charge and therefore produce an air gap in the nose of the shell. This being the  
80 location of the booster in point fused shells, will result in a cavity surrounding at least a portion of the booster casing. A quantity of the energy of the booster is, therefore, entirely lost in its direct detonating effect and  
85 its power is so diminished that a low order of detonation in the shell or complete failure must result. To overcome this condition, the common practice has been to provide a booster charge much in excess of that actually  
90 required to detonate a shell under ideal conditions. The failure to present sufficient energy to the shell charge to initiate the breaking down of the molecular structure of the charge to its most effective form must  
95 result unsatisfactorily.

In boosters now in common use, the walls of the casing are of immaterial thickness, the determining factor being easiness of manufacture and strength sufficient to carry the load during the period of acceleration. 100

When explosion of the booster takes place the walls being relatively thin and of more or less uniform thickness, the force of explosion is expended equally in all directions. The total energy thus transferred to the shell is distributed over a relatively large surface and unless the energy per unit of surface is sufficiently great to initiate a sympathetic detonating wave in the charge a low order of detonation must result. The presence of an air gap around ordinary cup boosters is considered detrimental to the transmission of detonation from the booster to the shell charge, even though the booster be completely surrounded by the charge. As an air space of varying dimensions is inevitable due to the necessary tolerances in manufacture and loading, all boosters of the ordinary type are necessarily less effective under actual conditions than in ideal conditions.

Bearing these, and other inherent weaknesses of existing boosters in mind, I inaugurated a series of experiments to develop a booster of more efficiency by eliminating or minimizing the above mentioned defects and by providing some logical means of initiating the detonation in the booster itself. My experiments were made in an attempt to direct the entire effective force of the booster toward one point in the shell charge, in much the same manner as light waves may be controlled and directed. In carrying out these experiments I found that the force of explosion at the mouth of a cup containing explosives is much greater when the cup was not ruptured than when the cup was blown to pieces and that when the cup was ruptured the force of explosion varied directly with the thickness of the wall. It was, therefore, concluded that a booster made of strong metal and having thick walls to prevent equal expansion of the gases in all directions and so constructed as to cause the gases to flow in the desired direction thereby giving a concentrated explosive effect, would be of more value than thin walled boosters such as are now in use.

Furthermore I found that better results were obtained when the mouth of the cup was obstructed less, hence I concluded that a thick wall booster should be sealed only sufficiently to hold the explosive in place and to prevent undue exposure to moisture, etc. I found furthermore that in the thick wall cup the force of explosion was also dependent upon the interior shape of the cup, the detonating effect being greatest in an ellipsoidal cavity, and diminishing in the other paraboloidal, cylindrical, and conoidal. It is, therefore, concluded that a booster having a cavity whose vertical section is a conic section and particularly an ellipse is to be preferred. One exception is to be noted, however, and that is that a cylindrical cavity is better than a conoidal cavity. Obviously any form

approximating the above true curves will give approximate results.

In all of the above experiments the detonation in the booster was originated at or near the center of the base of the cup or in the conic section forms near the focus of the form. This method of originating the detonation is to be preferred over other methods. An improvement in the position of the detonator was also found. Ordinarily a detonator is counter-sunk in the main booster charge so that it is surrounded by the booster. This is objectionable, however, on account of the amount of metal which must necessarily exist between the detonator and the charge itself, on account of assembling methods. Furthermore, since the detonator is not highly confined, the force of detonation occurs equally in all directions and consequently the charge must be of sufficient strength to produce the required energy per unit area to initiate the detonation in the booster charge. I have found that if the detonator is removed from the booster charge and is closely confined by thick metal walls being connected with the main booster charge by a small cord of high explosive, preferably the same as the booster charge, a concentrated effect is obtained, and as a result the amount of fulminate used may be materially reduced. In common practice, a detonator contains from 20 to 50 grains of fulminate of mercury but in this preferred type of detonator four grains has been found sufficient to insure detonation, although a greater amount than this is to be preferred. The advantage in using this type of detonator may be found in the additional safety, economy, and efficiency afforded.

With these and other objects in view the invention resides in the novel arrangement and combination of parts and in the details of construction hereinafter described and claimed, it being understood that changes in the precise embodiment of the invention herein disclosed may be made within the scope of what is claimed without departing from the spirit of the invention.

Practical embodiments of the invention are shown in the accompanying drawings wherein

Fig. 1 is a view in longitudinal section of an ordinary form of booster, the shell in which the booster is secured being shown in broken lines;

Fig. 2 is an enlarged view in longitudinal section of the booster, the dispersion of the force of explosion thereof being represented by arrows;

Fig. 3 is a view in longitudinal section of a booster constructed in accordance with my invention;

Fig. 4 is an enlarged view of the same, a fragment of the shell to which it is secured being shown and a modified form of detonator casing also being shown;

Figs. 5, 6, 7, 8, 9 and 10 are fragmentary sectional views showing preferred forms of cavities.

Referring to the drawings by numerals of reference, 1 refers to a shell body having a cavity 2 for the reception of the charge of high explosive in the end of which shell is threaded an ordinary booster casing 3, containing the booster charge 4 in which is counter-sunk the detonator 5 inclosed in a suitable detonator casing comprising the containers and holders 9, 10 and 11.

The booster has connected thereto the usual form of fuse 7 which operates to fire or detonate the detonator. 8 refers to the usual air gap between the booster casing and the explosive charge in the shell while the dotted line 6 indicates the air gap as the same would appear after set back of the charge upon firing of the shell from the gun.

In Fig. 2 the series of dotted arrows indicate the dispersion of the force of explosion of the detonator while the solid arrows indicate the dispersion of the force of explosion of the booster charge, showing that in the ordinary form of booster the energy generated by the explosion of the charge is dispersed over a large area of the explosive in the shell thereby diminishing the force upon a unit area.

Referring to Figs. 3 and 4 a typical booster constructed in accordance with my invention is shown. In these figures the booster casing 12 is formed with thick heavy walls 13 which surround the booster cavity in which is contained the booster charge 14. The booster casing is centrally bored, such bore communicating with the cavity and being adapted to receive the cord of explosive 15 which may be the same explosive material as that filling the booster cavity. The casing may be counter-sunk to receive a detonator casing 17 which is centrally bored for the reception of the detonator 16.

As shown in Fig. 4, the bore for the reception of the detonator 16 may be formed directly in the booster casing 12 thus obviating the necessity for the extra piece 17.

A thin metal cap 18 may be secured in any suitable manner over the end of the booster casing 12 for the purpose of closing the cavity, retaining the booster charge in place and excluding moisture therefrom. The usual air gap is indicated by the reference numeral 8 in Fig. 4 and the increase of this air gap due to set back is indicated by the dotted lines 6.

While the ellipsoidal form of cavity is preferred a number of cavities from which good results have been obtained are shown in Figs. 5 to 10, inclusive, in which Fig. 5 is the ellipsoidal form, Fig. 6 shows a cavity in the form of paraboloid; Fig. 7 shows a cavity in the form of a cone; Fig. 8 a cavity in the form of a cylinder; Fig. 9 one in the form of a

hemisphere and Fig. 10 a cavity composed of superimposed cylinders. The cylinder shown in Fig. 8 is very efficient when surrounded with strong walls, and is a preferred form in boosters not requiring the highest efficiency.

Having described by invention what I claim is:

1. Means for increasing the effectiveness of booster charges embodying, a strong walled container having a cavity therein, the walls of which gradually converge toward the bottom, a detonator located in the strong walled container and remote from the booster cavity and a cord of explosive connecting the detonator and booster cavity.

2. Means for increasing the effectiveness of booster charges embodying, a strong walled container having a cavity therein, the walls of which gradually converge toward the bottom, a detonator located in the strong walled container remote from the booster cavity, a cord of explosive connecting the detonator and booster cavity located so as to direct the initiation of detonation in the booster charge along the axial line of the booster cavity.

3. Means for increasing the effectiveness of booster charges embodying, a strong walled container having a booster cavity therein, a detonator located in the strong walled container and remote from the booster cavity and means for communicating the wave of detonation from the detonator to the booster cavity.

4. Means for increasing the effectiveness of booster charges embodying, a strong walled container having a booster cavity therein, a detonator located in the strong walled container and remote from the booster cavity and means for communicating the wave of detonation from the detonator to the booster cavity along the axial line of said cavity.

5. Means for increasing the effectiveness of booster charges embodying, a strong walled container having a cavity therein, the walls of which gradually converge toward the bottom, a detonator located in the strong walled container remote from the booster cavity and communicating means between the detonator and the booster cavity whereby the wave of detonation from the detonator will be communicated to the booster cavity.

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

7. A detonating fuse comprising, a body in one end of which is a chamber for the booster charge, the walls of which chamber converge

at the rear, so as to close the chamber except for a channel of detonation leading to the chamber and being curved to direct and concentrate the waves of detonating force, produced by the detonation of the booster charge, into the bursting charge of the shell to which the fuse is applied.

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

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

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

JOHN H. WOODBERRY.

35

40

45

50

55

60

65