March 10, 1942. W. O. SNELLING 2,276,110

EXPLOSIVE MISSILE

Filed March 18, 1939

Fig. 1.

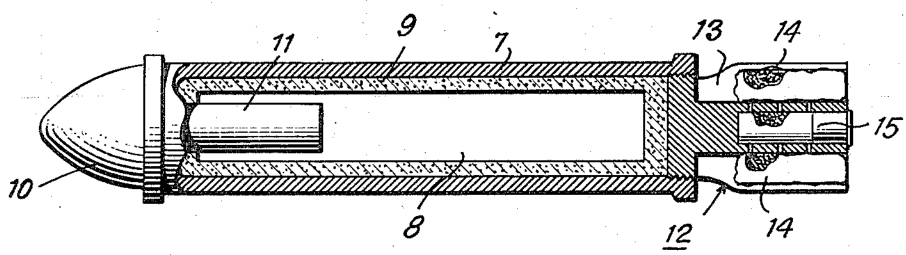


Fig. 2.

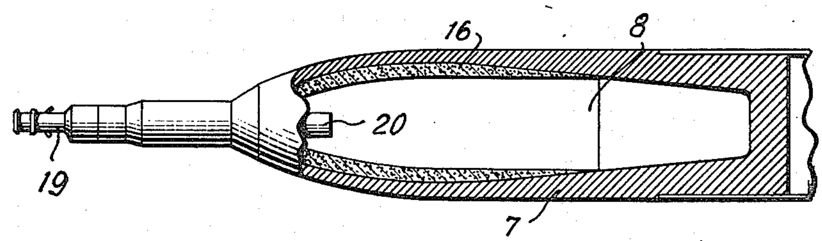
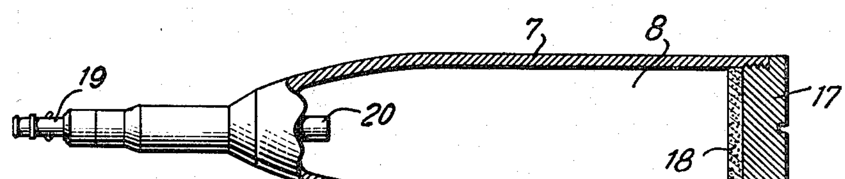


Fig. 3.



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Patented Mar. 10, 1942 2,276,110

UNITED STATES PATENT OFFICE

2,276,110

EXPLOSIVE MISSILE

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Application March 18, 1939, Serial No. 262,608

7 Claims. (Cl. 102—29)

This invention relates to explosive missiles. It relates more particularly to projectiles for use against troops and especially to means for causing proper fragmentation of brittle metal shell.

The missiles to which the invention refers include those adapted to be fired from guns, hurled or dropped, especially high explosive shell or projectiles.

Shell for use against infantry are now usually made of forged steel. The operation of forging the shells is relatively slow and expensive; the equipment required in the manufacture is costly and may prove to be difficult to obtain in adequate amount in times of major wars, when the need is greatest.

On the other hand, it is easy to provide the relatively simple equipment necessary to form cast iron into shell. Also, the operation of casting is relatively quick and inexpensive.

A reason for the use of steel forgings as shell in the past has been the impossibility of making cast-iron shell which meet the severe requirements. It is necessary that shell for stopping troops should give, on explosion of the charge therewithin, the largest possible number of fragments of effective size, moving at a sufficiently high velocity. Thus, shell for use against infantry should fragment predominantly into pieces of such size as to pass a screen having one mesh to the linear inch and be retained on a 3-inch screen. Furthermore, the individual particles should each have preferably not less than 60 ft. lbs. of energy and should be able to penetrate a ⅞ inch pine board and, preferably, penetrate twice this thickness of board.

When cast iron shell are used with the conventional high explosive charge therewithin, the shell are blown into small fragments of size predominantly below that preferred. If, on the other hand, there is used a charge of slow explosive, then the resulting pieces of the cast iron shell are sufficiently large, and are usually too large, but have insufficient velocity.

It is an object of the present invention to provide a cast metal shell of desired fragmentation when used with a detonating explosive bursting charge. Another object of the invention is to provide a shell containing a protection for an inherently weak but not necessarily brittle portion thereof. A further object is the provision of a method of making loaded shell of the kind described. Other objects and advantages of the invention will appear from the detailed description that follows.

Briefly state, the preferred embodiment of the invention comprises a shell of fragmenting relatively brittle metal, a detonating explosive charge therewithin, and a liner disposed between the shell and the said charge, the liner being firm so as to avoid set-back of the explosive charge, but crushable on explosion of the said charge.

The invention is illustrated in the attached drawing and will be exemplified by description in connection therewith.

Fig. 1 is a view largely in section of a trench mortar shell provided with the liner inside the shell.

Fig. 2 is a similar view of a shell for use in a 75 mm. or other calibre of cannon, the lining being omitted over the back portion of the shell.

Fig. 3 is a similar view of a shell having the lining over only a portion of the shell that is structurally relatively weak.

The figures are in part diagrammatic, features not illustrated in detail being conventional.

In the several figures there are shown the fragmenting metal shell 7 and the bursting charge of high explosive 8.

In the trench mortar shell of Fig. 1 there are shown a liner 9 fitting snugly within the shell and around the explosive charge, in tight relationship to each, means for exploding the said charge, including the fuse 10 and the booster charge 11, the tail 12 including suitably a number of radial fins 13, a propellant 14 such as a series of cylinders filled with smokeless powder and held in the space between adjacent ones of the fins, and a shot gun shell 15, or the like, adapted to ignite the propelling explosive 14 when the shell is dropped into the usual trench mortar.

In Fig. 2 the liner 16 extends over the side and front portions only of the shell; the rear portion of the shell is directly in contact with the explosive charge 8. Furthermore, in the said rear portion, the width of the explosive charge at all points is at least as great as that at the mid-point or widest portion of the charge, this feature avoiding set-back of the explosive under the most severe conditions of projection of the shell.

In connection with the danger of set-back, it will be understood that shells are frequently given a velocity of 1,800 to 2,200 feet a second or higher as the shell traverses only the length of the free portion of the barrel of the cannon. As a result of this tremendous acceleration, there is a tendency for the explosive charge to move backward and to fill any space presented to it at the rear of the shell, this movement or shift of the explosive being known as set-back and being likely to be accompanied by premature and hazardous explosion of the charge.

It is a feature of my construction that this dangerous set-back of the explosive charge is prevented in all embodiments of my invention; the firmness of lining which I use permits its extending completely around or behind the explosive charge as illustrated in Figs. 1 and 3, for most types of shell.

In Fig. 3 there is shown a modified form of shell that may be made, for example, from forged steel pipe shaped suitably at the front end and closed at the base or rear by means of the end portion 17 screwed into the main portion. In case the use of a liner inside all parts of the metal shell is not desired—and it is not necessary for all purposes when the material of construction of the shell is steel—then the liner is omitted except over the relatively weak end portion. In this case, the liner 18 should extend completely over the end portion, so as to protect the end portion momentarily from the full force of the explosive charge and thus avoid disrupting the screw engagement until there has been built up in the shell pressure adequate to give desired velocity to the resulting fragments of the shell.

In the shells shown in Figs. 2 and 3, the means for exploding the bursting charge are conventional and include suitably the fuse 19 which is inserted at any suitable time and the adapter and booster charge 20, the adapter not being shown.

The charge of high explosive 8 within the shell is of the brisant type and may be one ordinarily used by the United States Government as the bursting charge for such shells. Trinitrotoluene is the preferred explosive although there may be used to advantage a mixture of trinitrotoluene with ammonium nitrate (amatol). A suitable amatol is made by mixing molten trinitrotoluene and an equal weight of crystals of ammonium nitrate. Picric acid is another explosive that may be used. The detonating explosive substantially fills the space within the liner, that is, the space not occupied by the booster charge or casing.

The booster charge, also, may be of conventional kind or composition, as for example tetryl.

The shell wall should be thick, say one-half to one inch or so, and composed of a fragmenting metal. As stated, cast iron is satisfactory under the conditions of use. Being low in cost, it is preferred for the present purpose, but cast steel may be used for some purposes. Cast iron and cast steel are referred to herein as "cast ferrous metal." The liners 9, 16 and 18 are of a composition that must be selected carefully if there is to be on the one hand absence of set-back sufficient to explode the projectile on its projection from the gun, and on the other hand proper fragmentation on the explosion of the bursting charge.

The material of the liner should be inert to the extent of having no appreciable injurious effect upon the shell on the one side or the explosive on the other. The liner must absorb or mechanically transform a portion of the initial energy of the explosive charge 8. It must be so firm as to allow no appreciable set-back of the explosive at the time the shell is projected but must be crushable upon the explosion of the charge 8. In meeting the requirement as to minimized set-back, I find advantageous the use of material of at least the firmness of set plaster, that is, hydrated gypsum plaster or plaster of Paris.

Suitably, the liner is adhered to the inside of the shell as, for example, by being poured into the shell in flowable condition and hardened in situ or by means of an adhesive (not shown) forming a film that is preferably continuous between the shell and the liner. Adhesives that may be used are thin layers of tar, asphalt, pitch or the like.

The liner should be thick. For most purposes the liner should be at least half as thick and preferably should be as thick as the shell wall, say, ½ inch to 1½ inches thick, in order to give proper protection to a cast iron shell against fragmenting to a large extent into undesirably small pieces.

Among the materials that are suitable for use as the liner are compositions containing plaster, Portland cement, or magnesium oxychloride.

These various compositions may include reinforcing materials such as asbestos fibers or various fillers or admixtures.

Hydrated liner compositions such as described serve also as energy ballast, as will be discussed later.

The liner is preferably formed by introducing into the shell a flowable composition adapted to harden in situ. Thus, plaster or Portland cement compositions may be introduced in intimate mixture with water in amount required for hydration or setting, the shell being supported vertically and rotated during the period of filling and setting, so as to spin a liner of desired interior contour. If Portland cement is used, the retarder of setting conventionally present in Portland cement may be omitted, in order to avoid long delay in hydration of the Portland cement. Preferably, no appreciable excess of water is used over that which chemically combines in the hardening. Should any excess water be used or the set liner be not dry, drying is effected at a temperature below that of dehydration of the set material.

Additional thickness of liner may be provided at any point within the shells, as over thin spots of the liner centrifuged into position. Such additional lining material may be introduced in any convenient way and the shell inclined, in such manner as to cause the said material to flow over the spot to be further protected. Hardening is then effected as described.

The liner may be made to have any desired shape of interior surface by being cast to fill the entire shell space and then bored out, to remove undesired material.

A serious problem arises in the use of the liner in shells that are to be accurate from the ballistic standpoint. For this reason, I incorporate into the liner a density-establishing ingredient to adjust the over-all density of the liner to substantially that of the high explosive charge at the same temperature, so as not to interfere with the ballistic characteristics of the complete assembly. In this manner there is produced a final loaded shell having, for a given calibre, the same weight as would be produced with the lining omitted, and with the explosive charge occupying the entire shell cavity.

To increase the density of the lining composition there may be used particles of heavy materials such as finely divided barytes, celestite, magnetite, ilmenite, calcite or the like. To lower the density of a liner composition that, by itself, is more dense than the explosive charge 8, I may incorporate such light weight fillers as diatomaceous earth, pumice or the like, pores in or between particles of the fillers being left largely in unfilled condition, in order to give the desired lightness.

In place of the centrifugal method of filling described above, the liner composition may be introduced so as to fill approximately the entire space within the shell; drilling is then employed, to form the central cavity for receiving the explosive charge.

In introducing the lining over the screwed-in end portion only of the shell shown in Fig. 3, the shell is placed upright with the said end portion downward and the liner composition in flowable condition introduced, so as to give the desired depth of layer, this introduction obviously being made before the shell is loaded. The composition is then hardened as described previously.

The rear end of the shell of Fig. 1 may be lined in the same manner in lining the forward end of this shell, the proper quantity of composition is introduced, the shell closed by a temporary cap or plug, the shell placed vertically, with the forward end down, and the composition hardened. The cap or plug is then removed and the liner drilled to receive the booster casing. The sides of this shell may be lined as previously described, either before or after the ends are lined.

Shell lined as described and filled with a detonating explosive such as trinitrotoluene fragment on detonation of the explosive into pieces predominantly of size such as are retained on a 3-mesh screen. Without the lining, the fragments formed are mostly of size finer than 3-mesh.

The superior fragmentation produced in shells made in accordance with the present invention is considered as being due mainly to the result of the action of the liner during that short period of time which is required for the detonating explosive to detonate completely. In previous efforts to use cast iron shells with brisant explosives, the shell has been resolved into fragments too small to be effective, because of the pulverizing or disintegrating action of the brisant explosive in direct contact with the relatively brittle metal of the shell wall. Efforts to correct this pulverizing action by employing slower explosives has resulted in improved fragmentation, but in such cases the fragments have not been projected with sufficient velocity to be effective. By the present invention the brisant explosive reaches full detonation by the time the shell wall is fragmented, and accordingly the shell fragments are projected at the desired high velocity, although the momentary effect of the lining is to control and moderate the pulverizing action of the brisant explosive upon the brittle metal.

The explosive missiles herein described, are adapted for use particularly in connection with shells of about three to six inches internal diameter. Shells of larger size are ordinarily used primarily for demolition and in such demolition shell, the fragmentation of the shell into pieces of preferred size for stopping infantry is not a feature of special importance.

However, the invention is applicable to other shapes of shells or explosive missiles than those shown in the drawing.

One of the purposes of my improved shell lining is to act momentarily as an absorbent of energy or "energy ballast," during the period of time required for the brisant explosive to reach full detonation. I find highly desirable the presence in the shell lining of an energy absorbing material, suitably a stable hydrated substance, as, for example ulexite, colemanite, gypsum or vermiculite. In the presence of such a compound having combined water of crystallization or water of constitution, a portion of the energy of the explosive is absorbed momentarily in performing chemical or physical effects upon the lining material, part or all of this absorbed energy being then available to increase the propellant action, the action being best explained as a transformation of the brisant or shattering effect of the explosive into a propulsive or propellant action, thuns modifying the manner in which the energy is utilized rather than a change in the total quantity of energy involved.

When such energy ballasting material is used, it may be incorporated in granular or powdered form in the liner composition, as by being mixed with a binder, such as sulfur, rosin, or the like, the binder being in molten condition before the composition is introduced into the shell and allowed to solidify. A suitable proportion is 5 to 40 parts by weight of the said material to 100 of dry weight of the liner composition.

It will be understood that the admixed absorbent of energy is not necessary when the liner is composed largely of a hydrated composition, such as plaster or Portland cement, that is itself an energy absorbent. It is to be understood that the terms "liner" and "lining composition" as used herein refer to materials that do not constitute a portion of the explosive charge of the shell or missile and that are wholly or predominantly non-explosive in nature.

It will be understood also that the details given are for the purpose of illustration, not restriction, and that variations within the spirit of the invention are intended to be included in the scope of the appended claims.

I claim:

1. An explosive projectile for use against troops comprising a cast iron shell, a charge of detonating explosive within the shell, means for exploding the said charge, and a crushable energy-modifying liner disposed between the shell and detonating explosive, in direct contact with each, the liner being at least as firm as set plaster, so as to prevent set-back of the explosive charge on projection of the projectile, but crushable by the force of explosion of the said charge and having a thickness of at least half the thickness of the wall of the shell.

2. An explosive missile for use against troops comprising a cast iron shell, a charge of detonating explosive within the shell, means for exploding the said charge, and a crushable liner disposed between the shell and detonating explosive, in direct contact with each, the liner being at least as firm as set plaster, but crushable by the force of explosion of the said charge and being one-half inch to one and one-half inches thick and the shell fragmenting on explosion of the charge predominantly into pieces of size of the order of those retained on a 3-mesh screen.

3. An explosive missile comprising a cast iron shell, a hollow liner, therewithin of a hydraulic cementitous composition in set condition, a charge of detonating explosive filling the space within the liner, and means for exploding the

said charge, the liner being in direct contact on one side with the shell and on the other side with the said explosive.

4. An explosive missile comprising a fragmenting metal shell, a hollow liner therewithin of a solidified monolithic sulphur composition, a hydrated material distributed throughout the said composition, a charge of detonating explosive filling the space within the liner, and means for exploding the said charge.

5. An explosive missile for use against troops comprising a thick fragmenting metal shell, a charge of detonating explosive within the shell, means for exploding the said charge, and a crushable liner within the side and front portions only of the shell and around the explosive charge, the rear end of the shell being in direct contact with the explosive.

6. An explosive projectile for use against troops comprising a thick fragmenting cast ferrous metal shell, a charge of detonating explosive within the shell, means for exploding the said charge, and a crushable liner within the side and front portions only of the shell and around the explosive charge, the width of the explosive charge at all positions back of the midpoint of the shell being at least as great as at any other position in the shell, so as to minimize the danger of premature yielding of the liner and set-back of the charge.

7. An explosive missile comprising a fragmenting metal shell, an end portion thereof screwed into the main portion of the shell, a detonating explosive charge within the shell, means for exploding the said charge, and a firm liner disposed within and completely over the said end portion, the said liner being of thickness at least half that of the end portion, being at least as firm as set plaster, filling the space between the said end portion of the shell and the explosive charge, and protecting the said portion momentarily from the full force of the explosion of the explosive charge.

WALTER O. SNELLING.

CERTIFICATE OF CORRECTION.

Patent No. 2,276,110. March 10, 1942.

WALTER O. SNELLING.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, line 30, for "3-inch" read --3-mesh--; page 3, second column, line 18, for "thuns" read --thus--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 14th day of July, A. D. 1942.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

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