

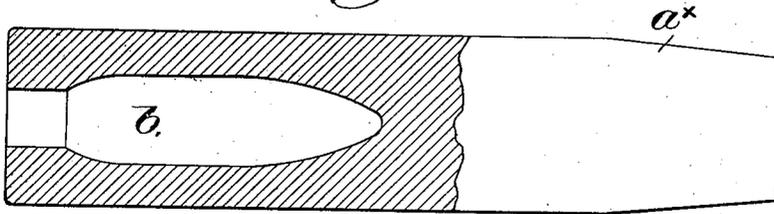
(No Model.)

R. A. HADFIELD.  
SHELL.

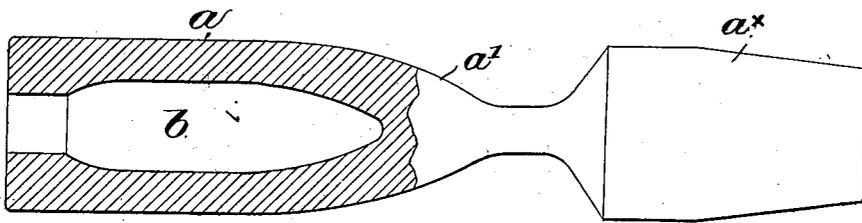
No. 522,012.

Patented June 26, 1894.

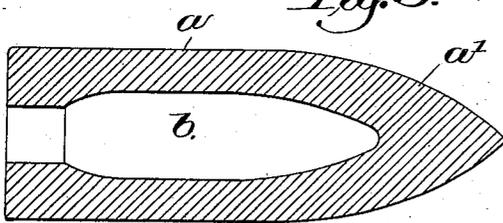
*Fig. 1*



*Fig. 2.*



*Fig. 3.*



*Witnesses.*

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Edward F. Allen.*

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# UNITED STATES PATENT OFFICE.

ROBERT ABBOTT HADFIELD, OF SHEFFIELD, ENGLAND.

## SHELL.

SPECIFICATION forming part of Letters Patent No. 522,012, dated June 26, 1894.

Application filed May 28, 1892. Serial No. 434,711. (No model.)

*To all whom it may concern:*

Be it known that I, ROBERT ABBOTT HADFIELD, a subject of the Queen of Great Britain, residing at Sheffield, county of York, England, have invented an Improvement in Projectiles, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention relates to armor piercing projectiles, and particularly to that class of projectiles designated "shells." The points or noses of projectiles of this class must be extremely hard so that they will not "set-up" on striking the armor plate, yet they must not be so brittle as to break on striking the plate, and the metal must be such as not to crack during the operation of hardening, if they be hardened subsequently to being formed. Prior to this invention it has been customary to forge this class of projectiles from ingots of solid steel, the forged points being afterward usually hardened, while the chamber which is to receive the explosive substance is bored or machined out of the solid metal, or is otherwise produced by hydraulic pressing or forging or by steam forging. Projectiles manufactured in this manner possess the hardness and toughness requisite to enable them to penetrate heavy armor, but the cost of manufacturing is excessively great, owing principally to the fact that the chamber must be bored or machined out of the solid steel of which the projectile is composed. The reason for forging such projectiles has been that forged steel can be given a greater combination of hardness with toughness than it has hitherto been possible to give unforaged steel, but the chambered rear end or part of such a projectile does not require so great a combination of toughness and hardness, because such rear part does not have to perforate the armor plate, nor is it exposed to so severe shock on striking the plate, nor usually to so severe internal stress in hardening. Indeed it is better that such rear part be not very ductile, so that if the projectile explodes it may fly in pieces and not simply tear apart.

I have aimed to produce a novel and efficient projectile at the minimum cost, and as the result thereof I have devised a projectile

having its rear or chambered end left in the condition of a casting, while its integral nose or point is in the condition of a forging, as will be described.

In the production of my novel projectile I employ a mold and when the projectile is to be chambered I also employ a core, and with the core in the mold I make a casting from which to form the projectile, the mold itself giving shape to the body or rear part of the projectile, while the core, in manner well understood in casting processes, defines or makes the chamber in the body part. That portion of the projectile forming the point or nose end may be subsequently hardened in any suitable manner.

A projectile of the kind described possesses the requisite penetrative qualities for practical work and it may be produced at the minimum of cost.

Figure 1 in elevation shows partially broken out a cast blank from which to produce my novel projectile. Fig. 2 shows the blank partially forged as in the production of the projectile, and Fig. 3 is a section of the finished projectile.

Referring to the drawings, Fig. 1 shows the casting produced by a mold, the mold in practice containing, when desired, a suitable core, said core forming the chamber *b* which is to receive the explosive, or other substance, the mold giving to the rear of the blank the shape required for the body of the projectile, the same being used in the more or less brittle condition left by the casting, or, if desired, slightly turned externally, or not, as desired.

The projectile referred to will preferably be cast with the chambered end toward the bottom of the mold, the integral end *a*, denominated the sinking or feeding head, being the part which is to be forged to provide the point or nose; but the projectile may, if desired, be cast with the point or nose end down. The casting, when subsequently cooled, is removed from the mold and the sinking or feeding head is forged or drawn down see Fig. 2, until a portion thereof shall have had given to it the shape desired for the point or nose, and thereafter the waste portion of the sinking or feeding head will be suitably removed leaving a projectile, see Fig. 3, with a body portion *a* the metal of which is in the condi-

tion of the casting, but the nose integral therewith is in the condition of the forging. If need be, the point or nose end of the projectile may be further forged after detaching the end  $a^x$ .

If the projectile is made from self hardening metal, it will be worked in the usual manner practiced with such metal.

By means of accurate dies the nose end of the projectile may be forged with sufficient accuracy to avoid machining on the ogival parts, but the projectile may be machined in any usual manner if considered necessary or desirable. The chamber  $b$  is cored out for casting and need not be machined unless to insure great accuracy, and even in such case the amount of machining necessary is vastly less than when the chamber is bored out of solid metal.

If desired a collapsible or other mandrel may be placed within the chamber  $b$  while the point or nose portion is undergoing forging, and after the projectile has been brought into desired shape it will be subjected to such treatment by heat or otherwise as the nature of the material of the casting calls for.

In the case of most classes of steel the projectile will usually be annealed, or otherwise treated, and then hardened in usual manner.

The ogival, or such portion of the projectile as is forged, is better fitted, due to the forging operation, to withstand the stresses arising during the process of hardening.

This invention is not limited to the particular shape of projectile herein used to illustrate my invention, nor to the shape or size of the chamber  $b$  within it, nor to the use of any particular class of steel, nor to any particular method of treating the steel by heating or by cooling, or to the exact shape of the nose or point.

Prior to this invention I am not aware that the point or nose of a cast projectile has been formed integral therewith by forging or drawing down only the nose part of the cast body thus leaving the metal of the body in the more or less brittle condition due to casting while the point or nose is in the condition due to forging. 45

The nose of my projectile herein described, has sufficient hardness to penetrate armor and the point is sufficiently tough not to break on impact, while the rear part is in the condition left by the casting and of such brittleness that in exploding it will break in pieces and be thereby more destructive than if it were forged or rolled, for in the latter case it would open more like a copper boiler, without scattering in pieces. 50 55

In speaking of forging I do not refer to hammering only, but I use the word generically, including hammering, pressing, and other like modes of working metal.

Having described my invention, what I claim, and desire to secure by Letters Patent, is— 60 65

1. The herein described projectile, it having its rear end left in the condition of a casting, and having an integral forged nose or point, substantially as and for the purposes described. 70

2. A projectile having its chambered rear end left in the condition of a casting, and having an integral forged nose or point, substantially as and for the purposes described. 75

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ROBERT ABBOTT HADFIELD.

Witnesses:

FRANK M. CLARK,  
GEO. MOUNT.