Jan. 29, 1946. C. A. MARTIN 2,393,648

PROJECTILE

Filed Feb. 20, 1942

Fig. 1. Fig. 2. Fig. 3. Fig. 4.

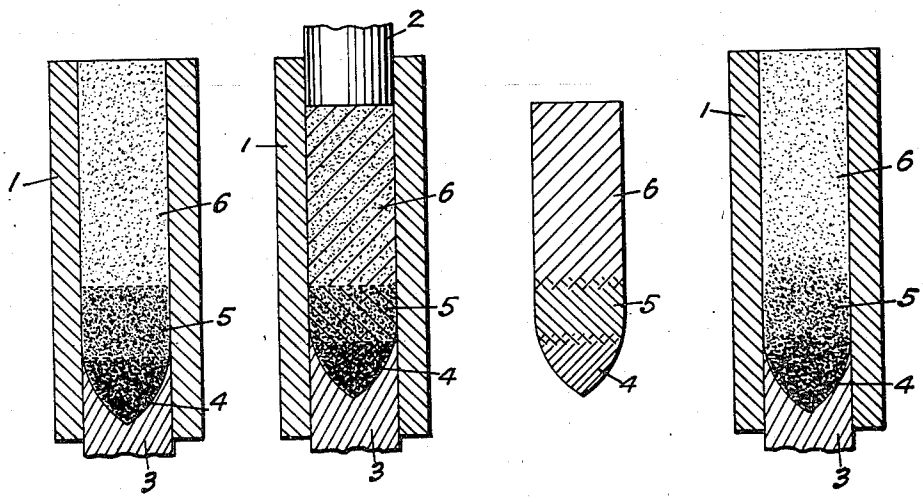
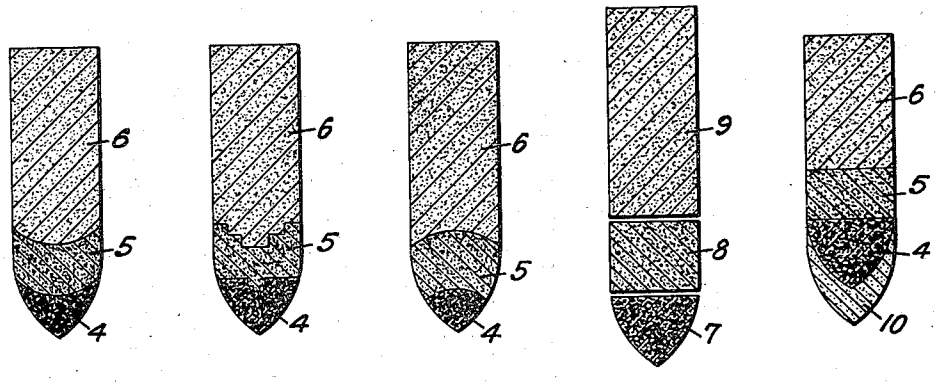


Fig. 5. Fig. 6. Fig. 7. Fig. 8. Fig. 9.



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PROJECTILE

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3 Claims. (Cl. 102—52)

(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.

This invention relates to a projectile and more particularly to an improved form of armor piercing projectile and method of making the same.

Modern armor plates which have proven to have the greatest protective qualities are, as is well known, provided with an extremely hard face by any one of several processes. Examination of projectiles after impact with such face-hardened plates seems to show that the resistance to penetration of such plates is due to the fact that on impact there is a tendency for the head of the projectile to be shattered or upset by the blow of impact, in the happening of either event losing its power of penetration. However, if the shape of the projectile can be maintained and the body thereof kept intact until the hardened surface of the plate has been destroyed, there will generally be no difficulty in penetrating the underlying layers of softer material.

Prior attempts to reach this end in practice have involved the provision of a projectile having a head portion of such great hardness as to shatter the face of the plate. Attempts have been made by the provision of soft nose caps in advance of the hardened head and by controlled local heat treatment of the body to further increase penetration. However, efforts to control the zone hardness of armor piercing projectiles of small caliber have not been successful as the small size of these projectiles precludes any effective variation in the heat treatment which is applied to the various zones of the projectile.

It is therefore an object of this invention to produce an armor piercing projectile or core therefor which, even in the small and medium calibers, will have optimum physical characteristics in respect to hardness and strength of each increment.

It is a further object to provide a method of producing such projectiles which will relieve critical shortages of strategic materials and which will release machine tools, such as the automatic screw machines, for other essential employment.

It is a further object to improve the economy and efficiency with which such projectiles may be produced.

The exact nature of the invention as well as other objects and advantages thereof will clearly appear from a description of a preferred embodiment as shown in the accompanying drawing in which:

Figures 1, 2, and 3 are longitudinal sectional views of a projectile formed according to my invention and representing the products of the three principal steps of the method.

Figures 4, 5, 6, 7 and 8 are longitudinal sectional views of a projectile produced according to modifications of the method.

Figure 9 is a similar view of a modified form of projectile produced by a similar method.

Referring to the drawing by characters of reference there is shown in Fig. 1 a die 1 having a shape complementary to that of the desired projectile and provided with a pair of cooperating punches 2 and 3. Mixtures of powdered alloys or of the relatively pure constituents of the alloys are added to the die in such a manner that they are arranged in layers or strata along planes perpendicular to the long axis of the bullet. The metal powders used are chosen for the characteristics which are to be desired in the projectile. For example the tip zone 4 may be of material on the order of a hard mineral carbide with a suitable binder metal, while the head zone 5 is of a material which on alloying will produce a characteristically hard steel, and the base zone 6 is of a material which will produce a less hard but characteristically tough steel. As indicated in Fig. 2 the powdered mixtures are then subjected to pressure, preferably from each end simultaneously, to obtain a body having sufficient strength and cohesiveness to resist ordinary handling. To promote adhesion at this stage it may be necessary to add a binding constituent to the original mixtures.

The formed bullet may then be removed from the mold and subjected to a sintering process the details of which are determined in a known manner by the materials being treated. Normally sintering will be done by radiated heat in closed boxes with sufficient charcoal to combine with the oxygen of the air and form a reducing atmosphere. The finished bullet shown in Fig. 3 will be physically homogeneous and the physical properties of the various strata will be in accordance with the properties of the materials used therein. At the interfaces between the various strata there will be considerable diffusion and interalloying between the layers thus avoiding any abrupt changes in characteristics which might weaken the structure.

The modifications shown in Figures 4 to 7 inclusive correspond to the step shown in Fig. 2, previously described. The modifications consist in variations in the method of charging the die for the molding operation. In the form shown

in Fig. 4 the addition of the mixture comprising zone 4 was gradually stopped and at the same time the delivery of the powdered mixture comprising zone 5 was gradually increased. A similar procedure resulted in a similar blending or gradual transition between zones 5 and 6. By choice of the rates of addition of the powdered material it is possible to produce a smooth variation in composition so that hardness may be made to vary decrementally from the tip while the toughness of the metal varies incrementally. In the forms shown in Figs. 5 to 7 each unit of the powdered composition has been introduced separately to the die and separately compressed. The shapes of the punch faces used in compressing each unit of the charges may be varied as desired to produce interfacial junctions of any desired section, those shown being merely illustrative of some of the possible variations. In this way it is possible to carry a core of tougher material well forward into a head zone of harder material thus reinforcing the latter and serving to prevent shattering thereof. Figure 8 corresponds generally to the Figure 1 step of the basic method and shows preformed and almost completely compressed pellets 7, 8 and 9, of the powder mixtures ready to be inserted in the die for the application of final pressure to form the projectile body ready for sintering.

The modified form of projectile shown in Fig. 9 is of a type which would be particularly useful as an unjacketed projectile and is provided with a soft nose 10 of powdered iron or other relatively soft material which on impact serves to assist in penetration by lessening the tendency to ricochet and by supporting and lubricating the body during penetration. These functions are fulfilled in conventional construction by means of a jacket and point filler or by soft caps welded, brazed, soldered, or mechanically secured to the projectile body. Such a projectile might be provided with a rotating band or other conventional rifling engaging means.

It will be obvious that a projectile body may be thus formed in any desired shape suitable for use directly or as a core for the conventional jacketed projectiles. The fact that exact quantities of powdered materials may be charged into the dies results in elimination of wastage of materials. In the typical projectile cores used at present a high percentage of metal is lost in turning the body in automatic screw machines from bar stock. Such elimination of wastage results in increased economy of critical metals and the method is also economical in that a pressure molding operation replaces precision machining from bar steel.

It is generally contemplated that the harder sections of the projectile will be made of such materials as tungsten and similar metallic carbides or the other abrasive compounds such as silicon carbide or aluminum oxide sintered with a conventional binder metal, and that the other sections be composed of mixtures of steel alloying ingredients capable of producing steels of the desired characteristics. Obviously it is within the limits of my invention to vary the constituent metals or arrangement of the various strata as may be desirable. An important advantage of the powder metallurgy process for such applications will be found in the fact that a composite structure may thus be produced in which each of the alloy compositions retains its own identity and its own physical characteristics although associated in a homogeneous body with materials of greatly differing characteristics.

I claim:

1. A homogeneous projectile body comprising heat treated, stratified mixtures of compressed powdered metallic products, the nose of said body being relatively soft, the portion of said body adjacent the nose being of great hardness, and the remainder of said body being decrementally hard and incrementally tough and formed from a plural number of compositions, one of which is a heat treated ferrous metal of a high hardness and another of which is a heat treated ferrous metal of great toughness.

2. A homogeneous projectile body comprising a sintered composite structure of mixtures of compressed metallic powders, the nose of said body comprising a relatively soft material, an armor piercing portion comprising a mixture of a hard metal carbide and a binder metal in rear of said nose, and a base portion comprising a material varying decrementally in hardness and incrementally in toughness from said armor piercing portion, said base portion being formed from a plural number of compositions, one of which is a heat treated ferrous metal of high hardness and another of which is a heat treated ferrous metal of great toughness.

3. A homogeneous projectile body comprising a nose portion of a relatively soft metal, a hard armor piercing portion of a mixture of metallic carbide and a binder metal behind said nose, and a metallic base portion varying decrementally in hardness and incrementally in toughness from said armor piercing portion, said metallic base portion being formed from a plural number of compositions, one of which is a heat treated ferrous metal of a high hardness and another of which is a heat treated ferrous metal of great toughness the portions of said projectile body being interfacially allowed with each other.

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