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E. S. PATCH ET AL
PROJECTILE

2,409,307

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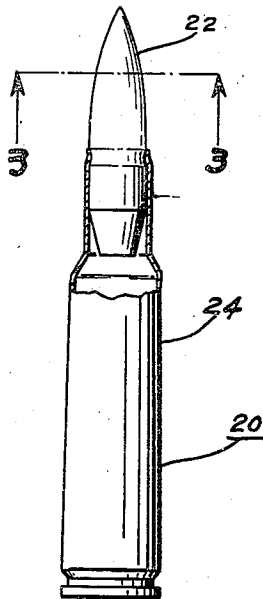


Fig. 1

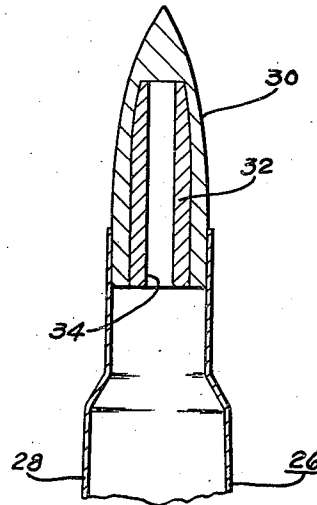


Fig. 2

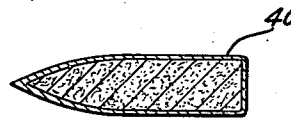


Fig. 4

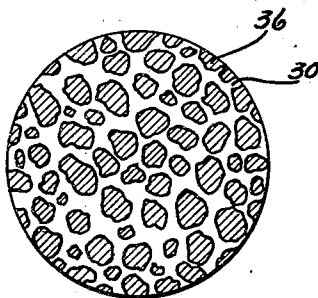


Fig. 3

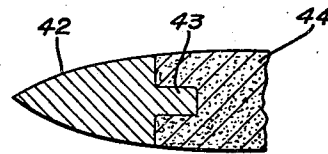


Fig. 5

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2,409,307

PROJECTILE

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5 Claims. (Cl. 102—92.5)

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This invention relates to porous metal and is particularly concerned with porous metal projectiles and the like.

An object of the invention is to provide a projectile part such as a bullet or bullet core which is made from molded and sintered metal powder that has been impregnated with another material to raise the apparent density thereof.

In carrying out the above object, it is a further object of the invention to impregnate the pores of said porous metal part with a heavy metal for increasing the apparent density of the part.

A still further object of the invention is to provide a porous iron projectile part which has the pores thereof substantially filled with a metal, such as lead or lead alloy, which has a greater density than iron whereby the apparent density of the entire part is appreciably increased.

Another object of the invention is to provide a projectile part made from porous metal which has ballistic performance comparable to a solid metal.

A further object of the invention is to provide a method for controlling the apparent density of porous metal parts by impregnation of said parts with another metal whereby the apparent density may be controlled by controlling the porosity of the porous metal part thereby controlling its absorbing capacity toward the impregnant.

A still further object is to provide a bullet and method for making same wherein the bullet has a relatively soft exterior surface and a relatively harder interior surface whereby the exterior surface thereof will not injure the rifling in the gun and the harder interior will act as an armor piercing portion.

Another object of the invention is to provide a bullet made from iron powder which is preferably impregnated with a soft metal, such as lead, and which has a nose portion thereon of a hard metal which in some cases is a solid metal bonded to the remainder of the bullet.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawing

Fig. 1 is a sectional view of a cartridge;

Fig. 2 is a fragmentary enlarged sectional view of an incendiary and/or explosive cartridge;

Fig. 3 is a diagrammatic sectional view taken on line 3—3 of Fig. 1 showing on a greatly enlarged scale the metallurgical structure of the bullet;

Fig. 4 is a view of the bullet made from iron powder impregnated with lead or the like which

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includes a jacket thereover made from brass or other easily formable metal; and

Fig. 5 is a fragmentary view of a nose portion of the bullet wherein the piercing nose of the bullet comprises a solid metal or extremely hard metal portion keyed and bonded to the remainder of the bullet which is made from iron powder.

Projectile parts in general, such as bullets, bullet cores and the like are usually made from steel or lead. Each of these materials has its advantages. The steel bullet has great strength as occasioned by the physical characteristics of the steel, and lead bullets due to their great weight have a tremendous inertia force. Heretofore, machine gun bullets and rifle bullets for army purposes have been made from steel parts made on a screw machine. In view of war-time conditions it is desirable to relieve the load on screw machines and, therefore, porous metal bullets made from metal powders were contemplated, such bullets being formed from iron powder, for example, pressed to shape and sintered under suitable conditions of time, temperature and atmosphere to form a porous bullet having an apparent density somewhat less than iron. For example, the apparent density of the average porous iron bullet is usually above .6 of the density of iron.

Porous metal bullets are sufficiently strong for use in machine guns and rifles but ballistically are not as suitable as solid metal bullets or projectile parts due to their lower density. To improve the ballistic performance of these parts, we impregnate them with another metal preferably lead or lead alloy which substantially fills the pores thereof and yields an apparent density greater than that of porous iron and variable according to control conditions. Projectile parts of this character are highly desirable from every standpoint since they have the necessary strength due to the strong framework of porous iron and likewise they have greater weight, due to the high density of lead. For this reason, a lead impregnated porous iron bullet is more desirable in use than either a lead bullet or a steel bullet since it combines the most desirable features of both of these prior types of projectiles.

It is also possible to form a bullet from other metal powders, if desired, for example, bronze powders, nickel and copper powder, iron and copper powder and the like may be used in accordance with the manufacturer's desires. These bullets may then be impregnated with a heavy metal, preferably lead. In some cases, however, impregnation with other materials may be desirable; this is especially true where the apparent

density of the bullet material does not necessarily have to be as great as the density of conventional metals and where it is desirable to close the pores of the bullet. In this instance, the bullets may be impregnated with thermosetting resins, non-metallic materials in the molten state, etc., such variations coming within the scope of our invention.

In the bullet material discussed herein the sintered iron is generally sufficiently soft so as not to injure the rifling of the guns. In other words, the rifling can cut in the leaded iron surface of the bullet and give a twist to the bullet during the passage of the bullet through the bore of the gun. In some cases where a particularly hard bullet is desired carbon may be incorporated in the iron powder and the bullet may be decarburized at the surface thereof to form a relatively softer surface while the remainder of the bullet remains carburized and hard. This may be accomplished while sintering by using an atmosphere with sufficient water vapor present to decarburize the surface but controlled so as to prevent oxidation of the iron. This is in differentiation of the usual type of steel bullet which is jacketed with a soft metal such as brass to improve the action of rifling and also to prevent injury to the rifling at the bore of the gun. However, it is understood that in bullets made from iron powder which are preferably impregnated with a heavy metal, such as lead, and wherein the entire bullet is carburized and tempered to a high degree of hardness, a jacket 40 may be provided as shown in Fig. 4, which completely covers the iron. In this case the iron powder is briquetted to a size slightly smaller than desired so that the covering of brass or other metal thereover brings the outer diameter of the bullet to that necessary for any particular gun bore.

Another embodiment of the invention is shown in Fig. 5 wherein a solid nose portion 42 including a key 43 is placed in the die and iron powder is then briquetted thereon to form the remainder of the bullet as at 44. The assembly is next sintered for causing the iron powder to form a strong porous structure which is bonded to the nose portion 42. The iron portion of the bullet may then be impregnated with lead or other metal as desired.

The nose portion 42 in this embodiment may be a hardened steel or may be formed in some cases from metal powders such as tungsten carbide. In this instance the nose portion is first formed and sintered and then placed in the die whereupon the remainder of the bullet is briquetted thereon. Obviously the second sintering temperature being carried at relatively lower temperatures has no effect on the nose portion. Tungsten carbide or similar materials are very hard and suitable for armoring piercing purposes. Similarly it is possible to selectively briquette a bullet similar to that shown in Fig. 5 wherein carburized iron powder is used in the nose portion and wherein the die is partially filled with a predetermined amount of this powder to form the nose portion and then the remainder of the die is filled with a softer iron powder containing substantially no carbon. In this instance the briquetting operation may be simultaneous for both portions of the bullet or may be carried out in two steps, as desired, the simultaneous operation being preferred. A bullet made in this manner may be sintered in a single operation since the temperatures involved are similar for both types of metal powders.

Methods for forming porous metal parts are disclosed in a number of patents and such methods form no part of the present invention. Reference may be made to the Lenel Patents Nos. 2,226,520 or 2,191,936, both of which disclose methods of making porous iron articles.

The impregnation of porous parts may be carried out by conventional methods such as immersing the part in a liquid or molten material, and then removing it therefrom. In this case, if metallic material is utilized it may be heated until molten or if non-metallics are used, such as resins, they may be either heated to a molten state or dissolved in a solvent. In this case, after impregnation the solvent must be evaporated, either by air drying or heating. Also where finely porous materials are to be impregnated, it is often desirable to evacuate the part prior to impregnation, thus expediting the impregnation thereof. We have found in most cases and in accordance with the example to be given hereinafter that evacuation is unnecessary. However, where impregnation is found to be difficult, it is to be understood that such a step may be carried out within the scope of my invention. Another impregnating method which may be utilized is shown in Kurtz, Patent No. 2,192,792, wherein iron articles are simultaneously sintered and impregnated with lead.

The drawing shows two specific embodiments of the invention wherein a cartridge 20 is shown in Fig. 1 including a bullet or projectile part 22 held in a shell 24. The bullet 22 is made under the teachings of this invention. Fig. 2 is an enlarged view of an incendiary and/or explosive cartridge 26 which includes a shell 28 and a bullet 30, which has a bullet core 32 therein which includes a bore 34 that may be filled with an incendiary or explosive charge. Fig. 3 is a diagrammatic cross-sectional view of this material in these bullet parts wherein the dark areas 36 indicate iron and the lighter areas 38 indicate the impregnated material.

A specific example in the formation of a projectile part given for illustrative purpose only is as follows:

Iron powder, preferably made from reduced oxide or comminuted iron particles and having a mesh size smaller than 100, is briquetted to the desired shape at pressures ranging from 20,000 to 70,000 pounds per square inch and preferably at 45,000 pounds per square inch. The part when removed from the briquetting die is self-sustaining and of the size and shape desired. This part is then sintered under non-oxidizing conditions at a temperature of between 2,000 and 2,050° F., for a period of about a half hour whereupon it is cooled under a non-oxidizing condition. The part is next immersed in molten lead maintained at a temperature above the melting point of lead and preferably at 1,700° F. where it remains for a period of about ten minutes. The part is then removed and allowed to cool; upon cooling the lead contracts slightly so that there is little if any excess lead on the external surface of the bullet. A part made in this manner will have an apparent density in the order of 7.8, which is the density of steel.

A sizing step may be resorted to after the sintering steps if the parts are not exact size. However, this is unnecessary in most instances and depends upon control conditions since it is apparent that by varying the briquetting pressure and sintering temperatures and the like that

slight variations in the finished size of the sintered briquette may be obtained.

We have found that by varying the briquetting pressure and/or particle size, it is possible to control the apparent density of the finished part. In this manner it is possible to obtain apparent density of parts in accordance with predetermined specifications. Thus, by changing the briquetting pressure, it is possible to increase or decrease the porosity of the part and thereby increase or decrease the quantity of lead absorption thereof, thus changing the apparent density of the part. Similarly by changing the particle size and/or briquetting pressure similar results are obtainable. In this manner we have found that it is possible to closely control the apparent density of the part so that specified apparent density may be easily obtained. Thus, it is possible to form projectile parts having apparent densities greater than the density of steel, if desired. This is a very important part of our invention since by suitable control methods the projectile parts having desired apparent densities may be obtained whereby the ballistic performance of the parts may be changed according to the use thereof.

In some cases it is desirable to add a wetting metal to the lead. One of such metals is tin in quantities up to 10%. In this instance, the tin tends to make lead wet the surface of the iron more readily. Thus, lead as mentioned in the appended claims is understood to include small quantities of wetting metals if desired.

Alloys of lead may also be used where appreciable quantities of tin, antimony and the like are present or these other metals may be used in the substantially pure state. Similarly, to facilitate the wetting action of the impregnant and impregnation of the sintered iron briquette, it may be desirable in some instances to flux the part either with a liquid flux or by means of a reducing atmosphere at an elevated temperature for cleaning the surface of the article of oxides. In this respect it should be understood that the briquette may go into the impregnating bath immediately after sintering and prior to exposure to atmospheric air. In this instance the article may be cooled down to a suitable temperature in controlled atmosphere prior to impregnation.

It is manifest that instead of lead or alloys thereof that other metals may be used as impregnants. For example, copper or copper alloys are quite suitable for use as impregnants for iron

parts. In fact the only limiting factor in an impregnating metal is the melting point. Obviously, this figure must be less than the melting point of the projectile part.

While the embodiments of the present invention as herein disclosed, constitute preferred forms, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A projectile, made from sintered briquetted iron powder which is coated over with and has the pores substantially filled with a metal softer than and heavier than iron and impregnated therein, whereby the said projectile has a relatively soft surface thereover and an apparent density greater than a sintered iron briquette.

2. A projectile, made from sintered briquetted iron powder having an apparent density in excess of 60% of the density of iron, said projectile being coated over with and having the pores substantially filled with lead which is impregnated therein, whereby said projectile has a soft surface thereover.

3. A projectile, made from sintered briquetted iron powder and having an apparent density in excess of 60% of the density of iron, said projectile being coated over with and having the pores substantially filled with a lead alloy which is impregnated therein, whereby the said projectile has a soft surface thereover.

4. A projectile, made of two portions, including a nose portion formed from a relatively hard metallic material and a body portion formed from sintered briquetted iron powder, said body portion being metallurgically bonded to said nose portion, said body portion of the projectile being coated over with and having the pores filled with a lead base alloy for producing a relatively soft surface thereover and for increasing the weight of the projectile.

5. A projectile, made of two portions, including a nose portion formed from a relatively hard metallic material and a body portion formed from sintered briquetted iron powder, said body portion being metallurgically bonded to said nose portion, said body portion of the projectile being coated over with and having the pores filled with lead for producing a relatively soft surface thereover and for increasing the weight of the projectile.

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