June 4, 1946. F. R. HENSEL ET AL 2,401,483

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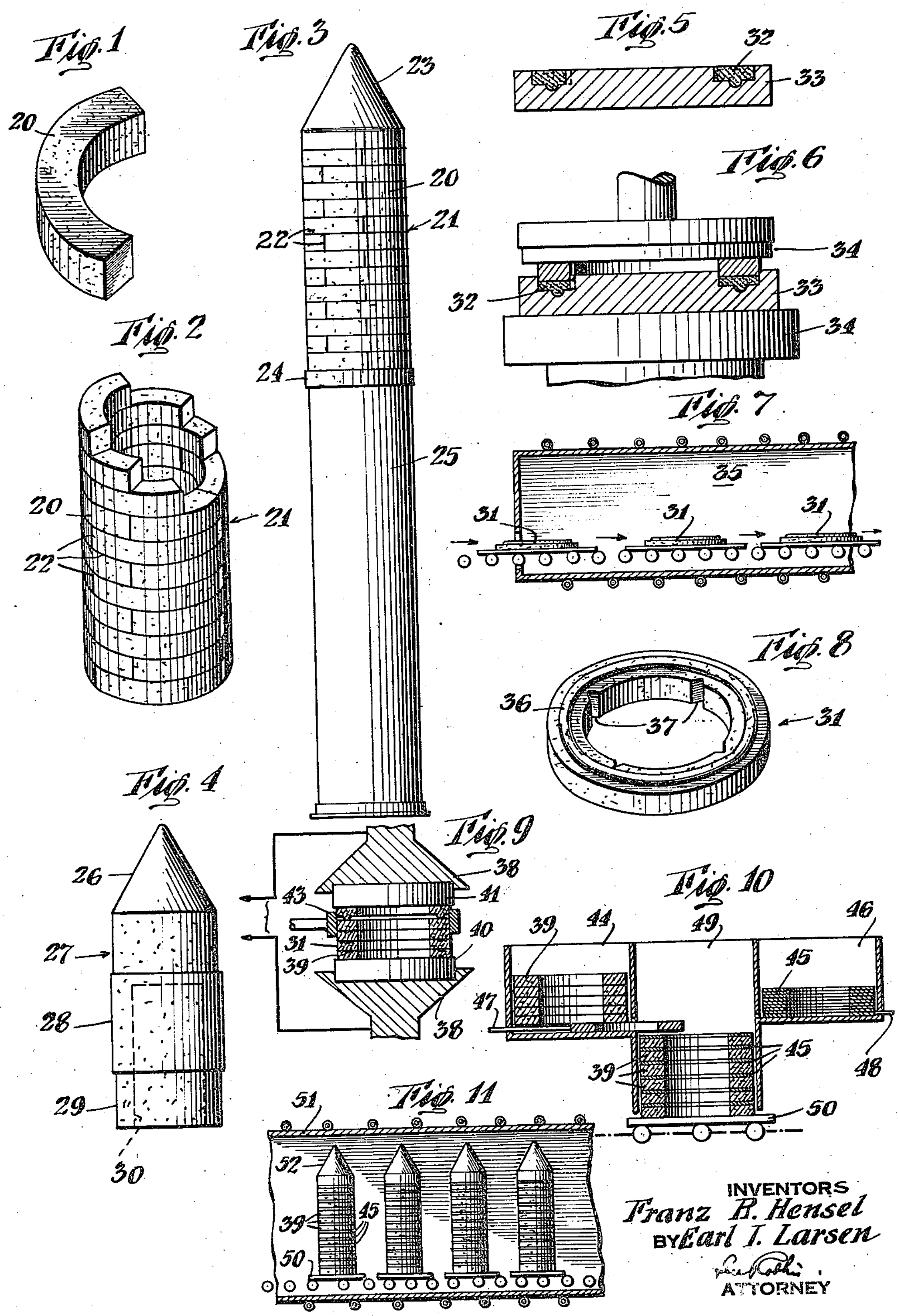
Filed July 31, 1940



INVENTORS
Franz R. Hensel
BY Earl I. Larsen

ATTORNEY

Patented June 4, 1946 2,401,483

UNITED STATES PATENT OFFICE

2,401,483

PROJECTILE AND METHOD OF MAKING THE SAME

Franz R. Hensel and Earl I. Larsen, Indianapolis, Ind., assignors to P. R. Mallory & Co., Inc., Indianapolis, Ind., a corporation of Delaware

Application July 31, 1940, Serial No. 348,674

3 Claims. (Cl. 102—92.5)

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This invention relates to projectiles and the manufacture thereof.

An object of the invention is to improve projectiles.

Another object is to improve the methods used in projectile manufacture.

Other objects of the invention will be apparent from the following description and accompanying drawing taken in connection with the appended claims.

The invention comprises the features of construction, combination of elements, arrangement of parts, and methods of manufacture and operation referred to above or which will be brought out and exemplified in the disclosure hereinafter set forth, including the illustrations in the drawing.

In the drawing:

Figure 1 is a perspective view of a section of a shell embodying features of the present invention;

Figure 2 illustrates a partly assembled shell wall;

Figure 3 is a side view of a complete projectile;

Figure 4 is a side view of a shell body of modified construction;

Figure 5 to 8 inclusive are diagrammatic illustrations of steps in the manufacture of a section of a shell body;

Figure 9 shows one method of uniting sections into a unitary shell structure; and

Figures 10 and 11 illustrate steps in another method of assembling a shell.

According to one aspect of the present invention the shell body is made from metal powders, pressed into shape and sintered. Another feature of the invention resides in the use of segments of predetermined size and shape, a plurality of which are assembled to produce a complete shell body.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure and the construction of parts without departing from the spirit of the invention. In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Heretofore projectiles have been made from forgings and castings. The number of available compositions for forgings are limited by the requirement that the steel used must be capable of hot and cold working. Moreover, with both forgings and castings a considerable amount of machine work, expensive in both time and materials, is necessary.

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We contemplate the manufacture of shell bodies for projectiles from powdered metal, especially powdered iron on iron alloys or iron group metals, namely nickel and cobalt and their alloys. This may be used to produce a novel shell element which can be assembled in a novel automatic manner into a complete shell body.

Referring to the drawing Figure 1 illustrates one form of shell element or segment 20 formed from pressed and sintered metal powders. This is made by charging a metal powder or premixed powders into a die or mold of the shape desired, then applying the necessary pressure by means of a plunger in a suitable press, and subsequently sintering the pressed body in a neutral or reducing atmosphere.

Iron-group metal or steel powders or powder mixtures having such composition are suitable. Also alloys of iron with such metals as nickel, cobalt, manganese, chromium, molybdenum, tungsten, vanadium, columbium, tantalum, titanium, zirconium, copper, aluminum, beryllium and such non-metals as carbon, silicon, phosphorus, boron, sulfur, and nitrogen are suitable. The alloys may be made by melting and be subsequently reduced to a fine powder by crushing, ball milling or other methods of disintegration.

In some cases, where forming pressures have been used which leave the segment 20 somewhat porous after sintering, the segment may subsequently be impregnated with a lower melting point metal, such as lead or lead alloys, copper or its alloys, such as brass and bronze, or zinc, tin or cadmium base alloys, by immersing the segment in a molten bath of such metal or by impregnating it by any other convenient method. Low melting eutectics or compounds of binary and ternary alloy systems may also be used for impregnating. This fills the voids in the sintered segment and increases its density. Also, where a lubricant such as lead is used for impregnating, it aids in producing a low friction outer surface on the shell body.

Where still higher densities are desired it is contemplated that a high density metal such as tungsten or an alloy thereof may be substituted partly or wholly for the iron or iron alloy. The sintered tungsten (or other high density metal) body may be impregnated with lead or like low-melting metal or alloy.

A coining or repressing operation may be added to the above processes after sintering. Where an impregnating step is used the coining step, or an added coining step, may be applied after impregnation.

The segments 20 are assembled as illustrated in Figure 2 to form the shell wall 21 defining within it a chamber for the bursting charge of explosive and shrapnel. The joints 22 between segments 20 are sealed and the segments bonded together by metal fusion. This may be accomplished in several different ways, such as:

(1) Instead of impregnating the individual segments with low melting point metal, the sintered segments may be assembled as shown in a suitable holder or press and then the entire assembly impregnated by immersion in molten lead or other low melting metal, withdrawing the impregnated assembly, wiping the outer surfaces clean and smooth, and allowing to cool and solidify.

(2) The impregnated or unimpregnated segments may be brazed together by introducing a small quantity of brazing material in the joints and firing the assembly in a furnace. Copper or silver base alloys may be used as brazes as well as high manganese alloys such as copper manganese or nickel manganese alloys. Eutectics of iron group metals with phosphorus or sulfur, and other metals or alloys having lower melting points than the sintered body may also be used. Where impregnated segments are used the impregnant itself will form a fusion bond between segments when heated in the furnace.

The physical properties of the joints are determined by selecting the proper chemical composition. Thus where a brittle joint is desired a brittle brazing material is used. Also by regulating the porosity of the segments and selecting certain compositions of brazing metal the brazing metal will be almost wholly absorbed by the segments leaving a weaker bond.

High ferro-manganese, very low in carbon, with or without other elements such as cobalt, nickel, chromium, tungsten, molybdenum, silicon and titanium, can be used for bonding metals.

(3) It is also possible to combine the sintering with the bonding operation. Thus the brazing metal may be introduced in the joints and the assembly heated to effect both sintering of the metal of the segments and brazing of the segments together. Or the pressed segments may be assembled and immersed in impregnating metal, heated to sintering temperature for the pressed metal powder, effecting sintering and impregnation in one step.

Figure 3 shows a completed projectile comprising a nose, shell body 21, rifling ring 24 and drawn brass cartridge 25. The nose 23 is generally formed of harder and tougher metal or metal composition having armor piercing qualities. It may be made of cast or forged metal or of pressed and sintered alloy powders and brazed to the shell body 21.

Rifling ring 24 is required to be sufficiently soft to act as a bearing guide engaging the riflings of the gun to rotate the shell when it is fired. This may suitably be formed of copper or a copper alloy and may be attached to the shell body by brazing, shrinking, screwing or applied by electroplating. If the ring is electroplated onto the shell body the porosity of the pressed powder segments affords an excellent mechanically interlocking joint.

Figure 4 illustrates a shell body especially suitable for smaller projectiles, made from pressed metal powders. The nose 26 of armor piercing metal may be cast or forged metal although pressed and sintered metal powders such as hard metal carbide compositions are sometimes suitable. The nose is brazed or otherwise bonded to the shell body 27 formed from pressed and sintered metal powders of one of the aforementioned compositions. It may be impregnated with a lower melting metal. An integral rifling flange 28 is molded into the piece and the rear end is reduced to fit into the cartridge. A cavity 30 may be provided therein to hold explosives.

The shell if not too large or complicated in design may be made complete in a single molding operation. If desired, the powders may be molded directly against the nose 26 (which may be roughened or provided with projections to mechanically interlock with the molded powder). The entire body may then be sintered to effect bonding of all parts, and subsequently impregnated with lower melting point metal, such as lead.

Figures 5 to 8 inclusive illustrate the steps in a process of making ring-like sections 31 which can be welded together to form a shell body as shown in Figure 9. According to this process the metal powders 32 are charged into a circular die 33 (Figure 5) after which they are compressed under high pressure in a press 34 (Figure 6). The pressed rings 31 are removed from the die and passed through a sintering furnace 35 (Figure 7) where they are sintered, producing the finished rings 31.

The hollow in the die is formed with a groove to produce a welding ridge 36 on one face of the ring 31. Projections may be spaced about the inside edge to produce weakening notches 37 on the inside edge of the ring.

The desired number of rings 31 are welded together by resistance welding in the welding machine 38 shown diagrammatically in Figure 9. First a ring 39 which has no welding projection is placed on the lower electrode 40 of the machine and a ring 31 is laid, ridge 36 down, on top of it. Upper electrode 41 is brought down to clamp the two rings between them and after sufficient pressure has been applied electric current is applied through conductors 42. Since ridge 36 has the smallest cross section and hence highest resistance in the circuit it is fused by the electric current, spreading out and welding the rings together. Further rings 31 are added, one at a time, in like manner, the rings being aligned and guided by guide ring 43 supported by the machine. In fact the whole operation of feeding, aligning and welding may be almost wholly automatic.

Instead of providing integral welding ridges 36 on rings 31, a series of separate welding rings of reduced cross section may be used interspersed with a series of flat rings 39, the welding proceeding in the same manner.

Figures 10 and 11 illustrate an automatic apparatus and method for assembly and furnace brazing of shell bodies. Pressed powder rings 39 (having notches 37 if desired) are stacked in hopper 44 of the assembling machine of Figure 10 and thin rings 45 of brazing metal in hopper 46. A pair of automatic pusher arms 47 and 48 shove one of the rings 39 and 45 alternately into a third hopper 49 to form a stack of alternate rings 39 and 45. When a stack of the desired height is completed the truck 50 on which the stack is formed is released and rolls into furnace 51 of Figure 11 where the rings are brazed together in a unitary assembly. Nose pieces 52 may be added on top of each stack in the assembling machine and brazed to the assembly.

The presses for making the segments 20, or rings 31, 39 and 45 may be automatic in operation thus increasing the speed and reducing the man-power requirements. There is no waste of materials since the metal powders are charged directly into the dies and the finished pieces are of the exact or almost the exact dimensions desired, requiring little or no dressing.

In some cases the metal compositions may contain age hardening ingredients and the sintered bodies be given an age hardening treatment to increase their strength and hardness.

The shell bodies may be formed of segments all of one composition or different segments may, in some cases be made of different composition. The resistance welded, sinter bonded, brazed, impregnated or otherwise bonded projectile may be given a coining, broaching, pressing or shaping operation to bring the projectile to within the desired degree of accuracy.

While the present invention, as to its objects and advantages, has been described herein as carried out in specific embodiments thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. The method of making a shell body which comprises forming a plurality of individual sections, a plurality of said sections comprising compact bonded masses of metal powders, assembling said sections in contiguous relation and immersing the assembly in a body of molten metal of lower melting point than the metals of said sections, to impregnate said metal powder sections with said molten metal and bond said sections together.

2. A shell body formed at least in part of a compact mass of ferrous metal powders interspersed with an impregnating metal of lower melting point than said powders and selected from the group consisting of lead and alloys thereof, babbitt, copper alloys, silver alloys, zinc base alloys, tin base alloys and cadmium base alloys.

3. A hollow projectile comprising a head and a hollow body, said body comprising a series of ring sections bonded together with metal fusion bonds, a plurality of said sections comprising sintered iron powder compacts, and a lower melting point metal in the pores of said compacts.

FRANZ R. HENSEL.
EARL I. LARSEN.