Jan. 24, 1933. O. RINKEL 1,895,207

METHOD OF FORMING PROJECTILES

Filed June 9, 1932

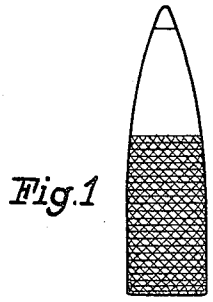


Fig.1

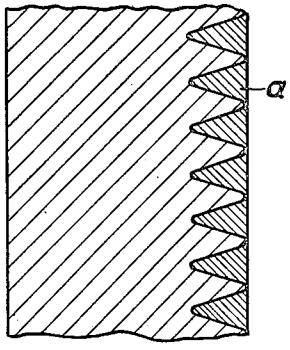


Fig.2

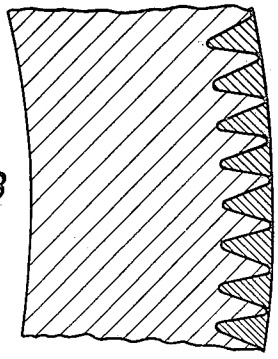


Fig.3

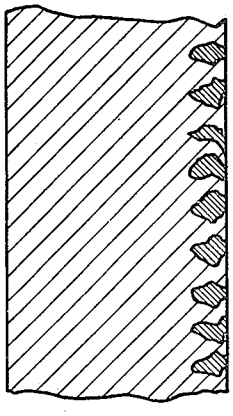


Fig.4

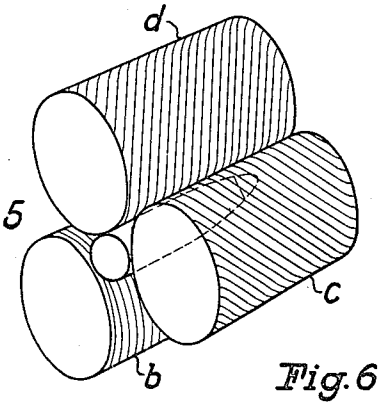


Fig.5

Fig.6

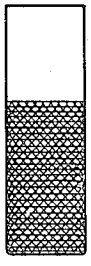
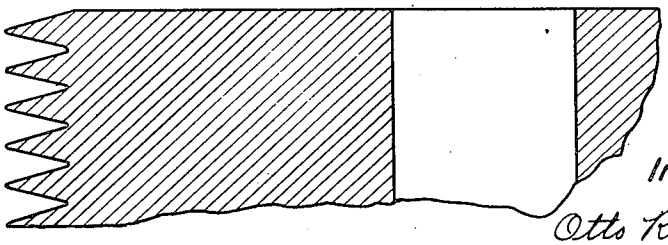


Fig.7



Inventor:
Otto Rinkel
By Watson, Cole, Morse & Grindle
Attys.

Patented Jan. 24, 1933 1,895,207

UNITED STATES PATENT OFFICE

OTTO RINKEL, OF BADEN, GERMANY, ASSIGNOR TO BERLIN-KARLSRUHER INDUSTRIE-WERKE AKTIENGESELLSCHAFT, OF BADEN, GERMANY, A COMPANY OF GERMANY

METHOD OF FORMING PROJECTILES

Application filed June 9, 1932, Serial No. 616,296, and in Germany June 25, 1929.

It is known that, in firearms, fouling of the interior of the barrel occurs not only on account of the residues of combustion, but also on account of the formation of metallic deposits originating from the projectile. This is very disadvantageous in many respects. It prevents the barrel-cleaning agents having access to the actual metal of the barrel, and thereby promotes the very undesirable after-rusting of the cleaned barrel. In addition, it diminishes the accuracy of fire in an undesirable manner. This metallic fouling occurs to a particularly great extent in the case of high projectile velocities of about 900 metres per second or over, and in such cases it may increase the dispersion of a weapon to an inadmissible extent, even after a very few rounds have been fired.

In the case of lead projectiles efforts have been made heretofore to obviate lead-fouling of the barrel by coating the projectiles with grease or wax. Frequently grooves were provided on the surface of the projectile in order to secure a better effect and a surer lodging of the grease. In the case of envelope projectiles also, such grooves have frequently been employed, with or without a filling of grease.

It is precisely in the case of envelope projectiles, however, which are generally fired at high velocities, that experience has shown that the method of treating the projectile surface as employed heretofore is incapable of preventing the formation of metallic deposits. The grease, wax or the like on those parts of the bearing surface of the projectile which lie between the grooves is scraped off at the very commencement of the movement of the projectile in the barrel, and thus in the case of the type of projectile surface employed heretofore, it is possible for comparatively extensive portions of the bearing surface to come into direct metallic frictional contact with the material of the barrel. For this reason, the very troublesome formation of metallic deposits cannot be prevented with the known projectiles particularly in the case of high velocities.

In order to obtain a particularly good adhesion of the lubricant on the projectile surface, it has also been proposed to provide the whole of the projectile bearing surface with closely adjacent, sharp and deep grooves, channels or notches, and to fill these with lubricant. This proposal certainly represented a step forward but it introduced new disadvantages which necessarily prevented the proposal being put into practice. Such grooving renders the surface rough and provides an excessive air resistance; also no means were provided to keep the lubricant in position during transport, handling and use.

Experiments of all kinds have also been made in order to obviate this disadvantage by the selection of a suitable material for the envelope of the projectile. Complete success has not been attained in this way, however, nor is it to be expected, since hard materials which are less inclined to form metallic deposits in the barrel wear the barrel to an inadmissible extent and must therefore be rejected. Softer materials which are more satisfactory materials in regard to barrel wear, are, however, all inclined to form metallic deposits.

According to the present invention, the bearing surface of the projectile is also provided in the well known manner with groups of comparatively deep and very narrow grooves and these grooves are filled with a lubricant.

The invention now consists in the fact that, after the lubricant has been introduced into the grooves, the sharp edges of envelope material existing between the grooves are forced down or smoothed mechanically, for example, by pressing, rolling, drawing, hammering or the like, in such a manner that, in the first place, a smooth outer surface of low air friction is produced, and in the second place the lubricant is enclosed firmly on all sides by a latticework of envelope material. Of course this enclosure does not prevent the internal surface of the barrel coming into contact with the lubricant during the passage of the projectile through the bore of the barrel, since the lands of the rifling will be forced deeply into the material of the envelope, causing elastic deformation of

the said material. The edges between the individual grooves, being very thinly tapered in themselves and forming the metallic latticework, will be partly scraped away and partly opened and will enable the lubricant to have access to the wall of the barrel, thereby preventing the deposition of envelope material on the barrel wall.

The invention is illustrated in Figures 1 to 7 of the accompanying drawing, wherein:

Figure 1 shows a projectile in elevation provided with a roughened surface for receiving the lubricant.

Figure 2 shows a part longitudinal section through the roughened projectile envelope provided with lubricant.

Figure 3 shows a part section, at right angles to the longitudinal axis, of the roughened projectile envelope provided with lubricant.

Figure 4 shows a section as in Figure 3, but after mechanically smoothing and compressing the outer surface.

Figure 5 shows an arrangement of the roughening rolls according to the invention with the projectile in the working position.

Figure 6 shows a part longitudinal section through a roughening roll.

Figure 7 shows in elevation a preliminary stage in the formation of a projectile with a roughened surface.

The roughening shown in Figure 1 and particularly adapted to accommodate the lubricant consists of three groups of closely adjacent narrow and deep grooves, one group being annular, one group helical right-handed and a third group helical left-handed.

The cross-section of each of these individual grooves *a* (Figure 2) may have approximately the shape of an isosceles triangle, but any other suitable shape may be selected, for example, a triangle having unequal sides or the like. After these grooves have been made on the surface of the projectiles, the projectiles are treated with a suitable lubricant such as graphite or the like, so as to fill the grooves with this lubricant.

The intersection of these groups of grooves with each other produces on the bearing surface of the projectile a very close latticework of short narrow depressions which are separated from each other by intermediate, sharply tapered, knife-edge-like metal projections. Such a latticework is capable of accommodating a maximum amount of lubricant and is particularly well adapted for the subsequent smoothing and consolidating according to the invention. The intimate arrangement of lubricant and envelope material in such a roughened surface, on subsequent mechanical consolidation according to the invention, provides a latticework of envelope material and lubricant, which latticework is excellently well adapted for the attainment of the object according to the invention, in a manner similar to the successful use of such a lattice in the case of brake lining compounds consisting of copper wire mixed with filling agents.

Figure 4 shows on a larger scale the way in which the metal projections of the envelope material, during the mechanical consolidation and smoothing of the surface, are bent over and to some extent forced together and are so deformed that they enclose, as it were the lubricant in pockets. This does not only provide the smooth surface essential for the satisfactory ballistic behaviour of the projectile but also provides an absolute protection against the falling out or loss of the lubricant during transport and handling of the projectiles.

Another feature of the invention is constituted by a particularly advantageous device for making the roughened surface of the projectile. This device is shown in elevation in Figure 5 and consists of three rolls *b*, *c*, *d* which are arranged in a machine and driven in any way, and are provided on their surfaces with a group of sharp cutting edges. On introducing the projectile between these rolls and then reducing the distance between the rolls, the cutting edges of the rolls penetrate into the envelope material and produce in it corresponding grooves. In order to obtain in the simplest manner the particularly satisfactory arrangement of these grooves which is shown in Figure 1, it is merely necessary to provide one of these rolls, for example *b*, with annular cutting edges, the second *c* with right-hand helical cutting edges and the third *b* with left-hand helical cutting edges.

Other arrangements of these cutting edges may be employed, however, but it is preferable to make the groups of cutting edges of different pitch.

It is also possible to effect the roughening of the projectile envelope by means of one roll only which is provided with a suitably roughened surface. The co-operation of three rolls in the manner hereinbefore described affords, however, the advantage that the individual rolls may be provided in a simple and satisfactory manner with very sharp and lasting cutting edges which are also durable in the hardened condition, and which in their co-operation result in a particularly suitable and deep roughening.

Figure 6 shows by way of example a cutting edge profile for such a roughening roll. Instead of the isosceles triangles, however, triangles with unequal sides or other suitable shapes may be selected for the cutting edges.

It is not necessary as regards the invention that the roughening, filling with lubricant, smoothing and consolidation of the surface should only be effected on the finished projectile. In many cases, even, this will be disadvantageous because undesirable deformation of the projectile or projectile core may

be produced by the radial compression stresses, and such deformation cannot then be satisfactorily eliminated from the finished projectile. For the practical manufacture of the projectiles, therefore, it will be usually preferable to effect the surface treatment according to the invention at an earlier stage of manufacture of the projectile, for example, before forming the pointed shape of the projectile. A substantially cylindrical blank, as shown in Figure 7, will then have to be dealt with, and this may be treated with comparative ease and is quite insensitive. Any deformation during the surface treatment is in this case of no importance, because the projectile is only given its finished form by pressing, etc. later, and all previous deformation is then eliminated again. The consolidation and smoothing of the surface according to the invention, with simultaneous closing of the grooves may be effected by forcing the roughened projectile or projectile blank provided with lubricant through a drawing die, by pressing in a pressing die, by rolling the surface between smooth rolls, or in any other suitable way. Since such measures are known and are familiar to anyone versed in the art, it is not intended to specially illustrate and describe them here.

The invention is applicable not only to projectiles for small-arms but also to projectiles of larger calibre which are constructed in accordance with the principle of projectiles for small-arms. The invention can further be used for the treatment of the surface of driving bands for artillery projectiles.

I claim:—

1. A method of manufacturing a projectile which comprises the steps of forming indentations on the bearing surface of the projectile, inserting lubricating means in said indentations, and working the projectile surface to substantially completely close the mouths of the indentations to maintain the lubricant means therein, whereby the lubricant means may be retained until the mouths of the indentations are opened by the action of the rifling of a weapon.

2. A method of manufacturing a projectile which comprises the steps of forming indentations on the bearing surface of the projectile, inserting lubricant in said indentations, and deforming the projectile surface by the application of pressure thereto to substantially completely close the mouths of the indentations to maintain the lubricant therein, whereby the lubricant may be retained until the mouths of the indentations are opened by the action of the rifling of a weapon.

3. A method of manufacturing a projectile which comprises the steps of forming three series of grooves in the cylindrical bearing surface of the projectile, the grooves in one series following a right-hand spiral, the grooves in the second series following a left-hand spiral, and the grooves in the third series being substantially circumferential, inserting lubricating means in said grooves, and applying pressure to the projectile surface to substantially completely close the mouths of the grooves to maintain the lubricant therein, whereby the lubricant may be retained within the projectile surface until the mouths of the indentations are opened by the action of the rifling of a weapon.

4. A projectile provided with indentations on the bearing surface thereof, and lubricant means within said indentations, the bearing surface of the projectile being deformed to provide a thin wall of metal over the mouths of the indentations to substantially completely close the latter, whereby the lubricant means may be retained until the mouths of the indentations are opened by the action of the rifling of a weapon in penetrating the thin wall.

In testimony whereof I have signed my name to this specification.

OTTO RINKEL.