

UNITED STATES PATENT OFFICE.

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PROCESS FOR THE AUTOMATIC REMOVAL OF COPPER FROM ORDNANCE.

1,359,338.

Specification of Letters Patent. Patented Nov. 16, 1920.

No Drawing.

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To all whom it may concern:

Be it known that I, ALAIN ELIE ALFRED DAGORY, a citizen of the French Republic, and residing in Bois Colombes, Seine, 8 Avenue Robert Bain, France, have invented certain new and useful Improvements in and Relating to Processes for the Automatic Removal of Copper from Ordnance, of which the following is a complete specification.

This invention relates to a process for automatically freeing guns of all calibers from the copper which is deposited during the firing in the interior of the bore.

After a certain number of shots have been fired especially when they are fired rapidly, and when guns are employed having grooves the pitch of which is not progressive, there is produced in the grooves and on the ribs between them, deposits of copper which are derived from the driving bands of the shells. This metal adheres very strongly to the walls of the bore of the gun and the effect thereof is to interfere with the function of the grooves and consequently act prejudicially on the accuracy of the firing. It also accelerates in an appreciable manner the wear of the guns by increasing the strain on the grooves and it may go so far as to cause the bursting of the gun.

The operation which consists in removing this copper, and is ordinarily called "de-coppering," takes place rapidly and automatically by utilizing the process which constitutes the subject matter of the present specification.

This process is based on the affinity which tin when in a state of fusion has for copper and on the property which these two metals possess of forming together compounds of relatively low melting point and in all cases lower than the temperature attained by the powder gases during the passage of the projectile through the bore of the gun.

The method consists in covering the base of the shells with a metallic composition composed of tin and lead.

By way of example one may be cited which gives good results and consists of the following proportions viz. 55 per cent. of Sn (tin) and 45 per cent. of Pb (lead).

These metals, previously melted together, are arranged on the base of the projectile, either over the whole of its surface or in the form of a ring around its circumference. The quantity necessary varies with the cali-

bers proportionally to the surface of the bore of the gun, taking as a basis the figure of 10 grams for a 75 mm. gun.

As soon as the powder gases have made their action felt and the projectile has commenced its course through the bore of the gun, the layer in question becomes fused. The tin and the lead the melting points of which are 232° and 325° respectively present in fact the property of forming compounds of a disaggregation point which varies according to the proportions of one or the other metal, and the minimum melting point of which corresponding to the eutectic mixture of tin and lead is 187°.

If it be considered that the temperature attained in the bore of the gun by the powder gases is of the order of from 2000° to 2200° it will be readily understood that in the presence of such an excess of temperature the disaggregation of the composition of tin and lead adhering to the base of the projectile takes place almost instantaneously. Examination of blank trial shells which were fired and found intact in the ground after firing leave no doubt as to the production of this phenomenon.

The tin and the lead, being reduced to the liquid state are projected, by the centrifugal force due to the rotation of the shell along the wells of the bore of the gun, in the form of fine small drops which are brought into contact with the copper. This latter metal then forms with the tin fusible alloys as has been explained above, the copper and the tin giving rise in fact to the formation of a eutectic mixture composed of 97 per cent. of tin and 3 per cent. of copper the melting point of which is 220°.

With the proportions of 60 per cent. of Sn and 40 per cent. of Cu the disaggregation point is still only 625°. Seeing that in the present case, there is an excess of tin, the conditions of temperature necessary to the disaggregation of the compounds which are formed are thus certainly realized.

As regards the lead, it does not combine with the copper but under the circumstances it plays the part of a lubricant. Its adhesive power is not comparable to that of the copper, and it disappears on the passage of succeeding shells along with the fusible compounds of tin and copper.

Experience has shown that even a few shells covered on their bases with tin and lead are sufficient to remove the copper from

a gun. In the case of the 75 mm. gun for example, the number of shells necessary does not exceed 15. Of course shells thus prepared and fired from a gun in good condition, prevent all obstruction of the grooves and the ribs between them, by the copper.

It goes without saying that the proportions of tin and lead above given as examples may be subsequently modified according to the exigencies of practice, as also may the nature of the fusible metals employed.

The metallic composition of tin and lead or other metals, intended to produce the removal of the copper from the gun may not only be placed on the base of the projectile, but also in any other manner, on condition of course that this composition is subjected, the moment the shot is fired to the heat developed by the combustion of the powder. Thus for example it is possible:

1. Instead of placing the alloy on the base section to place it on the cylindrical part behind the driving band. This method has certain advantages in the case of shells which are of truncated conical form at the rear.

2. To introduce the metallic composition into the shell or cartridge case.

The alloy may be placed either in the powder charge or immediately in front of it. It may be employed in any form *e. g.* Washers, pastilles, powder, granules, etc. In this case it is the extremely rapid movements of the powder gases which bring about the contact between the alloy in its liquid or volatilized state and the copper deposited on the bore of the gun.

Finally, experience has proved that the figure of 10 grams of alloy given as a basis for use with the 75 mm. shell, is in no way absolute. It may be considerably reduced.

What I claim is:

1. A process for the automatic removal of copper from ordnance consisting in bringing into contact with the copper deposited either in the grooves, or on the ribs between the same or in the smooth part of the bore of the gun, a body which forms with the said copper an easily melting compound at the temperatures which exist in the said bore during the firing of the gun, in order to cause the fusion of the copper, and then its driving out of the gun.

2. A process for the automatic removal of

copper from ordnance, consisting in bringing into contact with the copper deposited either in the grooves or on the ribs between the same, or in the smooth part of the bore of the gun, tin in order to constitute with the said copper an easily melting compound at the temperature existing in the gun during the passage of the projectile through the bore of the gun.

3. A process for the automatic removal of copper from ordnance, consisting in bringing into contact with the copper deposited either in the grooves or on the ribs between the same, or in the smooth part of the bore of the gun a compound of tin with lead, in the following proportions: tin, 55% to 60%; lead, 40% to 45%; thus effecting, on the one hand the combination of the said tin with the said copper deposited in the bore of the gun, and, on the other hand, the lubricating of the shells by the said lead.

4. In a process for the automatic removal of copper from ordnance, the step which consists in bringing into the gun together with the load, a compound of tin with lead.

5. In a process for the automatic removal of copper from ordnance, the step which consists in putting onto the rear part of the shell, a compound of tin with lead which is soldered on the said rear part of the projectile, the said compound being then, at the firing of the gun, projected by the centrifugal force due to the rotation of the shell along the walls of the bore of the gun, in the form of fine small drops which are brought into contact with the copper.

6. In a process for the automatic removal of copper from ordnance, fastening onto the rear circular face of the shell a compound of tin with lead, the said compound to be projected along the walls of the bore of the gun, and brought into contact with the copper.

7. In a process for the automatic removal of copper, from ordnance, applying to the shell a compound of tin with lead, the said compound to be projected along the walls of the bore of the gun and brought into contact with the copper deposited on the said walls.

In testimony whereof I have hereunto set my hand at Paris, France, this 23rd day of June, 1920.

ALAIN ELIE ALFRED DAGORY.