July 23, 1957 E. F. OSBORN 2,799,959

NITRIDED GUN BARREL WITH CHROMIUM DEPOSIT

Filed June 11, 1947

Fig. 1.

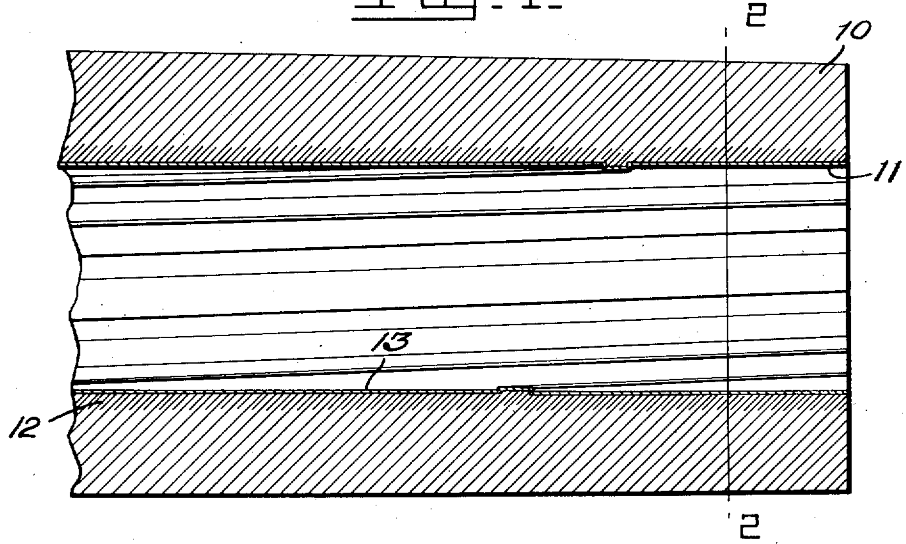
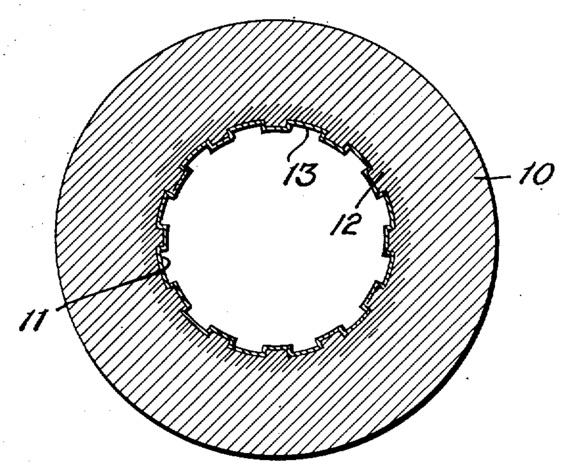


Fig. 2.



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1

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NITRIDED GUN BARREL WITH CHROMIUM DEPOSIT

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4 Claims. (Cl. 42—76)

The present invention relates to guns and more particularly to gun barrels having a long life and to a method of producing such barrels.

The effectiveness and accuracy of a gun barrel depends to a large extent in maintaining the dimensions of the gun bore at or very close to original dimensions. When the barrel becomes worn by erosion and the like, the accuracy and muzzle velocity of projectiles fired therefrom soon are reduced to the point that the barrel must be replaced. In order to increase the life of gun barrels, their bores have been plated with a metal which is highly resistant to erosion and corrosion. Such plating of the gun bore fails to correct one important cause of reduced accuracy and muzzle velocity, however, namely the plastic deformation of the metal of the barrel adjacent the bore. This plastic deformation is most pronounced in automatic weapons after prolonged firing which causes the metal of the barrel to reach and remain at relatively high temperatures for some time. This overheated metal is so altered and weakened by heat as to be displaced by projectiles passing through the barrel with the result that the bore is deformed to permit escape of gases past the projectile during its passage through the bore. The action of the projectiles upon the altered and weakened metal of the barrel is such as to displace it in all directions and to greatly alter the rifling of the barrel, actually obliterating the lands adjacent the breech in cases of prolonged firing. Where the bore is plated with erosion resistant material the metal beneath the plating may be displaced carrying with it the resistant plating, thereby undermining the resistant plating and destroying its effectiveness. Where no resistant plating is used, the weakened barrel metal is not only displaced by the projectile but is so reduced in strength by the high heat that it may be readily eroded and corroded by the physical and chemical action of the gases in the barrel.

An important object of the present invention is the provision of a gun barrel which will be resistant to plastic deformation as well as to erosion and corrosion of the bore surface, and to the provision of a method for producing such a barrel.

Another object of the invention is the provision of a gun barrel which will maintain a high efficiency and accuracy for long periods of automatic or single fire use.

A further object of the invention is to provide a method of the above mentioned character which may be applied to the manufacture of guns or to the modification or repair of guns already manufactured or used.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings, which form a part of this specification and wherein like characters of reference denote like parts throughout,

Figure 1 is a longitudinal sectional view through a portion of the length of a gun barrel embodying the present invention, and,

Figure 2 is a transverse sectional view thereof.

2

In the drawings, wherein for the purpose of illustration is shown one embodiment of the invention, the numeral **10** designates a portion of the length of a gun barrel having a bore **11** which may be rifled or smooth. In accordance with the present invention, the entire surface of the bore or a portion of the length thereof is hardened as indicated at **12**, and a relatively thin plating **13** of a suitable erosion resistant material is applied to the hardened surface of the bore and finished to final bore dimensions.

The steel of the gun barrel is of the usual composition and has the usual properties. While the invention may be applied to various types of guns, it will be described in connection with a caliber .50 machine gun, although it is to be understood that this gun is selected for illustrative purposes only. The steel used for the barrel such, for example, as SAE 4150 modified steel, will usually have a hardness of B. H. N. 277 to 321 (Brinell Hardness Number). This hardness is usually obtained by quenching in oil at 300 to 400° F. from just above the critical, and then drawing immediately after the oil quench at about 1100° F. A steel of these properties will not have sufficient hardness to withstand the high heat, such as often generated by automatic fire, without being deformed at or near the bore surface.

Although other hardening processes might be used, such for example as high frequency induction heating followed by quenching, it is preferred to use a nitrogen penetration hardening process such as the well known nitriding process for hardening the bore surface, and either liquid or gas nitriding may be employed. The barrel bore should be carefully cleaned before the nitriding process is commenced, and before cleaning may be subjected to a stress relieving annealing treatment, if desired. The procedure for either gas or liquid nitriding should follow good commercial practice, and is so well known in the art that the details of the process are not described here. However, it has been found that with gas nitriding a treatment for about 38 hours at a temperature of about 950 to 975° F. will produce the desired hardness and depth of case. With liquid nitriding, a treatment of about 24 hours at this temperature has been found to produce the desired results. The foregoing examples are illustrative, but obviously changes in time of treatment may be made to suit varying conditions such as compositions of steel used, the hardness or depth of case desired for a particular gun, and the particular nitriding or hardening process employed.

With the nitriding treatment described above, at .001 to .002 inch below the surface of the bore the hardness will be from 500 to 600 V. H. N., and at .010 inch below the surface the hardness will be at least 400 V. H. N. (Vicker's Hardness Number). These hardness values were obtained by using a Micro-Vickers hardness tester with a 260 gram load on a polished barrel section.

After nitriding it is desirable to scrub the barrel bore, to remove any scale which may have formed, followed by suitable polishing of the bore. The hardened bore surface is then ready for plating. Where a standard barrel is used, it is necessary to remove some of the bore surface to accommodate the plating. This step may be performed either before or after the nitriding operation, and where performed after nitriding, there will still be a sufficient depth of hardened case to serve as a non-deformable foundation for the plating. This surface may be removed by any suitable method, such for example, as electrolytic polishing. Even where it is not necessary to remove metal to make room for the plating, an electrolytic or other type polishing operation may be performed to provide a smooth surface to be plated.

After the nitriding and polishing operation, the bore surface is plated with a suitable erosion resistant material such as chromium, tungsten, molybdenum or tantalum. Chromium makes a firmly adhering, erosion and corrosion resistant plate and has had considerable success as a bore plating. The chromium, or other plating material, is preferably applied electrolytically by methods which are well known in the art and which will not be described in detail. The barrel is placed in the plating solution with its muzzle up, and a stright anode is disposed centrally of the bore. Any portion of the barrel which is not to be plated, such as the chamber for example, is protected from plating by interposing a protective sheath between the anode and such portion of the barrel, or by any other suitable means. The thicknes of the plating layer is controlled by the length of time the barrel is subjected to the plating process. The layer of plate will range, for example, from .001 to .004 inch and a thickness in the neighborhood of .002 inch has been found highly satisfactory. Where desired, the thickness of the plate can be varied at different points in the barrel. After plating, the barrel is washed and dried, and then checked to be sure the proper bore diameter has been obtained. The barrel is then ready to be assembled with other elements to make up a finished gun.

In place of electroplating the barrel bore, an erosion resistant material, either a pure metal or alloy, may be applied to the hardened bore surface in any suitable manner. Where permanent or removable sleeves are employed in the gun barrel, part of the sleeve may be hardened and covered interiorly with erosion resistant material. In such a case, the barrel bore which is to receive the sleeve may be hardened or not, depending upon the thickness of the sleeve and of the hardened portion thereof.

In the drawings the thickness of the plating is greatly exaggerated, as is the thickness of the hardened portion of the barrel, for the purposes of illustration.

A gun having a hardened foundation surface beneath the erosion resistant plating layer will maintain a smooth bore surface without enlargement of the bore dimensions over a long period of time in which the gun is subjected to automatic fire. The accuracy of the gun and its muzzle velocity will be substantially unimpaired after use which destroys the effectiveness of guns made in the usual manner. After prolonged periods of firing, guns made in accordance with this invention were found to

have their erosion resistant plating substantially intact with no appreciable enlargement or deformation.

The present invention may be applied to all types of guns, but it has particular utility when applied to machine guns and automatic guns such as aircraft and antiaircraft cannon which are subjected to high temperatures due to automatic firing.

While the invention has been described in its preferred form, it is to be understood that various changes may be made therein without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. A gun barrel having a bore therein, said bore having a nitrided surface hardened to a value that will resist plastic deformation at prolonged high temperatures, and a thin adherent deposit of erosion resistant material superimposed on the hardened bore surface.

2. A metal gun barrel having a bore therein, said bore having a nitrided surface hardened to a value of at least 500 V. H. N. at .001 inch below the surface of the bore, and a thin layer of erosion resistant material superimposed on said hardened bore surface.

3. The invention recited in claim 2 wherein said layer of erosion resistant material is an electroplated layer of chromium.

4. A metal gun barrel having a rifled bore therethrough, at least a portion of the surface of the bore having a hardness of 500 to 600 V. H. N. at .001 to .002 inch below the surface of the bore and a hardness of at least 400 V. H. N. at .010 inch below the surface of the bore, and a thin adherent deposit of chromium superimposed on said hardened bore surface, the deposit of chromium having a thickness of at least .001 inch and not more than .004 inch, the hardened bore surface serving as a deformation resistant foundation for the deposit of chromium.

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