

LIGHT WEIGHT MACHINE GUN

CROSS REFERENCE TO RELATED PATENTS

[0001] The priority benefit of US provisional patent application serial number 60/945,808, filed June 22, 2007, is claimed.

BACKGROUND OF THE INVENTION

[0002] An important and basic part of the US Army small arms arsenal is the M240B machine gun. The M240B, first used by the US military in the late 1970s, is referred to as a light-weight machine gun. Compared to other machine guns, at about 27.5 pounds without ammunition, it is one of the heavier light machine guns. It is intended to be carried, along with several belts of ammunition, by individual soldiers in combat and to deliver sustained firepower during an enemy engagement.

[0003] The M240B would be less of a burden on the soldier if it were lighter. Accordingly, there remains a need for reducing the weight of the M240B. A likely route to reducing weight, particularly if a redesign of the basic configuration of the M240B is to be avoided, is the substitution of lighter weight metals, such as titanium alloys, wherever possible for the heavier carbon steel currently used. Nonetheless, light weight metals, and titanium alloys in

particular, do not have the same performance characteristics as carbon steel and are not compatible with the remaining components particularly in the environment of use of a combat machine gun. Accordingly, while it may be helpful to consider, and even to try, titanium alloys for at least some of the components of the M240B, the resulting performance may be altered for the worse by such a substitution. Notwithstanding the advantage in overall weight reduction, performance sufficiently degraded may be unacceptable. Accordingly, there remains a need for a way to reduce weight from the current M240B machine gun without degrading performance.

SUMMARY OF THE INVENTION

[0003a] In an aspect of the invention, there is provided a machine gun, comprising: a stock; a receiver body attached to said stock, said receiver body including a back sight bracket, two opposing side plates, a bottom plate, a cocking handle guide, a fire control spring, and a front block; a receiver cover attached to said receiver body; a feeder ramp carried by said receiver body; a trigger assembly in operative connection with said receiver, said receiver carrying said said trigger assembly; and a barrel in operative connection with said receiver body, with a heat shield, a carrying handle, a carrying handle bracket, a front sight collar, and a bipod; wherein said back sight bracket, two opposing side plates, cocking handle guide and bottom plate are made of titanium material having a coating of a wear-resistant material.

[0004] According to embodiments of the present invention is an improved M240B machine gun. The improvement is in the substitution of coated titanium components for carbon steel components to reduce weight. In particular, the components of an M240B currently made of carbon steel that are replaced in the present light-weight M240E6 with coated titanium alloy components are the receiver side plates, bottom plate, cocking handle guide, back sight bracket, front block, carrying handle rod and bracket. A front sight collar is made of titanium in the improved machine gun but not coated with the same special coatings as the other titanium parts. In addition the final exterior surfaces of the receiver of the present machine gun are coated with a ceramic to eliminate shine and also to be able to apply a suitable camouflage color.

[0005] In example embodiments, the coating for several, but not all, of these components is tungsten diamond-like coating (DLC) applied to a thickness of 0.005-0.010 mm on wear surfaces. For the front block, two coatings are used, a first coating of chrome nitride for achieving the requisite performance characteristics of wear resistance and high temperature resistance, and a second coating of chrome carbo-nitride to hide the shiny surface of the chrome nitride. For the carrying handle rod and cocking handle guide, a coating of tungsten DLC is used for wear resistance. Boron carbide is used to coat the carrying handle bracket for high temperature resistance.

[0006] The advantage of the replacement of the various components with titanium alloy components can be significant weight savings, helping to reduce the overall weight by more than four pounds. The advantage of the use of coatings can be that performance of the coated surfaces of the M240E6 is expected to be as good as the carbon steel surfaces of the components replaced and with no loss of interchangeability with the prior art, carbon steel components of older M240Bs.

[0007] These and other features and their advantages will be apparent to those skilled in the art of firearm manufacture from a careful reading of the Detailed Description of Preferred Embodiments, accompanied by the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] In the figures,

[0009] Fig. 1 is a left side view of the present machine gun, according to a preferred embodiment of the present invention;

[0010] Fig. 2 is a right side view of the present machine gun, according to a preferred embodiment of the present invention;

[0011] Fig. 3 is a right side, lower perspective view of the machine gun of Fig. 2 with major components shown in exploded relationship;

[0012] Fig. 4 is a left side, upper perspective view of the machine gun of Fig. 1 with major components shown in exploded relationship;

[0013] Fig. 5 is a left side view of the receiver of the machine gun of Fig. 4 with its parts shown in exploded relationship; and

[0014] Fig. 6 is a right side view of the receiver of the machine gun of Fig. 3 with its parts shown in exploded relationship.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0015] The present invention is, in its most preferred embodiment, a light-weight machine gun based on the M240B but with some of the components being replaced with coated titanium alloy components. The replacement components are dimensionally interchangeable with the carbon steel components of the prior art M240B. The specially-coated titanium alloy parts are the receiver side plates, back sight bracket, bottom plate, front block, parts of the carrying handle, and cocking handle guide.

[0016] Referring now to Figs. 1 and 2, there is shown a left and right side view of machine gun 10, typical in appearance of the M240B machine gun used by the United States Military. It has a buttstock 12, a receiver 14, a trigger assembly 16, a barrel 18, a heat shield 20, a front sight 22, a flash hider 24, a carrying handle assembly 26, a rear sight 28, a feeder ramp 30, and a bipod assembly 32. Carrying handle assembly 26 includes a carrying handle bracket 34 and a carrying handle rod 36. For the most part, these components are dimensionally equivalent to the prior art components made of carbon steel and their function is the same.

[0017] Figs. 3 and 4 show the same machine gun 10 with its major components shown in exploded relationship. In addition, top cover assembly 40 is shown separated from the balance of receiver 14; and bipod assembly 32, including bipod bracket 42 and bracket bolts 44, and stock locking pin 46 are also apparent.

[0018] Figs. 5 and 6 focus on receiver 14, and show its parts from an upper left perspective, exploded relationship in Fig. 5 and in upper right perspective, exploded relationship in Fig. 6. Receiver 40 has back sight bracket 48, a left side plate 50, a right side plate 52, a bottom plate 54, a front block 56, and gas cylinder 58. Steel rails 60, 62, are located on left and right side plates 50, 52. Cocking handle guide 62 is carried by the outside of right side plate 52.

[0019] Those components of present machine gun 10 made of titanium material must exhibit a low coefficient of friction, low wear rate, good corrosion

resistance, good compatibility with existing carbon steel components, and a dark, non-reflective appearance. Front sight 22 and portions of the carrying handle 26 are replaced with different material because, by doing so, machine gun 10 is lighter compared to the prior art M240B. The performance requirements of these latter components are not as critical as the subcomponents of receiver 40 made of titanium material.

[0020] The choice of titanium material reduces weight, and the coating on the material allows the lighter-weight material of machine gun 10 to perform in a manner comparable to that of the carbon steel of the prior art M240B. Coating of the titanium parts prevents galling of the otherwise relatively soft titanium surface.

[0021] The components that replace the prior art carbon steel components are made of titanium material, preferably titanium alloy, and most preferably a particular alloy, Ti-6Al-4V, also known as Grade C-5 according to ASTM B367 or titanium alloy according to AMS 4985, both of which industry standards are incorporated herein in their entirety by reference.

[0022] The coating material for all but one of the titanium material replacement parts of receiver 14 (namely, front block 56) is a diamond-like carbon (DLC), preferably tungsten DLC. The part of receiver 14 having a coating other than tungsten DLC is front block 56, which has two different coatings, namely, a first coating of chrome nitride followed by a second coating of chrome carbo-nitride. In addition, receiver 14 has a second coating, namely, a ceramic

coating, such as, for example, CERAKOTE applied by NIC Industries, to cover any shiny metallic areas and to allow receiver 40 to take on a suitable color such as black or brown or a camouflage color.

[0023] Carrying handle assembly 26 includes carrying handle bracket 34 and carrying handle rod 36. The latter is coated with tungsten DLC; the former with boron carbide because it comes into contact with the hot barrel and requires good resistance to high temperatures. (Additionally, there are steel and nylon components within the carrying handle assembly that are not coated with tungsten DLC or boron carbide.) Front sight 22 is also coated with phosphate along with the rest of barrel 18.

[0024] Tungsten DLC is an amorphous coating with tetrahedral bonding, and is available from manufacturers such as IonBond of Greensboro, North Carolina. Tungsten DLC is applied by physical vapor deposition (PVD), and by the technique known as sputtering in particular, which process is well known. The duration of the process determines the thickness of the coating. A thicker coating requires continuation of the process longer than a thinner coating.

[0025] Proper surface preparation of the titanium material is critical. Prior to coating, all titanium alloy parts are thoroughly cleaned to remove, dirt, dust, grease, oil and other foreign substances. The surfaces are then given a chemical wash, or preferably are blasted to achieve a surface that will bond well with the coating to be applied. They are masked to expose only those areas that need to be coated and then subjected to the coating process.

[0026] The coating for tungsten DLC is 0.001 to 0.005 mm for most coated component surfaces, preferably at least 0.005 mm for wear surfaces but not more than 0.010 mm. The tungsten DLC measured static coefficient of friction is 0.20 to 0.26, and its measured dynamic coefficient of friction is 0.20 to 0.24 although its coefficient of friction in the literature is 0.06 to 0.20. The exact coefficient of friction is dependent on the surface to which the tungsten DLC is applied. In general, the rougher the surface, the higher the coefficient of friction. It is deposited on a titanium material surface by physical vapor deposition (PVD), and by sputtering in particular. According to the literature, its maximum service temperature is 662°F. Its color is dark gray to black.

[0027] Boron carbide is not applied in as thick a layer as tungsten DLC; rather, it is applied to a thickness of 0.001-0.005 mm. Its measured static coefficient of friction is 0.19 to 0.33; its measured dynamic coefficient of friction is 0.18 to 0.29. Boron carbide is also deposited by PVD, and by sputter-coating in particular. The literature identifies its coefficient of friction as 0.12. Its maximum service temperature according to the literature is 2000°F, and its color is also dark gray to black.

[0028] Front block 56, which sees operating temperatures to 1200°F is coated with a first coating of chrome nitride for wear resistance and high temperature resistance, followed by a second coat to front block 56 of chrome carbo-nitride to cover the shiny silver first coating. The chrome nitride coat by itself is shiny silver in color and would be unacceptable in a military firearm as it

shows up when night vision devices are used. Arc evaporation is used to apply these coatings.

[0029] Chrome nitride is applied to front block 56 to achieve a coating thickness of 0.0005 to 0.005 mm; the chrome carbo-nitride is applied to a coating thickness of not more than 0.006 mm, preferably 0.001 to 0.006 mm, and most preferably 0.002 ± 0.0002 mm by a PVD process

[0030] The tungsten-DLC-coated titanium material achieves specific performance requirements for use of those particular components in machine gun 10. Specifically, these components must be corrosion resistant, have high resistance to wear, a low coefficient of friction, and dimensional and compositional stability at operating temperatures. For most of these components, the operating temperature is not likely to exceed 700 degrees F.

[0031] Titanium material coated with DLC, and titanium alloy coated with tungsten DLC in particular, meets the operating requirements surprisingly well. Its performance on receiver side plates 18 with respect to wear appears to be better than chrome electrolytically deposited on steel.

Example 1

[0032] A light-weight machine gun made according to the present machine gun 10 design was tested by firing 20,000 rounds of ammunition with it. The test weapon broke in (that is, increased and then leveled off its operating group velocity) prior to 2000 rounds, typical of M240B machine guns. There was

no evidence of wear of the tungsten DLC-coated components even after 20,000 rounds. The rate of firing and operating group velocity were measured to be within normal specification limits and the average measured rate of fire was 580 rounds per minute.

Example 2

[0033] A light-weight machine gun made according to the present machine gun 10 design was tested by changing barrel 18 1000 times to test the wear on front block 56, counting the number of clicks needed to install barrel 18 and comparing that to the results of a prior art M240B. Performance of the coated front block 56 equaled that of the M240B.

[0034] The use of coated titanium alloy substitute components and sub-components significantly reduces the weight of M240E6 below that of M240B by approximately four pounds without compromising on performance characteristics and full interchangeability. The performance of tungsten DLC exceeded that of nickel boride, well-known as a titanium coating material but which tended to chip and to exhibit poor dimensional stability.

[0035] It will be apparent to those skilled in the art of the manufacturing of moving metal components that the present invention, defined by the appended claims, can be applied to other components besides light weight machine guns, as described in the preferred embodiment, without departing from the spirit and scope of the present invention, as hereinafter claimed.

WHAT IS CLAIMED IS:

1. A machine gun, comprising:
 - a stock;
 - a receiver body attached to said stock, said receiver body including a back sight bracket, two opposing side plates, a bottom plate, a cocking handle guide, a fire control spring, and a front block;
 - a receiver cover attached to said receiver body;
 - a feeder ramp carried by said receiver body;
 - a trigger assembly in operative connection with said receiver, said receiver carrying said said trigger assembly; and
 - a barrel in operative connection with said receiver body, with
 - a heat shield,
 - a carrying handle,
 - a carrying handle bracket,
 - a front sight collar, and
 - a bipod;

wherein said back sight bracket, two opposing side plates, cocking handle guide and bottom plate are made of titanium material having a coating of a wear-resistant material.
2. The machine gun as recited in claim 1, wherein said wear-resistant material is a diamond-like carbon (DLC) coating.

3. The machine gun as recited in claim 2, wherein said DLC is tungsten DLC.
4. The machine gun as recited in claim 2 or 3, wherein said coating is between 0.005 and 0.010 mm thick.
5. The machine gun as recited in any one of the preceding claims, wherein said titanium material is a titanium alloy.
6. The machine gun as recited in claim 5, wherein said titanium alloy is Ti-6Al-4V.
7. The machine gun as recited in any one of the preceding claims, wherein said front block is coated with a first coating of chrome nitride.
8. The machine gun as recited in claim 7, wherein said first coating is 0.0005-0.005 mm thick.
9. The machine gun as recited in claim 7 or 8, wherein said front block is coated with a second coating of chrome carbo-nitride.
10. The machine gun as recited in claim 9, wherein said second coating is not more than 0.006 mm thick.

11. The machine gun as recited in claim 10, wherein said second coating ranges from 0.001 to 0.006 mm thick.
12. The machine gun as recited in any one of the preceding claims, wherein said receiver body has a ceramic coating.
13. The machine gun as recited in any one of the preceding claims, wherein said carrying handle bracket is made of titanium material with a heat-resistant coating.
14. The machine gun as recited in claim 13, wherein said heat-resistant coating is boron carbide.
15. The machine gun as recited in any one of the preceding claims, wherein said carrying handle is made of titanium material having a coating.
16. The machine gun as recited in any one of the preceding claims, wherein said coating is tungsten DLC.
17. The machine gun as recited in any one of the preceding claims, wherein said front sight collar is made of a titanium material.

18. The machine gun as recited in claim 17, wherein said titanium material is coated with phosphate.

LIGHT WEIGHT MACHINE GUN

ABSTRACT OF THE DISCLOSURE

A light-weight machine gun is made by replacing selected components previously made of steel with interchangeable components made of coated titanium alloy. Several different coatings are used on the components depending on the performance requirements of the component as well as factors related to convenience. The back sight bracket, the side plates, bottom plate and cocking handle guide of the receiver, and the carrying handle rod of the carrying handle assembly, are made of titanium alloy coated with tungsten DLC; the front block, also made of titanium alloy, is coated with a first coating of chrome nitride for resistance to wear resistance and secondarily for high temperature resistance, followed by a second coating of chrome carbo-nitride to provide the appropriate appearance; and the titanium alloy carrying handle bracket of the carrying handle assembly is coated with boron carbide. Performance of the lighter machine gun is equivalent to the prior art carbon steel machine gun but with a weight reduction of over four pounds.

Fig. 1