

Dec. 8, 1959

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2,915,946

SEGMENTED MOLYBDENUM GUN LINER

Filed Oct. 30, 1951

Fig. 1.

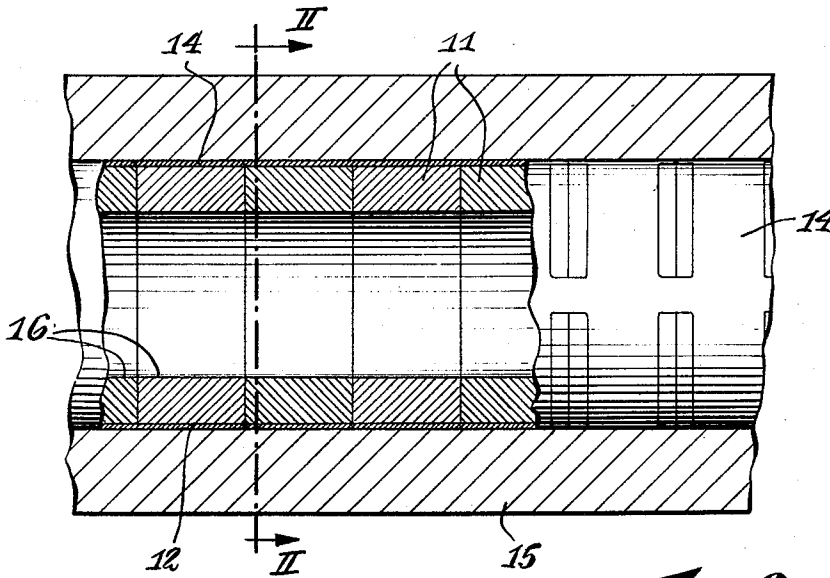


Fig. 2.

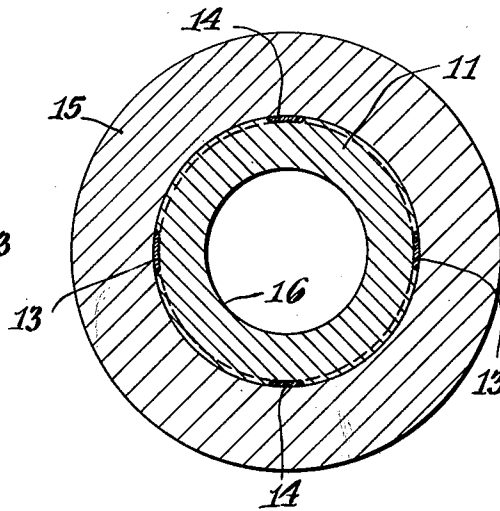


Fig. 3.

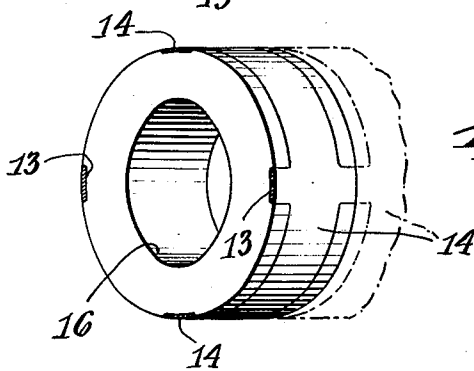
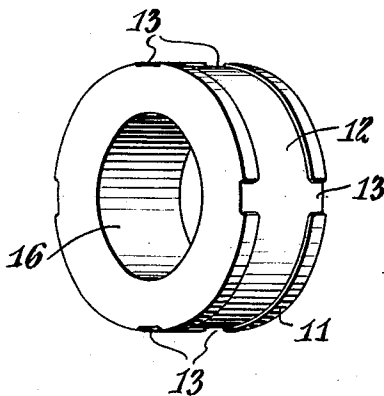


Fig. 4.

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1

2,915,946

SEGMENTED MOLYBDENUM GUN LINER

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Application October 30, 1951, Serial No. 253,913

6 Claims. (Cl. 89—16)

This invention relates to guns and, more particularly, to liners for such and methods of manufacture.

The principal object of my invention, generally considered, is to provide segmented ring-type molybdenum gun liners, with the parts connected by metal in longitudinal grooves therein, and the molybdenum portions connected to the carrier forming the gun barrel by shrinking the latter over metal in both longitudinal and circumferential grooves.

Another object of my invention is the provision of a gun liner with circumferential and longitudinal grooves in which metal of desired character, that is, not too refractory and having the ability to connect each liner ring to a carrier and a neighboring liner or liners, is disposed.

A further object of my invention is to provide a method for making a gun, the barrel of which is lined with a series of hollow cylindrical molybdenum members, comprising roughly machining a series of molybdenum rings while strung on a steel rod or bolt, pressed tightly together and held in place thereon by a nut or nuts, turning the assembly so formed, grooving each ring circumferentially and longitudinally, securing or incasting metal, such as steel, stellite, nickel or the like, in said grooves, completing the machining, inserting in a gun barrel or carrier, shrinking in place, and withdrawing the mandrel from the assembly.

Other objects and advantages will become apparent as the description proceeds.

Referring to the scale drawing:

Figure 1 is an axial sectional view of a gun barrel or carrier enclosing a series of rings forming a gun liner embodying my invention.

Figure 2 is a transverse sectional view on the line II—II of Figure 1, in the direction of the arrows.

Figure 3 is a perspective view of one of the liner rings before outer grooves therein have been filled with connecting metal.

Figure 4 is a view corresponding with Figure 3, but showing a complete liner ring with connecting metal in place in its grooves.

Molybdenum has a lower coefficient of expansion than steel. For this reason when a tube of molybdenum is fastened in a steel gun barrel, or as a gun liner, and the barrel or carrier becomes very hot as during firing, the steel expands away from the molybdenum liner and there is a gap left therebetween. In order to make the liner expand as much along the length of the gun or carrier as its steel carrier during firing, such have been made of rings individually fastened to the steel, so that large gaps do not form, and so that other undesirable effects, due to differences in thermal expansion, may not take place.

Ring-type liners have been experimentally tested and it has been found that longitudinal cracking takes place, where such liners are made composite with steel portions and connected thereto by steel pins, where the molybdenum is thin over the pins. In accordance with my invention, however, I avoid the use of any separate con-

2

necting means, such as pins, between the molybdenum and the steel by other portions secured thereto to allow for the difference in expansion between the molybdenum and the steel, and to serve as connecting means between the liner rings, and between said rings and their carrier.

Each liner ring, according to my invention includes, with specific reference to the drawing, a hollow relatively-short, in this embodiment about $\frac{3}{8}$ " in axial dimension, generally cylindrical portion 11 formed of molybdenum or alloy thereof with small proportions of metal selected from the group consisting of cobalt, nickel, iron and tungsten, that is, in which the proportion of any of the first three alloying metals is not greater than $\frac{1}{2}\%$, and in which the proportion of the alloying tungsten is not greater than 15%. Each ring is formed so that its fibers run in such direction as to have great strength against bursting, reference being made to the Baker Patent No. 2,692,216, granted October 19, 1954, and showing the directional properties of molybdenum and its contemplated alloys; that is, that the greatest strength lies in the direction of greatest fiber elongation. The inner cylindrical surface 16 is of diameter corresponding with the bore desired. The outer cylindrical surface of each ring 11 is formed with groove 12 running circumferentially around the periphery of the ring, and a series of grooves 13 spaced circumferentially around the liner, but in this case running longitudinally or parallel to the axis thereof.

Although the grooves 12 and 13, in this case, are shown intersecting and forming + indentations connected around the periphery, it will be understood that I do not wish to be limited to this construction, as the indentations formed by the circumferential and longitudinal grooves may be T or inverted T-shape in appearance, or may involve segmented or separated circumferential indentations, or entirely separate longitudinal and circumferential indentations, that is, alternately longitudinal and circumferential around the periphery. Alternatively, the configuration may be reversed, that is, ridges positioned like the grooves 12 and 13, providing, in any event, areas lying on different cylindrical surfaces, those lying on the smaller cylindrical surfaces being built-up by the auxiliary metal. Sharp corners are avoided in the grooves or at the ridges which are, in the 40 mm. bore size, between .04" and .08" deep and a width which may be proportioned approximately as illustrated. The shallower the grooves can be made and still furnish enough steel or other inset metal to retain the liner in place, the better will be the performance of the gun.

These grooves may be filled with metal 14 in any desired manner as by electroplating, in-casting or welding. In addition to steel, which appears to be the most desirable material for the purpose, nickel and various ferrous alloys, including "stellite," may be employed.

In making a gun containing such a liner, the separate rings, of the segmented liner, are anchored to the carrier 15, or in the barrel of the gun, by the outer plated or in-cast steel or other material 14 in the grooves 12 and 13, to thereby prevent both forward and rotational movement of the liner segments. The metal in the longitudinally extending grooves 13 abuts corresponding metal in the corresponding grooves of adjacent segments and serves to connect said segments longitudinally by metal of coefficient of expansion corresponding with that of the carrier or gun barrel 15.

The entire assembly of pieces of a liner may be handled on a mandrel as a single unit, thus greatly reducing the machine work required in the finishing and insertion of the liner. A schedule of operations in making such a liner involves: roughly-machining the rings while supported on a mandrel, which may be a steel rod or bolt, said rings being tightly held together in place on said mandrel,

3

as by a nut or nuts. The assembly is then turned on the mandrel to proper dimensions, each segment grooved, as illustrated, or in accordance with a suggested modification, and then the plating or in-casting of the metal 14 is effected, resulting in a connection of the rings by the metal. The assembly is then finish machined, cooled, as by a refrigerant such as liquid air, and inserted in carrier or gun barrel while hot, to effect a shrink fit. Thereafter the mandrel may be withdrawn from the liner.

From the foregoing, it will be seen that I have devised an improved liner segment and gun liner, avoiding the use of pins or other auxiliary or separate connecting elements and instead using shallow grooves containing cementing or connecting material which not only serves for holding the liner elements in place in the gun barrel, but also for connecting the elements to one another and preventing longitudinal and circumferential displacement in the barrel or carrier.

Although preferred embodiments of my invention have been disclosed, it will be understood that modifications may be made within the spirit and scope of the appended claims. The term "molybdenum," as used in the claims, includes alloys thereof as herein defined.

I claim:

1. In a gun, a hollow steel carrier, a liner therein comprising a series of hollow cylindrical molybdenum portions with inside diameter corresponding with bore of gun and outside diameter corresponding with that of the inside of said carrier, the outer surface of each portion being formed on two cylinders of different radii to form a crossing longitudinal and circumferential pattern, and metal of lower melting point and higher coefficient of expansion than molybdenum building up the areas of the smaller cylindrical surface to the larger cylindrical surface and serving to connect said molybdenum portions together and to said carrier.

2. In a gun, a hollow carrier, a liner therein comprising a series of hollow cylindrical molybdenum portions with inside diameter corresponding with bore of gun and outside diameter corresponding with that of the inside of said carrier, the outer cylindrical surface of each portion having longitudinal and circumferential grooves, and metal of lower melting point and higher coefficient of expansion than molybdenum filling said grooves and serving to connect said molybdenum portions together and to said carrier.

3. In a gun, a hollow steel carrier, a liner therein comprising a series of hollow cylindrical molybdenum portions with inside diameter corresponding with bore of

4

gun and outside diameter corresponding with that of the inside of said carrier, the outer cylindrical surface of each portion having crossing longitudinal and circumferential grooves, and metal of lower melting point and higher coefficient of expansion than molybdenum filling said grooves and serving to connect said molybdenum portions together and to said carrier.

4. In a gun, a hollow carrier, a liner therein comprising a series of hollow cylindrical molybdenum portions with outside diameter corresponding with that of the inside of said carrier, the outer cylindrical surface of each portion having longitudinal and circumferential areas on a different radius, and ferrous metal of lower melting point and higher coefficient of expansion than molybdenum inset over the areas on the smaller radius and serving to connect said molybdenum portions together and to said carrier.

5. In a gun, a hollow steel carrier, a liner therein comprising a series of hollow cylindrical molybdenum portions, the outer surface of each portion having both longitudinally extending and circumferentially extending spaced grooves, and steel filling said grooves and serving to connect said molybdenum portions together and to said carrier.

6. In a gun, a hollow carrier, a liner therein comprising a series of hollow cylindrical molybdenum portions with outside diameter corresponding with that of the inside of said carrier, the outer cylindrical surface of each portion having a series of longitudinally extending and circumferentially extending grooves, and metal of a lower melting point and higher coefficient of expansion than molybdenum cast in said grooves and serving to connect said molybdenum portions together and to said carrier.

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