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2,845,741

COMPOSITE FIREARM BARREL

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FIG. 1

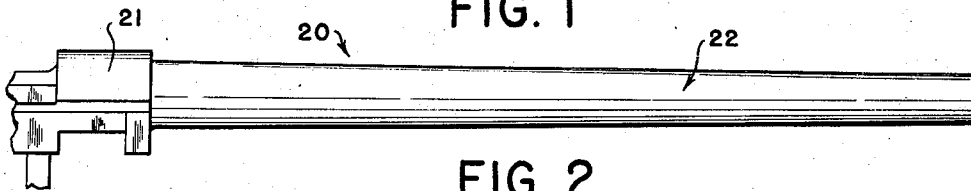


FIG. 2

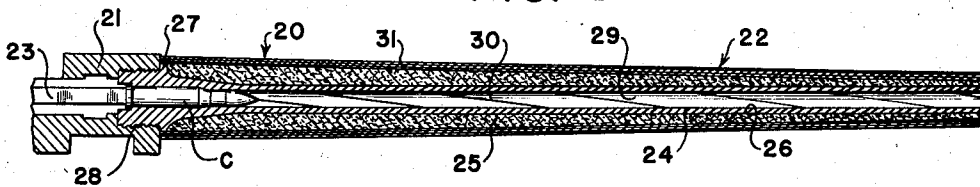


FIG. 3

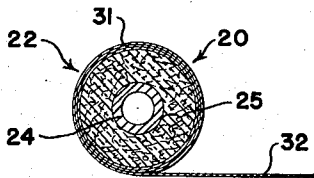


FIG. 4

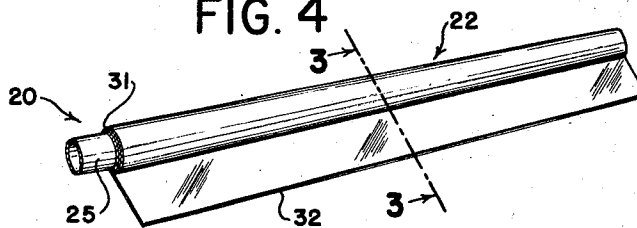


FIG. 5

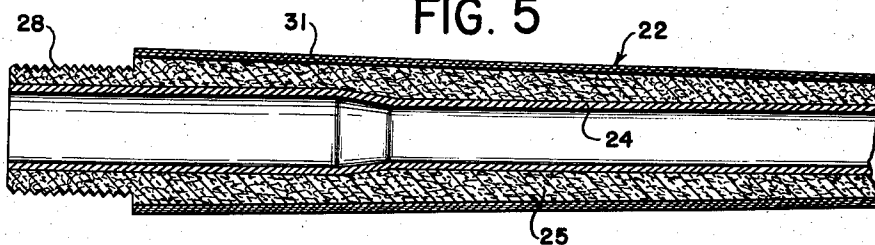
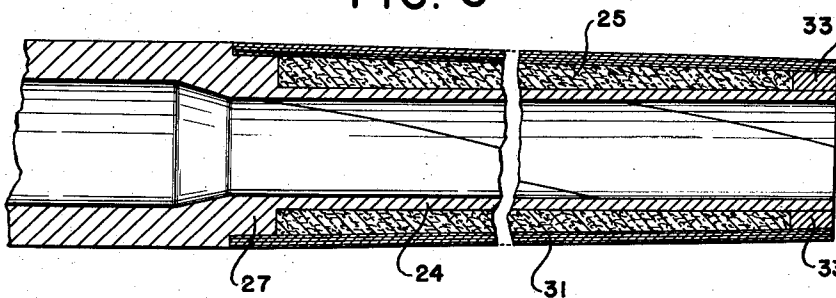


FIG. 6



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2,845,741

COMPOSITE FIREARM BARREL

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6 Claims. (Cl. 42—76)

This invention relates to a novel structural element which is outstandingly useful for the attainment of increased stiffness of a pliant member, such as is encountered on extremely light-weight firearm barrels of composite construction and similar tube-like members. The invention will be described with particular reference to firearm barrels of such light weight construction and which are characterized by the provision of a projectile discharge bore through which a suitable charge of propellant, such as smokeless powder, discharges a projectile at high speed.

To secure the utmost accuracy of such barrels, it is necessary that the tubes or barrels and particularly their bores be maintained in a straight line and the deflection of the muzzle reduced to a minimum. The travel of the projectile tends to correct any deflection of the bore and thereby sets up a muzzle vibration which affects accuracy.

Alloy and carbon steels have been extensively used in gun barrels which are capable of withstanding the stresses resulting from the firing of cartridges and shot shells under normal conditions, and are also capable of withstanding, to a great extent, abnormal stresses which are encountered when a shot shell or cartridge is fired against an obstruction in the barrel. Properly made, such gun barrels exhibit the important and desirable characteristics of non-fragmentation if the barrel should burst because of excessive loading.

One of the ends constantly sought in gun designing and manufacture is lightness. But unless the barrel is made of a different material from those heretofore used, the weight of the barrel cannot be reduced without sacrificing strength and thus reducing the ability of the barrel to withstand abnormal stresses to which it might be subjected if the barrel is obstructed when the gun is fired. The ratio of strength to weight is a matter of compromise not permitting much variance in what is looked upon as standard practice with the materials heretofore available for manufacture of gun barrels.

Aluminum has been tried in shot-gun barrels with apparent initial success. That is a shot-gun with an aluminum barrel produced excellent endurance and wear characteristics under normal conditions. But a satisfactory gun, either sporting or military, must be designed to meet abnormal conditions, such as firing of a shell when the barrel is clogged. Because of this, gun manufacturers submit new gun barrel designs to certain tests in which shells are fired through barrels against certain predetermined obstructions. When aluminum barrels were tested in this manner, it was found that instead of bulging or bursting, as present-day steel barrels do, the aluminum was shattered and fragments were blown in all directions, thus producing a very dangerous condition.

In the present invention, I provide a light-weight barrel for firearms of all kinds which will withstand, without significant change, firing conditions under which present-day steel alloy barrels would bulge or burst. However, if the gun should be fired under even more extreme conditions causing the liner to burst, the metal particles

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will be contained and not be scattered. The barrel of the present invention is of a composite type, the components of which cooperate to lend to the barrel the attributes of greatly increased strength under high intensity stresses of very short duration so as to render it substantially burst-and-fragmentation proof on the one hand, and an overall weight usually substantially less than that of present-day barrels on the other hand.

While the composite type of barrel embodied in my invention satisfactorily meets the requirements of lightness and strength for certain types of barrels, it has been determined that under certain conditions and proportions, this construction can develop an excessive deflection or muzzle drop.

Although my invention is presently described in connection with a rifle or shot-gun barrel, it is within the scope of my conception that gun barrels of much larger bore and greater length may be constructed according to the disclosure of copending application Serial No. 486,322. It is well known that in the design of guns of larger bore, which are mounted on carriages or other supports, the trunnions of necessity are placed rearward of center and additional weight must be included in the barrel, rearward of the trunnions for balance and forward of the trunnions to secure the necessary stiffness for reducing the muzzle deflection to a minimum. This problem is exaggerated in guns mounted on vessels or tanks where the movement of the vehicle is transmitted to the gun structure.

An object of the present invention is to provide a firearm barrel of the composite type, the components of which may be arranged to lend to the barrel vastly increased strength under high intensity stresses of very short duration not only radially but longitudinally as well, thereby not only rendering the barrel burst-and-fragmentation proof as aforementioned, but also producing a stiffened structure which further permits the safe use of higher energy propellants, with the ensuing advantage of permitting the firing from the barrel of projectiles at greater velocity in a flatter trajectory than was possible heretofore, with a substantial decreased barrel weight.

While the use of materials having widely different resonance characteristics produces a more effective and satisfactory damping of the vibrations produced on firing the projectile, they also have a tendency to produce a barrel more easily deflected. The accuracy of present-day rifles is known to be adversely affected by the vibrations which are induced through the oscillatory nature of the propellant burning and also by the stresses transmitted to the barrel material through the movement of the projectile down the bore. The tendency of the projectile, in flight through the bore, to correct the muzzle deflection is a contributing cause to excessive muzzle vibration. Differences in vibration load, with respect to the projectile exit produce varying transverse forces which are responsible for a considerable proportion of the shift of the flight path in successive shots. However, where the barrel is formed of materials having widely different resonance periods, the early damping of these vibrations tends to significantly minimize transverse forces on the projectile and thus to decrease variations in the flight path from shot to shot.

To attain these ends I provide a firearm barrel type which has as one of its components an inner liner of any suitable material, such as aluminum, steel, stainless steel, or titanium, for instance, which is primarily relied on to provide in the barrel a suitable projectile discharge bore, that may be rifled, and which will withstand the erosive action of projectiles and hot powder gases, and has sufficient hardness to withstand engraving pressures of the projectile, and which has for another component a jacket bonded to the liner and formed of a multitude

of light-weight fibers of relatively high individual strength, which is primarily relied on to lend the barrel the overall strength required to render the same burst-proof as aforementioned and an additional component consisting of a sheet of foil material wrapped around the fiber component. The liner distributes the stresses to the jacket fibers most uniformly causing them to act in unison rather than individually while the foil wrapper supports the liner and jacket fibers to impart stiffness to the elongated tube member.

It is a further object of the present invention to provide a firearm barrel of the composite type in which the fibers wound on the liner are supported and stiffened by a sheet of metal foil.

It is a still further object of the present disclosure to provide a composite firearm barrel having a metal tube, superposed layers of fibers, woven tape or cloth and resin and a casing of foil wound on the exterior surface of said fibers to form a rigid construction.

It is still another object of the present invention to produce a composite firearm barrel in which the tube may be of metal, the fibers of the jacket may be of any suitable light-weight material of high strength properties, with a sleeve of metal foil encasing the composite structure.

Further objects and advantages will appear to those skilled in the art from the following considered in conjunction with the accompanying drawings.

In the accompanying drawings certain modes of carrying out the present invention are shown for illustrative purposes:

Fig. 1 is a side view of a mounted composite firearm as constructed according to the present invention;

Fig. 2 is a longitudinal section through a composite rifle barrel embodying the present invention and showing the inner metal tube, the fiber winding and the foil wrapping, the foil wrapping being exaggerated for clarity;

Fig. 3 is an enlarged cross-section of the barrel on line 3—3 of Fig. 4 during assembly and shows the reinforcing foil wrapping partly in place;

Fig. 4 is a top plan view of a barrel partially wrapped;

Fig. 5 is a side view, partly in longitudinal section, showing the present invention as applied to a shot-gun barrel;

Fig. 6 is a perspective view of another form of applying the invention which may take the form of a sleeve of either wound cross-section or extruded form to be slipped over the basic winding.

Referring to the drawings and more particularly to Figs. 1 and 2 thereof, the reference number 20 designates a portion of a firearm, such as is shown and described in U. S. Patents 2,099,035 and 2,155,512 having a receiver 21 on the forward end of which is mounted a barrel 22. A conventional breech bolt 23 is movable in the receiver 21 into and from closed position (Fig. 2) in which to lock a cartridge C to be fired in the breech end of the barrel. The breech bolt 23 carries a conventional firing pin and associated mechanism for discharging the cartridge.

The barrel 22 comprises an inner liner 24 and a fibrous jacket 25. The liner 24 is over the greatest part of its length diametrically reduced externally to leave a cylindrical wall 26 of relatively small thickness, a non-reduced end of the liner forming the breech end 27 of the barrel which may conveniently be threaded at 28 for its reception in the receiver 21. As the exemplary barrel 22 is a rifle barrel, the projectile discharge bore 29 of the liner 24 may be rifled as at 30. The liner may be formed of metal, or other suitable materials, as the jacket is also relied upon to provide the required physical properties to withstand the high intensity, short duration stresses which are encountered when the gun is fired under abnormal conditions, and to prevent fragmentation if the barrel does burst. As set forth in said copending application, Serial No. 486,322, "high intensity, short dura-

tion stresses" in connection with a firearms barrel means pressures greater than 3500 p. s. i. and periods of 15 milliseconds or less. This permits lightening of the barrel by use of lighter-weight and less rigid metals than have heretofore been used in the manufacture of gun barrels. While the use of the above mentioned construction produces a sufficiently strong, light-weight construction to withstand the forces of explosion, certain combinations which may be utilized are conducive of exaggerated whip or deflection and it is the purpose of the present invention to supplement the composite structure shown in co-pending application Serial No. 486,322 to produce a stiffened structure which will reduce muzzle deflection to a minimum.

The preferred barrel may be constructed with a jacket 25 of fibrous material as described in the copending application before mentioned but upon the exterior surface of the jacket 25, I arrange a coating of metal foil 31.

This metal foil coating may be a single sheet bonded to the fibrous jacket or it may be formed of several layers of material, the several layers being suitably bonded one to the other. I have found that one of several resin binders may be used with satisfaction although certain metallic coatings may preferably be brazed or welded. The composite structure forming the body of the barrel as described in the copending application is of such texture and hardness that it may be ground to a smooth surface and to close tolerances. This feature permits the use of a preformed sheath in place of the wrapping, the sheath being shrunk over the prepared exterior of the jacket and fitting thereto in a manner to utilize the maximum compressive characteristics of the foil used.

The foil coating may be of any of the non-corrosive metals such as brass or stainless steel to protect the barrel. The preferred construction as shown further produces a barrel which has a lower heat factor for continuous fire than can be obtained with the standard metal barrel.

In accordance with the preferred method, the surface of the jacket 25 is finished to the desired profile and dimensions to accommodate the particular type and power of the ammunition to be used. Upon the exterior surface of the jacket, I wind a layer of thin metal foil 31, preferably stainless steel, and secure it thereto by a suitable binder. Excellent results have been achieved with a binder known to the trade as "Epoxy" which are condensation products of epichlorohydrin and a polyhydric phenol, such as diphenylolpropane. It is within the concept of my invention that the metal foil sheathing may be any one of several available metals and may further consist of one or several layers of foil, suitably bonded together in order to obtain the degree of stiffness necessary for the particular type of ammunition used.

Although the preferred method of applying the stiffening coat is by winding the foil on the preformed fiber coating, it is within the concept of my invention to prepare the foil wrapper in the form of a seamless, welded, or extruded tube and telescope the prepared tube over the surface of the barrel, employing suitable adhesive to secure the tube in place.

In Figs. 3 and 4 I have illustrated the application of the foil wrapping 31 by winding. As shown, a sheet 32 of foil of the desired thickness may be wrapped around the barrel of the firearm by rotating the barrel until the desired number of layers of foil have been applied. The foil may be coated with a binder of the type heretofore described prior to wrapping.

Fig. 5 shows the invention applied to the barrel of a shot-gun. It is generally similar to the rifle barrel heretofore described except the liner 24 is not rifled. This liner is formed of metal or other suitable material, as heretofore described, and is surrounded by the jacket 25. The foil coat 31 is then secured over the jacket to complete the barrel construction.

In the form of the invention shown in Fig. 6, liner 24 is provided with collar 33 at each end, the collars being either made integral with the liner or secured thereto. Jacket 25 is then placed on the liner between the collars and finished flush with the collars. The foil coat 31 is then applied, either by wrapping or in the form of a preformed tube. It is secured to collars 33 by brazing or welding and to the jacket 25 by a binder, such as the resins herein-disclosed.

The fibrous jacket 25 may be formed by any of a variety of methods. It is essentially composed of a multitude of fibers or filaments of relatively high strength properties which are bonded to each other and to the liner 24 in mutual stress-transmitting relation. A strand, or strands, of glass fibers or other high strength filaments may be wound on the liner 24 in superposed layers. The binder is preferably applied to the fibrous strands before they are wound on the liner. The binder may be applied by brushing, spraying, immersion, or pre-impregnation prior to winding.

Among various fibers which I have tested, glass fibers have produced the best results. Good results are also obtained with other mineral fibers, also with nylon, Dacron, Teflon, Orlon and other linear polymer fibers, for instance. In general I believe any fiber of high strength properties will serve the purpose of lending sufficient strength to a composite barrel to render it substantially burstproof under obstructed firing conditions.

As stated, the composite structure of the present invention is generally similar to the construction disclosed in copending application Serial No. 846,322, filed February 7, 1955, but it is within the concept of the present invention to incorporate the foil wrapping construction in any composite structure wherein the body may be stiffened by tensile and compressive properties of the foil.

I claim:

1. A composite firearm barrel, comprising a liner provided with a projectile discharge bore and having inadequate strength to withstand ordinary internal firing pressures, an outer jacket thereon formed of a multitude of glass fibers bonded to each other and to said liner in mutual stress-transmitting relation and adding sufficient strength to that of said liner to preserve the configuration of the latter and to render the composite barrel sufficiently strong to withstand the pressure generated during the propellant burning cycle, and a layer of metallic foil covering the jacket to increase the stiffness and rigidity of the barrel.

2. A composite firearm barrel, comprising a liner provided with a projectile discharge bore and having such small wall thickness as to lack strength to withstand ordinary internal firing pressures, an outer jacket thereon formed of a multitude of glass fibers bonded to each other and to said liner in mutual stress-transmitting relation and having sufficient strength to reinforce said liner so that the same will withstand ordinary internal firing pressures and will be fragmentation-proof if the barrel should burst under obstructed firing conditions,

and a layer of metallic foil covering the jacket to increase the stiffness and rigidity of the barrel.

3. A composite firearm barrel, comprising a liner having a projectile discharge bore, an outer jacket thereon formed of a multitude of glass fibers wound in successive layers and bonded to each other by a binder by which they are secured to each other and to said liner in mutual stress-transmitting relation, said fibers adding sufficient strength to that of said liner to render the barrel substantially burstproof under obstructed firing conditions, and a layer of metallic foil covering the jacket to increase the stiffness and rigidity of the barrel.

4. A composite firearm barrel, comprising a liner provided with a projectile discharge bore and having such small wall thickness as to lack strength to withstand ordinary internal firing pressures, an outer jacket thereon formed of a multitude of glass fibers wound in successive layers and bonded to each other by a binder by which they are secured to each other and to said liner in mutual stress-transmitting relation, said fibers adding sufficient strength to that of said liner to preserve the configuration of the latter and render the barrel substantially burstproof under obstructed firing conditions, and a layer of metallic foil covering the jacket to increase the stiffness and rigidity of the barrel.

5. A cylindrical vessel comprising a composite structure consisting of a metallic liner, an outer jacket thereon formed of a plurality of fibers bonded to each other and to said liner in mutual stress-transmitting relation, said fibers adding sufficient strength to said liner that said composite structure is capable of withstanding pressures greater than 3500 p. s. i. for periods of 15 milliseconds or less, a layer of metallic foil covering the jacket and closure means independent of said composite structure for closing, at least, one end of said vessel.

6. A cylindrical vessel comprising a composite structure consisting of a metallic liner, an outer jacket thereon formed of a plurality of glass fibers bonded to each other and to said liner in mutual stress-transmitting relation, said fibers adding sufficient strength to said liner that said composite structure is capable of withstanding pressures greater than 3500 p. s. i. for periods of 15 milliseconds or less, a layer of metallic foil covering the jacket and closure means independent of said composite structure for closing, at least, one end of said vessel.

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