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(54) Smooth bore muzzle device.

(57) The inventive device is composed of a device with a specifically shaped inner bore which is mounted on or integral with barrel (2) of a firearm so that the axis of the inner bore and the axis of the barrel are co-linear. The inner bore of the device is composed of two sections, seen in direction of propagation of the projectile:

(a) a reverse taper (12) which appears to the powder gases as an abrupt expansion around the projectile followed by

(b) a smooth bore section (13) whose diameter is equal to or less than the projectile diameter.

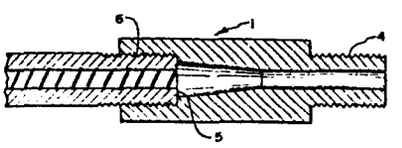

FIG. 3

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Applicant: D. C. Brennan Firearms, Inc.; U.S.A.

Title: Smooth Bore Muzzle Device

This invention relates to a smooth bore flash suppression device for firearm muzzles.

When a firearm is discharged, the propellant gases that were generated by the combustion of the propellant powder exit the muzzle in the wake of the projectile. This instantaneous discharge of hot propellant gas mixes vigorously with the ambient atmosphere, and certain chemical moeties in the propellant gases have a propensity to ignite by combining with atmospheric oxygen and producing a reaction which results in the release of a certain amount of energy. This energy release is accompanied by an increase in muzzle blast and the emittance of visible light. In conditions of low ambient light, e.g., at night, this flash not only discloses the location of the firer, but also destroys his night vision, especially if his eyesight had been accommodated to low light level prior to the discharge.

The jet of propellant gases also contributes materially to the recoil of the firearms, as the momentum of both projectile and propellant is imparted to the firearm. Because the velocity of the propellant gas jet is typically much higher than that of the projectile, the powder gases contribute a large fraction of the recoil energy to the firearm.

Prior art has repeatedly addressed the management of the energy of the escaping propellant gases. It has long been the practice for both small arms and cannon to equip the barrel with a muzzle brake which diverts part of the propellant gases rearward or at right angles to the muzzle exit, thus eliminating that portion of the recoil. Small arms, particularly assault rifles, submachine guns, and machine guns, are ordinarily equipped with muzzle devices intended to suppress the flash which would usually be expected upon discharge. On occasion, muzzle devices having the dual purpose of reducing both flash and recoil are fitted.

In the prior art, flash suppression has been sought in three different ways: (1) Chemical constituents are incorporated into the propellant powder so that the reaction between the powder gases and atmospheric oxygen is impeded; (2) A shroud is fitted to the muzzle to simply hide the flash; and (3) The powder gases are vented in such a way as to mix them with the atmosphere so that the conditions to initiate and support combustion are not attained. Method (1) is independent of the firearm, and most modern propellants incorporate a flash suppression additive.

In contrast, recoil reduction has always been addressed from the single approach of diverting the powder gases so that a smaller component of the recoil force is along the axis of the barrel.

It is an objective of this invention to provice a muzzle device that reduces visible flash from the muzzle of a firearm when discharged in an environment of low am-

bient illumination. It is an additional objective to reduce the perceived recoil of weapons that incorporate this device, without diverting gases so that the effectiveness of the weapon is improved, as well as its controllability, in fully automatic fire.

An additional objective is to improve accuracy of firearms incorporating this device by reducing muzzle pressure and the concomitant destabilizing effects that are ordinarily imparted to the projectile at muzzle exit, as well as assuring that the bullet path is accurately constrained to be colinear with the barrel axis.

It is another objective to accomplish this with a muzzle device which is similar in weight and bulk to those in contemporary usage.

Upon discharge of the firearm, the projectile, at the muzzle exit, moves into the reverse taper of the device. Powder gases escape around the projectile, but this venting of the powder gases is controlled by the taper; as the projectile moves further into the taper, the constricting walls of the taper cut off the flow of gases that are being vented around the projectile, similar to the action of a valve. The escape of this gas is critical to the satisfactory operation of the device.

When the smooth bore section of the bore is encountered (whose diameter is equal to or less than projectile diamter), the effect is to limit the gas which is permitted to escape via the taper, determine the interval until the subsequent gas release, and to realign the projectile with the bore. The vented gases move through the

device ahead of the bullet, inducing the favorable flow conditions prior to the release of the remainder of the propellant gases. The pre release of gas, in combination with the gas dynamics of the flash suppressor as specified in the co-pending patent application, positively prevent the afterburning that causes flash.

In a conventional barrel, strongly shocked air is ejected ahead of the bullet, and this air, which was once resident in the barrel, forms the ambient into which the powder gas is ejected upon uncorking of the bullet. The ejection of the instantaneously released propellant gases around the projectile forms a structure known as a "shock bottle". The pre-release of powder gas described for the inventive device hinders the formation of this "shock bottle", and the elevated pressures and temperatures of the propellant gases that result as the gases move through this shock wave. A gradual pressure gradient, instead of a sharp differential gradient, is formed by the method described.

Preferred embodiments illustrating the construction of the smooth bore suppression device are shown in the accompanying drawing in which:

Fig. 1 is a perspective view of the smooth bore muzzle device attached to the barrel of a firearm;

Fig. 2 a side elevational view of the device of the invention, showing it attached to a barrel of a firearm;

Fig. 3 a side elevational sectional view of an embodiment of the smooth bore device having a threaded section for receiving an additional flash suppression device;

Fig. 4 a side elevational sectional view of another embodiment of the smooth bore device;

Fig. 5 an end elevational sectional view of an embodiment of the device of the invention taken along Line 5-5 of Figure 2;

Fig. 6 an end elevational sectional view of an embodiment of the device taken along Line 6-6 of Figure 2;

Fig. 7 a side elevational sectional view of an embodiment of the invention showing its integral construction with an add-on flash suppression device;

Fig. 8 a side elevational sectional view of an embodiment of the invention coupled with an additional flash suppressor device;

Fig. 9 a side elevational sectional view of an embodiment of the invention showing the device as an integral part of a firearm barrel and an additional flash suppression device;

Fig. 10 a side elevational sectional view of an additional embodiment of the invention showing the device as an integral part of a firearm barrel with a separable add-on flash suppression device; and

Fig. 11 a side elevational sectional view of an embodiment of the invention showing the device attached to a firearm muzzle and a second smooth bore suppression device.

Figures 1 und 2 illustrate oblique and sideviews respectively of the cylindrical shell of the smooth bore device 1 attached to the barrel 2 of a firearm by means of a threaded connection 3. The end of the device contains a male thread 4 for optional attachment for other muzzle devices or more preferably, the flash suppressor as described in a co-pending patent application, serial number 642,784.

As shown in Figure 3, the smooth bore device 1 is attached to the muzzle 5 of a firearm by means of a threaded connection 6, so that the axis of the bore of the device and the axis of the barrel are co-linear.

A preferred method of attachment is shown in Figure 4, where a centered pilot 7 is machined on a gun barrel 2. This pilot is then mated with a cylindrical section 8 of the same or slightly larger diameter in the device. The base 9 of the device butts firmly against the mating surface 10 in the muzzle. Immediately adjacent to the muzzle, there is an abrupt expansion 11 which then tapers 12 uniformly to a constant diameter smooth-bore section 13 equal to or less than projectile diameter. The diameter and angle of the reverse taper determines the amount of propellant gases released ahead of the bullet. The smooth bore section 13, in conjunction with the moving bullet, acts as the obturating element of a valve by limiting the amount of propellant gases that are released ahead of the bullet. The length of the smooth bore section, in conjunction with the length of the projectile, determines the interval to the subsequent gas release. Accuracy, recoil, and controllability are improved as the resultant lower muzzle pressure reduces the destabilizing effect of the massive instantaneous gas release encountered in rifled barrels. The relative gradual introduction of propellant gases into the air results in a gradual imparting of the momentum of these gases to the firearm. Accuracy of the projectile is further improved because the smooth bore section more precisely aligns the projectile on its rotational axis.

Figure 5 illustrates an end view of the reverse taper previously described whereby the inner circle 14 is the

intersection of the taper and the smooth bore section of projectile diameter or less. The following circle 15 is the initial diameter of the reverse taper. Figure 6 depicts the cylindrical configuration 16 of this smooth bore section. Accuracy is improved, especially if the smooth bore diameter is slightly less than projectile diameter, because the projectile is more precisely aligned on its rotational axis.

Figures 7, 8, 9, 10, 11 illustrate the various ways that smooth bores can be mated with other devices or to themselves.

Figure 7 illustrates an add on device that consists, integral with each other, of the smooth bore device 1, as previously described, and an exit bore 17.

Figure 8 is similar to Figure 7 except here the exit bore 18 is threaded onto the smooth bore device 1. Other prior art devices could be substituted for the exit bore in this case. It should be noted in Figures 9 and 10 that the smooth bore is integral with the barrel. In retrofitting an existing rifled barrel, one can construct the reverse taper with a single point bit and not affect the rifled portion at the muzzle. In those cases, as illustrated in Figure 9, the existing rifling 19 could be substituted for the smooth bore portion 13 of projectile diameter or less.

Figure 11 depicts two smooth bore devices 1 joined together. The purpose here is to release in two impulses more propellant gases prior to bullet exit. A male thread 4 exists for optional attachment of other muzzle devices.

The following table shows the approximate levels of acceptable parameters for this smooth bore device. The following dimensions are for a muzzle device that has been constructed for a 5.56 mm military rifle cartridge. These are not the only dimensions that work and any combination of dimensions will give satisfactory results if the elements described are incorporated. It is also emphasized that different cartridges, barrel lengths, gas regulatory systems, propellants, primers, and/or projectiles may require a different optimized geometry as noted herein.

TABLE I

Length of taper and smooth bore	= 1.7 to 2.0 in. (= 4.318 to 5.08 cm)
Diameter of reverse taper	= .230 in. to .245 in. (= 5.84 to 6.22 mm)
Degree of Taper	= approx. 1°
Smooth Bore Diameter	= .223 in. (= 5.66 mm)

While this invention has been described and illustrated herein with respect to several preferred embodiments, it is understood that alternative embodiments and substantial equivalents are included within the scope of the invention as defined by the appended claims.

Applicant: D. C. Brennan Firearms, Inc.; U.S.A.

Title: Smooth Bore Muzzle Device

C L A I M S

1. A device for suppressing flash from the muzzle (5) of a firearm, comprising in combination:
   - a cylindrical shell for co-axial extension of the bore of a firearm;
   - an inner bore within said shell having an abrupt expansion (11) followed by a uniform contraction (taper 12) to a cylindrical smooth bore section (13) of not more than projectile diameter.

2. A device as set forth in Claim 1, wherein the initial diameter of the reverse taper (12) is at least 1.01 calibers.

3. A device as set forth in Claim 1 or 2, wherein the length of the reverse taper (12) is at least 0.01 calibers.

4. A device as set forth in Claim 1, 2 or 3, wherein the length of the smooth bore section (13) of projectile diameter or less is greater than one caliber.

5. A device as set forth in one of the preceeding claims, wherein at least two smooth bore devices (1) are used in conjunction with each other, and/or wherein said smooth bore device (1) is joined with another muzzle device.

6. A device as set forth in Claim 1, wherein the internal geometry of the inner bore in conjunction with a moving bullet provides for a valving action which is sequential in amount and interval.

7. A device as set forth in one of the preceeding claims, wherein the cylindrical smooth bore section is not aligned coaxially with the bore so as to destabilize a projectile.

8. A device as set forth in one of the preceeding claims, wherein only the reverse taper portion is smooth bore.

9. A device as set forth in one of the preceeding claims, wherein the device is made integral with a firearm barrel.

10. A device as set forth in one of the preceeding claims, wherein a smooth bore device (1) is connected to an additional suppressor device, wherein preferably the two sections are integral with each other, and/or wherein the two sections are made integral with a firearm barrel.

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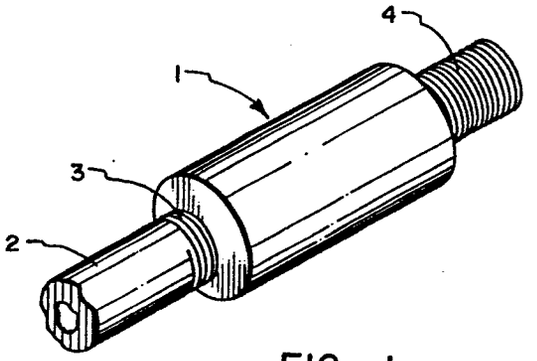

FIG. 1

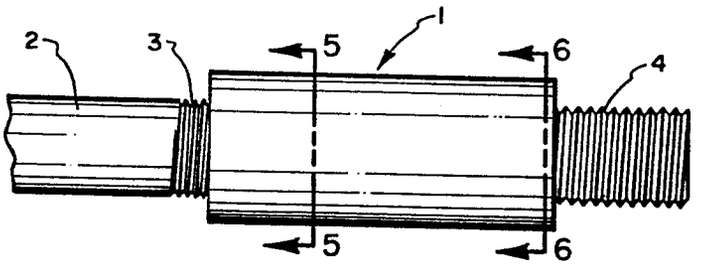

FIG. 2

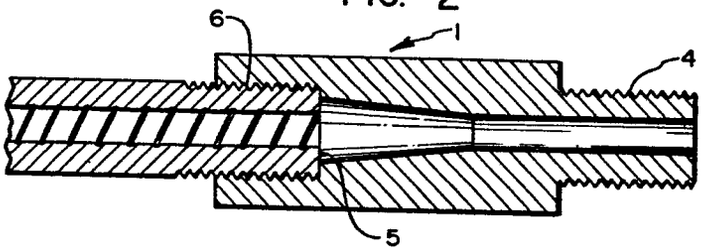

FIG. 3

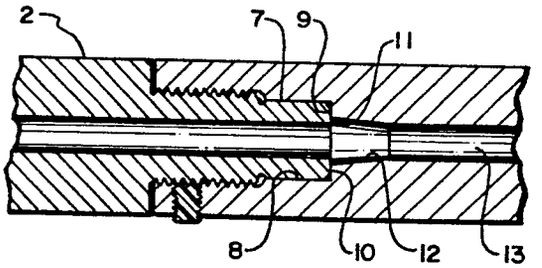

FIG. 4

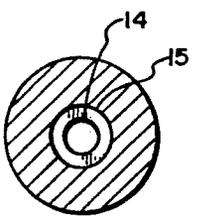

FIG. 5

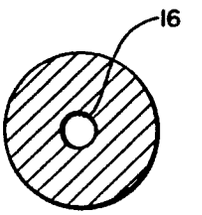

FIG. 6

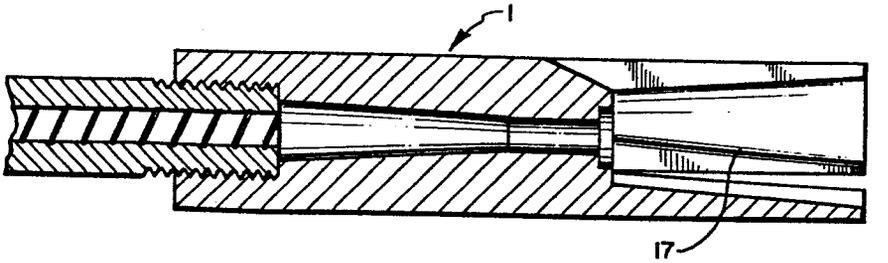

FIG. 7

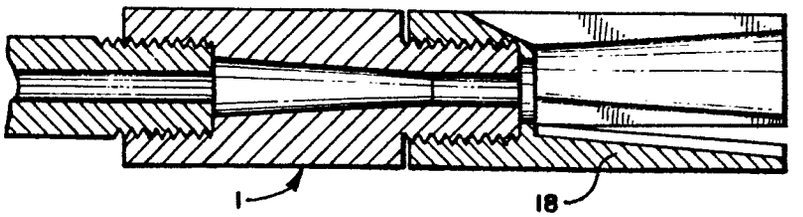

FIG. 8

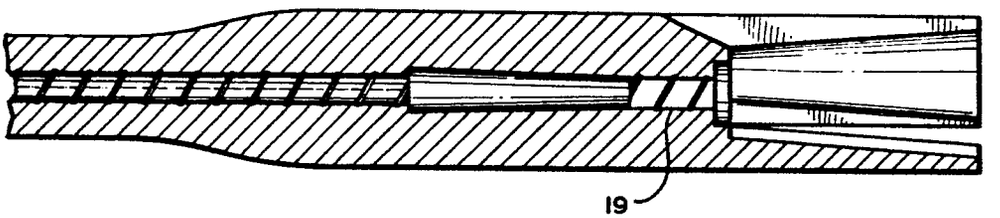

FIG. 9

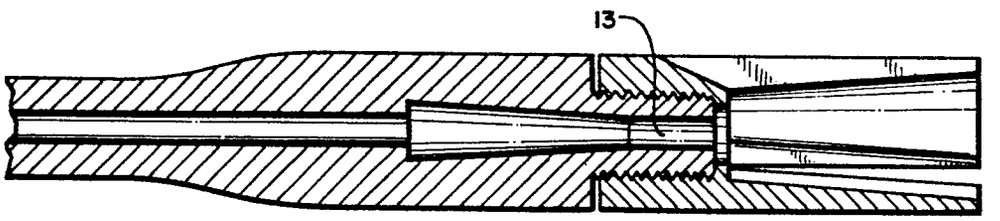

FIG. 10

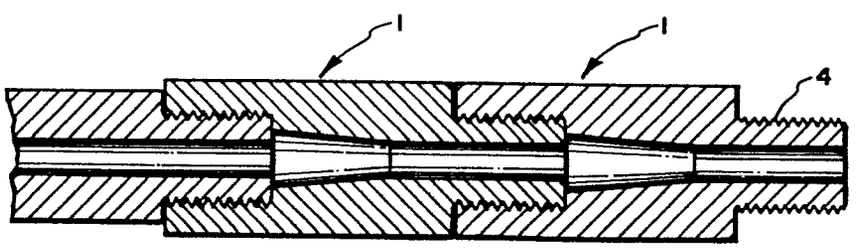

FIG. 11