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41402	*	2/1914	(DE)		89/14.4
2915506		10/1980	(DE)	.	
492535		7/1919	(FR)	.	
793373	*	1/1936	(FR)		89/14.4
897759		3/1945	(FR)	.	

OTHER PUBLICATIONS

A letter from Mr. Owen, Chief, Technology Branch, BATF, dated Oct. 2, 1998.

Al Paulson, "R.A.S.E. Innovation: From .45 Cans To Ruger 10/22 Bolts", Jun. 1996, pp. 34-38, Machine Gun News.

Al Paulson, "Gemtech's Quantum 2000 Suppressed Rifles", Mar. 1995, pp. 24-29, Machine Gun News.

Ivo Sturzenegger, "Swiss Developments In Silencer Technology by Brugger & Thomet Feinmechanik", Jan. 1995, pp. 20-21. Machine Gun News.

Al Paulson, "Design And Performace Of The French Silencieux Unique", Dec. 1994, pp. 36-39, Machine Gun News.

Al Paulson, "AWC's CQB M16 Suppressor", Aug. 1994, pp. 26-28, *Machine Gun News*.

* cited by examiner

Primary Examiner—Stephen M. Johnson

(74) *Attorney, Agent, or Firm*—Parson & Goltry; Robert A. Parsons; Michael W. Goltry

A method and an apparatus for suppressing muzzle blast and/or muzzle crack in a weapon. An apparatus for reducing muzzle blast upon discharge of one or more projectiles from a gun includes an outer shell and a first end cap adapted to be secured to a muzzle of a weapon and including provisions for detachably coupling to a first end of the outer shell. The apparatus further includes a second end cap adapted to be secured to a distal end of the outer shell and a plurality of baffles disposed between the first end cap and the second end cap. The plurality of baffles each comprise a bore section having an inner diameter no smaller than a bore of the muzzle and a baffle section coupled to the bore section, the baffle section extending from the bore section to the outer shell.

18 Claims, 6 Drawing Sheets

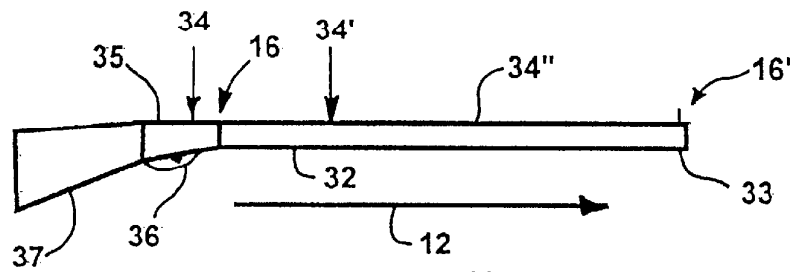


FIG. 4
10

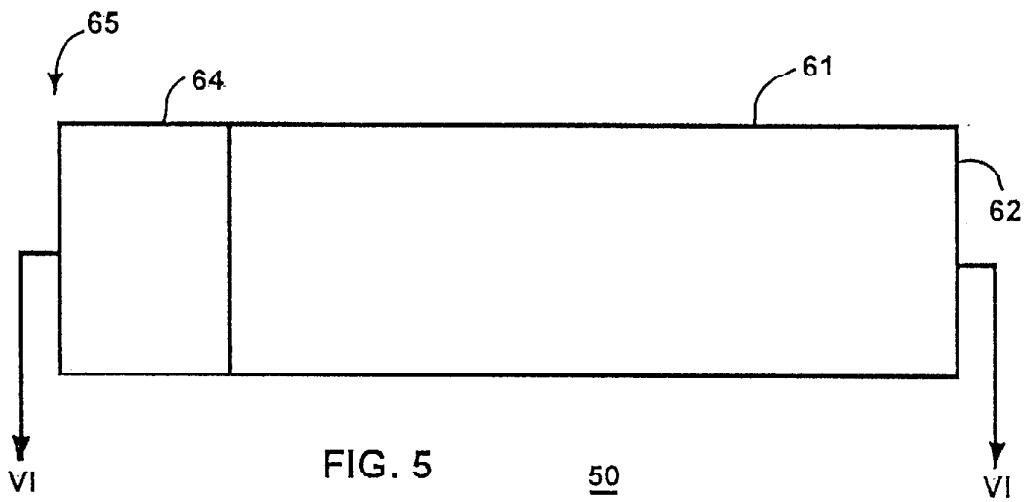


FIG. 5
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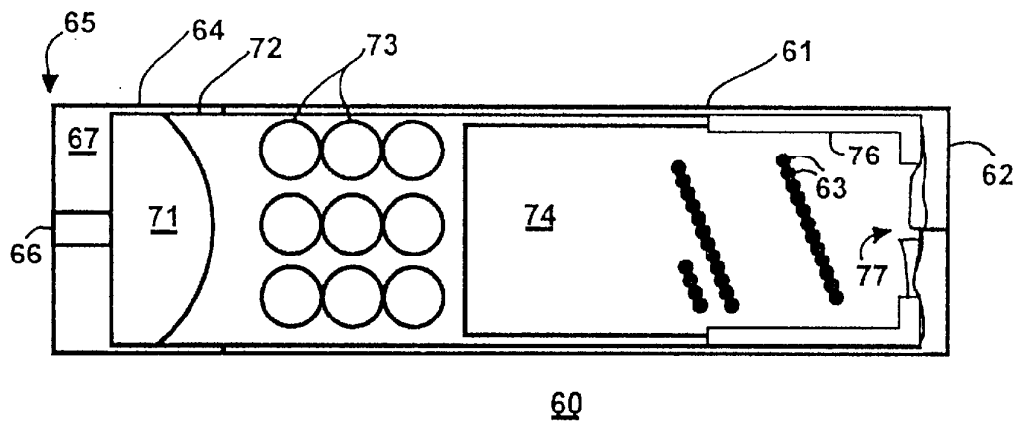


FIG. 6
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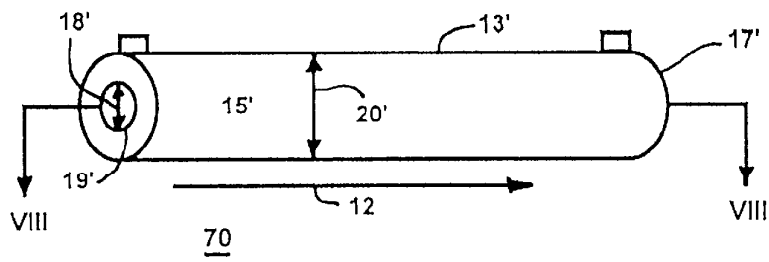


FIG. 7

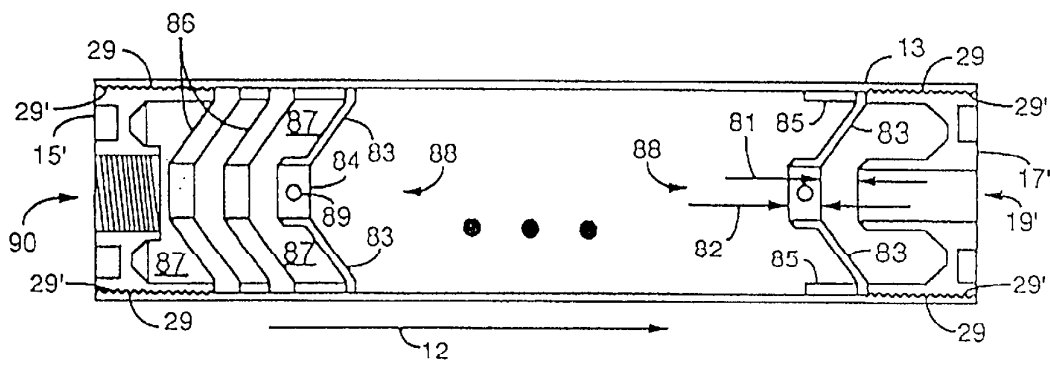
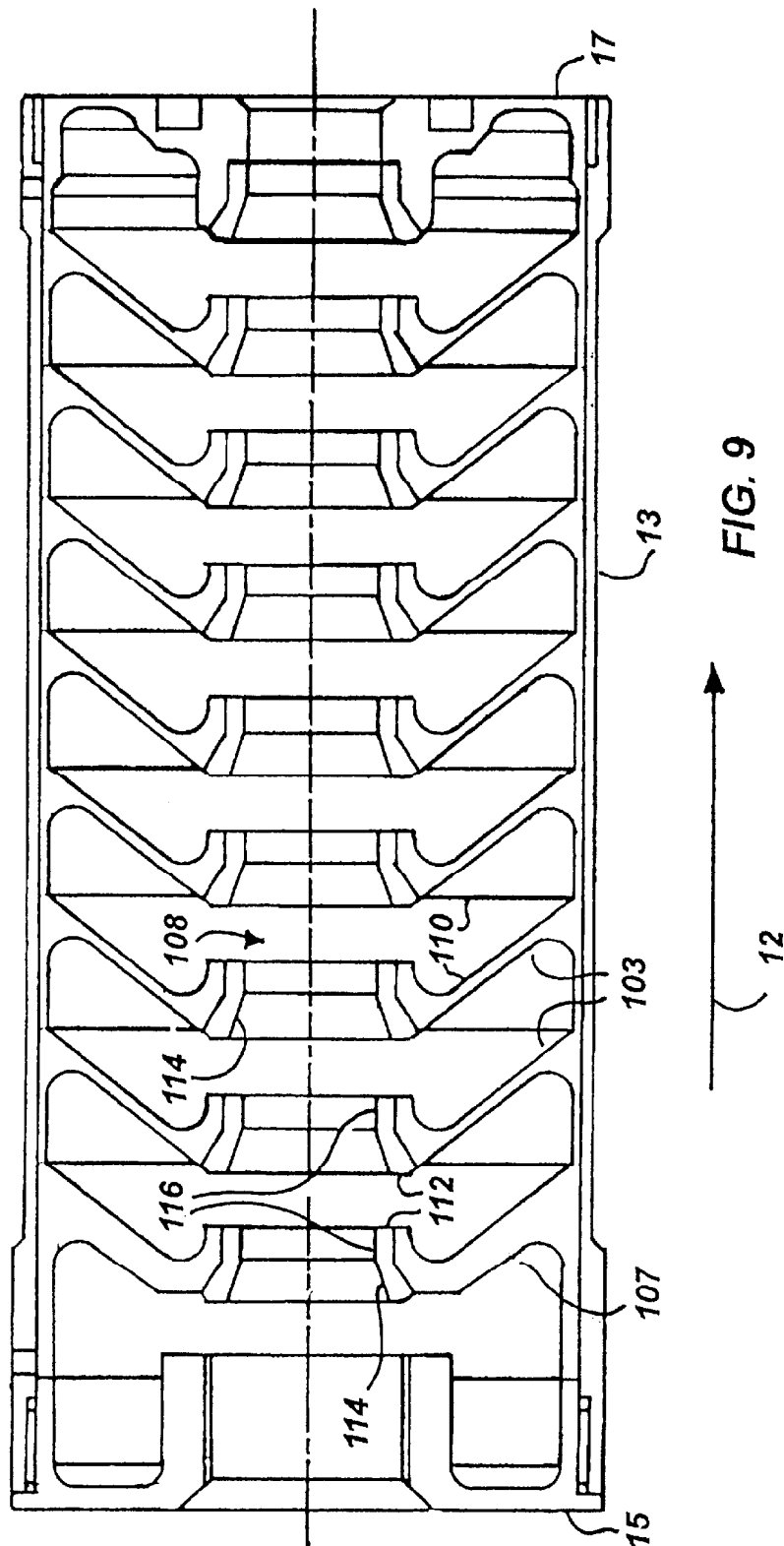


FIG. 8



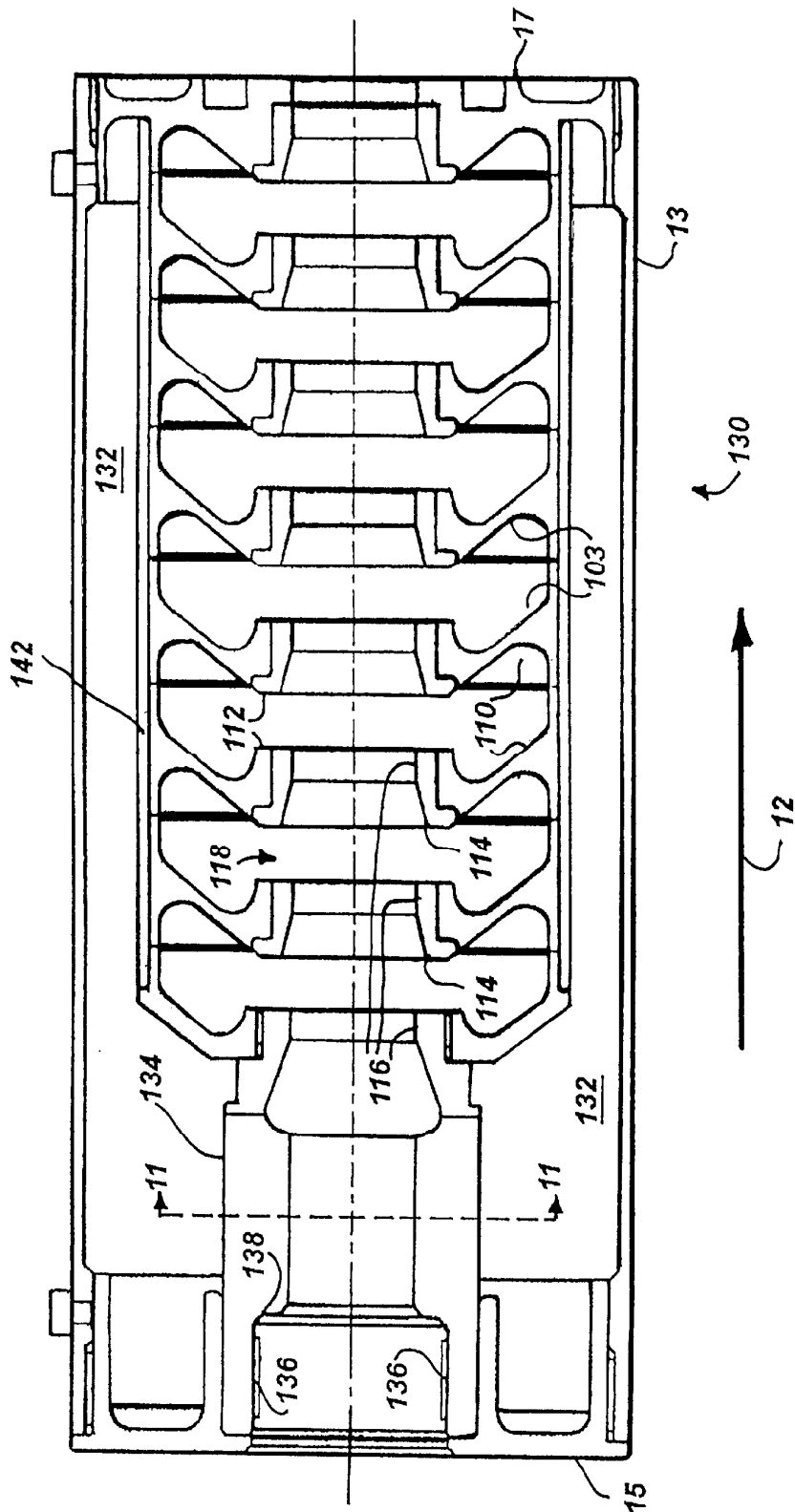


FIG. 10

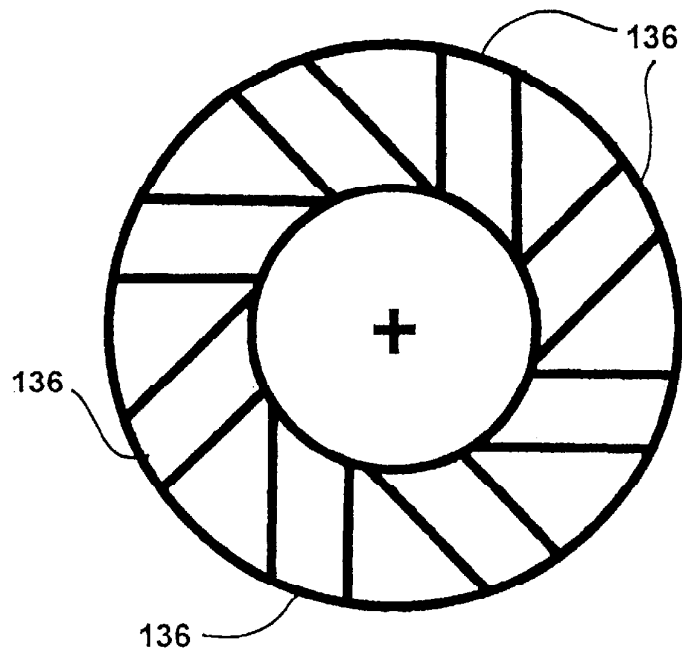


FIG. 11

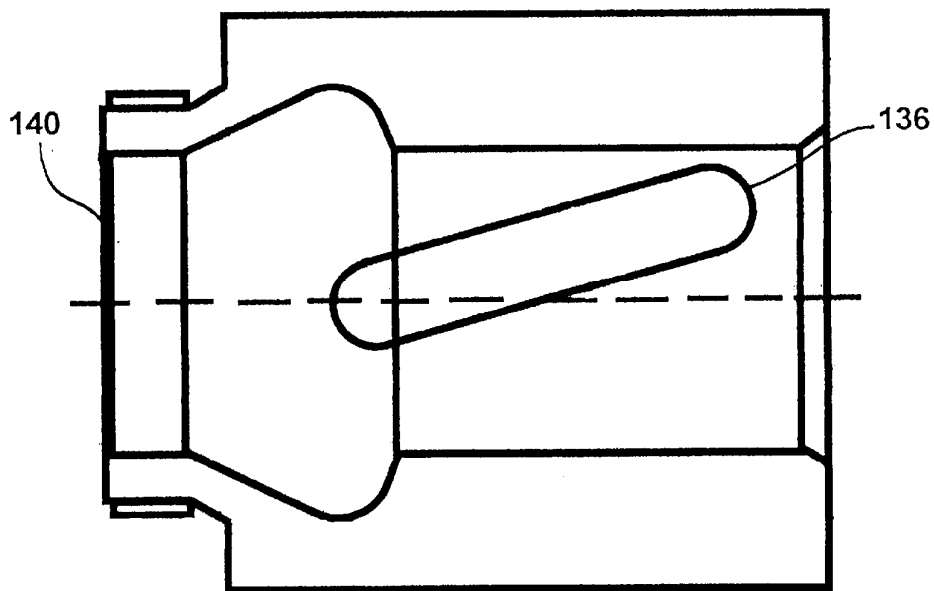


FIG. 12

SUPPRESSOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method, apparatus and system for suppressing muzzle blast and/or muzzle crack in small arms.

More particularly, the present invention relates to suppression of muzzle blast and/or muzzle crack in weapons such as shotguns.

In a further and more specific aspect, the instant invention concerns a method and apparatus for suppressing muzzle blast and/or muzzle crack in weapons employing shot loads.

2. Prior Art

In operation of small arms, it is known that it may be desirable to suppress muzzle jump and/or recoil. Muzzle jump and recoil both stem from the inherent physics of rapidly propelling a mass from the chamber of the weapon, through the barrel and out of the muzzle, via Sir Isaac Newton's law of physics that states "For every action, there shall be an equal and opposite reaction". These phenomena may be undesirable because they tend to (i) reduce accuracy of the shot and (ii) fatigue the person operating the weapon.

One approach to reducing perceived recoil and/or muzzle jump phenomena is to provide one or more, and usually many, ports that exit from near the muzzle end of the weapon. This has the effects of distributing the escape of burning gases over time, reducing the temporal impact of the recoil, and of directing the dispersal of the gasses in chosen directions, reducing and/or directing the impact of the recoil along the long axis of the weapon. However, this does relatively little towards reducing the muzzle blast and/or muzzle crack resulting from discharge of the weapon.

These types of adaptations are marketed by, among other gunsmiths, Pro-port® Limited (41302 Executive Drive, Harrison Township, Mich. 48045-1306, telephone number (810) 469-7323). These have the above-noted advantages but also include risk of damage to the weapon when they are mishandled, because they tend to weaken the barrel of the weapon in the region in which they are installed.

For example, when using a shotgun equipped with ports and a choke, it is generally undesirable to pass a deer slug through the weapon because the normal function of the choke is to compress the projectile(s). Deer slugs tend to be relatively incompressible and this likely will result in undue stress being developed in the region of the choke and ports, which may in turn result in fracture of the barrel at the muzzle end.

Muzzle blast is a loud noise or bang that generally accompanies the discharge of a firearm. A variety of techniques have been developed to redirect or eliminate muzzle blast for some types of small arms. These devices generally fall into two categories, known as (i) muzzle brakes and (ii) suppressors or silencers.

Flash hiders tend to constrict the path of the escaping, burning gasses, reducing the field of view from which the muzzle flash is readily visible. Muzzle brakes may be employed to counter muzzle climb or muzzle jump, e.g., the famous Cutts compensator employed on the Thompson submachine gun, amongst other weapons. Muzzle brakes do relatively little to ameliorate noise upon discharge of a weapon.

Sound suppressors also modify the path of the escaping gasses, but do so in such a way as to temporally disperse the escape of burnt and/or burning gasses from the muzzle. This

has the effect of dispersing over time what otherwise would be a loud bang, in order to provide a much softer noise.

Usually, this requires a series of chambers distributed in a canister that is adapted to be secured to the muzzle of the weapon and which chambers are coupled to the barrel in order to allow burning and burnt gaseous propellants to escape from the barrel into the chambers. The gasses then escape from the chambers back into the barrel, but they are dispersed and delayed and also are engaged in much more turbulent flow. The objective is to silence the escape of burning or burnt gasses from the muzzle of the weapon. These types of devices often work rather well for small arms that discharge a single projectile such as a bullet.

However, even with a suppressor that is adapted to reduce muzzle blast to levels that would not otherwise require hearing protection devices for operation of the weapon, another phenomenon gives rise to substantial noise upon discharge of weapons employing supersonic ammunition, i.e., ammunition that will result in a projectile traveling at a speed greater than Mach 1 when the weapon is discharged. Because the load, projectile or shot is often traveling at a speed greater than the speed of sound in air (i.e., 1100* feet per second) when the load exits from the muzzle of the weapon, the load or projectile also carries with it and radiates a shock wave or sonic boom. This phenomenon is known as "muzzle crack" and it may also result in substantial noise levels.

Muzzle crack and muzzle blast each generally serve to render operation of a weapon an event likely to be noticed by the person operating the weapon, any persons who are cooperating with the person operating the weapon and any persons who simply happen to be in the vicinity, providing that these various persons are not deaf. Moreover, these events are also likely to suggest to the person operating the weapon and persons cooperating therewith that hearing protection may well be a good idea for avoiding prematurely becoming deaf.

Hearing protection tends to inhibit conversation and may increase likelihood of ear infection if the hearing protection extends into the ear canal. Hearing protection devices may also inhibit wearing of a hat for obviating unwanted solar illumination or glare in target shooting and may additionally be a very poor idea in certain types of Special Weapons operations wherein peace officers are attempting to control inherently dangerous situations.

In these types of settings, it is not only desirable for the peace officer to not only make as little noise as possible in the course of resolving each element of the problem, it is also strongly desirable that the peace officer be able to tell what is going on in the immediate vicinity. Being able to hear sounds of movement may well be critical to the peace officer's continued ability to function effectively. Additionally, in these types of settings, it may well be that accuracy and shot placement not only are important in the short range or over a short distance, it may be extremely desirable to reduce the likelihood of a load or projectile(s) finding an inadvertent target at a greater distance, a problem known as "over penetration".

For example, in attempting to apprehend or neutralize an "armed and dangerous" band of thugs in a crowded apartment building, it is generally undesirable to employ projectiles having the capacity for killing after penetration of a multiplicity of walls. These settings call out for a weapon that is not only able to be operated relatively silently and which is also intended to be deadly or at least capable of disabling a human target at short range, but which also is at

least less likely to have a long range killing impact or potential. A suppressed shotgun deploying a subsonic shot load would be ideal for many types of Special Weapons operations.

A feature common to such suppressed weapons is a means for deploying a projectile without adversely affecting the ability of the operator to place the shot and without suffering the deleterious effects of muzzle blast, muzzle crack, muzzle jump and recoil. Because suppressors include chambers coupled to a length of barrel, they tend to be larger in diameter than the barrel. This tends to interfere with use of sights that are normally coupled to the barrel to enable accurate placement of the shot. Additionally, the added mass and bulk of the suppressor may interfere with rapidly aiming at a specific target. These effects are generally undesirable.

Accordingly, it is desirable, particularly with respect to weapons intended to deploy a shot load, to be able to suppress muzzle blast and/or muzzle crack without undue compromise of ease of aiming the weapon.

In order to combat these varied problems, some form of suppressor capable of repeatedly passing a shot load without damage to the weapon or the suppressor or substantial risk of injury from shrapnel arising from explosion of the barrel or suppressor would be highly desirable. It is also highly desirable that the weapon retain short-range accuracy and firepower without incurring undue potential for long-range stray shots having high killing probability.

While the various mentioned prior art devices function as apparatus for suppressing weapons adapted to deploying single, solid projectiles, certain inherent deficiencies preclude adequate, satisfactory performance of the purpose of suppressing weapons adapted to deploying a shot load. One set of experiments with a suppressor that had worked well with deer slugs being deployed from a 12 gauge shotgun left the suppressor looking as though "it had been stung by a swarm of bees" after inadvertent passage of a shot load through the suppressor.

It would be highly advantageous, therefore, to remedy the foregoing and other deficiencies inherent in the prior art.

Accordingly, it is an object of the present invention to provide improvements in suppressors.

Another object of the present invention is the provision of an improved method and apparatus for suppressing muzzle blast in weapons that are intended to deploy a shot load.

An additional object of the instant invention is the provision of an improved method and apparatus for providing reduction in both muzzle blast and muzzle crack in weapons that are intended to discharge a shot load.

Moreover, an object of the instant invention is the provision of an improved method and apparatus for providing reduction in muzzle noise without unduly interfering with aiming of the weapon.

Still a further additional object of the present invention is to provide an improved method, apparatus and system for reduction of muzzle blast typically experienced in operating shotguns.

And another object of the present invention is to provide an improved method, apparatus and system for reducing recoil and noise levels associated with operation of weapons intended to deploy shot loads.

Still another object of the present invention is the provision of a method, system and apparatus for suppressing muzzle noise for shotguns deploying shot loads without necessarily requiring specially-adapted ammunition such as deer slugs.

Yet still another object of the instant invention is the provision of a method, system and apparatus for suppressing muzzle blast in small arms.

And a further object of the invention is to provide a method, system and apparatus for suppressing both muzzle blast and muzzle crack in shotguns that can also accommodate repeated shot loads.

Still a further object of the immediate invention is the provision of a method, apparatus and system for reducing noise associated with discharge of a weapon.

And still a further object of the invention is the provision of method and apparatus, according to the foregoing, which is intended to allow operation of a shotgun without incurring muzzle blast or muzzle crack and without necessarily requiring specially-manufactured ammunition.

SUMMARY OF THE INVENTION

Briefly stated, to achieve the desired objects of the instant invention in accordance with a first preferred embodiment thereof, an apparatus is provided for suppressing muzzle blast from a weapon upon discharge of one or more projectiles therefrom. The apparatus includes an outer shell and a first end cap adapted to be secured to a muzzle of a weapon. The first end cap includes provisions for detachably coupling to a first end of the outer shell. The apparatus also includes a second end cap adapted to be secured to a distal end of the outer shell and a plurality of baffles disposed between the first end cap and the second end cap. The plurality of baffles each include a bore section having an inner diameter no smaller than a bore of the muzzle and a baffle section coupled to the bore section. The baffle section extends from the bore section to the outer shell.

The apparatus desirably but not essentially includes a series of openings distributed on the bore section. The series of openings desirably includes a series of openings having at least one dimension that is smaller than a diameter of the one or more projectiles. The series of openings desirably includes a series of openings having a forward edge inclined at an acute angle with respect to a direction in which a projectile passes and having a rear edge inclined at an obtuse angle with respect to the direction.

The bore sections desirably include a forward edge having a first bevel and a rear edge including a second bevel, wherein the first and second bevels are adapted to mate. The forward edges include a third bevel disposed at an interior edge of the bore section. The third bevel is preferably inclined in a direction that is the reverse of the direction of the first bevel.

The baffle sections desirably but not essentially each include a flange disposed on an exterior edge of the baffle section, and the apparatus further includes supports, each support distributed between two adjacent flanges and having an outer surface adapted to fit against an interior surface of the outer shell.

In a second preferred embodiment, the present invention contemplates a suppressed shotgun. The shotgun includes a stock, trigger mechanism and chamber and a first barrel segment disposed forward of the chamber. The first barrel segment is for containing and accelerating shot discharged from the chamber in response to the trigger. The shotgun also includes a second barrel segment disposed forward of the first barrel segment. The second barrel segment includes an outer shell, a plurality of openings distributed along and extending through the second barrel segment and a series of baffles. Each baffle extends from the second barrel segment to the outer shell.

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The suppressed shotgun desirably but not essentially further includes a first sight and a second sight, wherein the first and second sights are aligned with each other and are disposed at opposing ends of the outer shell.

The suppressed shotgun desirably but not essentially further includes a series of openings having a forward edge inclined at an angle in a range of from obtuse to orthogonal angle with respect to a direction in which a projectile passes.

The suppressed shotgun, wherein the series of openings desirably but not essentially further comprise groups of openings, with openings in any one group being disposed radially about the second barrel segment and with successive groups of openings being disposed at different locations along a length of the second barrel segment and the baffles are disposed between the groups of openings.

The first barrel segment desirably but not essentially includes one or more pressure reduction openings and a chamber coupled to the one or more pressure reduction openings.

In a further embodiment, the present invention includes a shotgun shell comprising a cartridge including a cylindrical outer wall extending the length of the shotgun shell and a base including a primer disposed at a first end of the cylindrical outer wall, an amount of powder disposed adjacent the primer and wadding disposed adjacent the amount of powder. The wadding includes a cup. A quantity of shot having a mass is disposed in the cup, wherein the amount of powder and the mass are chosen to provide a muzzle velocity of less than Mach 1.

The shotgun shell desirably but not essentially further comprises a cap contained in the cylindrical outer wall at an end distal with respect to the first end. The cup includes an opening disposed adjacent the distal end and encircles the shot.

In another embodiment, a suppressor consists of a series of baffles that are placed at a distance such that at least two of them will be in contact with a package of shot as it is discharged from a shotgun. The baffles are formed from a material that resists erosion from contact with the shot. In one aspect, the present invention includes steel inserts at the centers of the baffles for the purpose of contacting the shot load as it travels through the suppressor. The body of the suppressor may be formed of a material that is not as dense as steel, in order to preserve the advantages of light weight and maneuverability in operation of the suppressed shotgun.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and further and more specific objects and advantages of the instant invention will become readily apparent to those skilled in the art from the following detailed description of preferred embodiments thereof taken in conjunction with the drawings in which:

FIG. 1 is a simplified, isometric schematic illustration of a first preferred embodiment of a suppressor, in accordance with the teachings of the instant invention;

FIG. 2 is a simplified side view, in section, taken along section lines II—II of FIG. 1, of the first preferred embodiment of the suppressor, in accordance with the teachings of the instant invention;

FIG. 3A is a simplified side view, in section, taken along section lines II—II of FIG. 1, showing details of the first preferred embodiment of the suppressor, in accordance with the teachings of the present invention;

FIG. 3B is a simplified side view, in section, taken along section lines IIIB—IIIB of FIG. 3A, illustrating the pre-

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ferred range of angles of intersection θ of the openings with the walls of the barrel segments, in accordance with the teachings of the instant invention;

FIG. 3C is a simplified side view, in section, taken along section lines II—II of FIG. 1, showing details of a second preferred embodiment of the modified barrel segments and a blast plate for the suppressor, in accordance with the teachings of the present invention;

FIG. 3D is a simplified side view, in section, taken along section lines IIID—IIID of FIG. 3C, illustrating a preferred embodiment of the flanges for mating successive barrel segments to one another, in accordance with the teachings of the instant invention;

FIG. 4 is a simplified schematic illustration of a shotgun, in accordance with the teachings of the instant invention;

FIG. 5 is an enlarged and simplified side view of a shotgun shell, in accordance with the teachings of the instant invention;

FIG. 6 is an enlarged and simplified side view, in section, taken along section lines VI—VI of FIG. 5, of a shotgun shell, in accordance with the teachings of the instant invention;

FIG. 7 is a simplified, isometric schematic illustration of a second preferred embodiment of a suppressor, in accordance with the teachings of the instant invention;

FIG. 8 is a simplified side view, in section, taken along section lines VIII—VIII of FIG. 7, of the second preferred embodiment of the suppressor, in accordance with the teachings of the instant invention;

FIG. 9 is a simplified side view, in section, taken along section lines II—II of FIG. 1, of another embodiment of the suppressor, in accordance with the teachings of the instant invention; and

FIG. 10 is a simplified side view, in section, taken along section lines II—II of FIG. 1, of another embodiment of the suppressor, and FIGS. 11 and 12 are detailed views of portions of the embodiment of FIG. 10, in accordance with the teachings of the instant invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to the drawings, in which like reference characters indicate corresponding elements throughout the several views, attention is first directed to FIG. 1, which illustrates a simplified, isometric view of a first preferred embodiment of a suppressor, generally designated by the reference character 11, intended for use with a shotgun 40 (see FIG. 4, *infra*), in accordance with the teachings of the instant invention.

The suppressor 11 includes an outer shell 13 that is usefully generally tubular and that is preferable fashioned from a durable and lightweight material. While steel provides durability, titanium provides durability coupled with light weight and is preferred. Other materials that could usefully be employed in the construction of the outer shell 13 of the suppressor 11 include carbon fiber or graphite, KEVLAR®, aluminum and the like.

The outer shell 13 includes provisions for securing end pieces 15 and 17 thereto, such as arrangements for threadedly engaging end pieces 15 and 17 to the outer shell 13. The end pieces 15 and 17 include openings such as 19, having a diameter or bore 18 that is large enough to admit and pass projectiles (as indicated by direction arrow 12) of the caliber for which the suppressor 11 is adapted to accommodate.

Alternatively, the front end cap 17 and the rear end cap 15 may be secured together with the remainder of the suppres-

sor 11 by passing bolts through holes in the end caps 15 and 17 and through corresponding holes in the baffles 24. The bolts are desirably equispaced about and outside of the bore area, e.g., three bolts spaced 120° apart. The bolts may be hollow, to reduce mass, and are secured by nuts that thread-
 5 edly engage the bolts and which are tightened until the nuts encounter the outside edges of the end caps 15 or 17. In one embodiment, the bolts are fashioned from one-half inch titanium rod that has been hollowed out to provide a 0.90" wall.

The rear end cap 15 is adapted to be attached to the muzzle end of a weapon, traditionally via internal threads 21 disposed within the bore 18 of the end cap 15 and adapted to accommodate and threadedly engage with external threads (not illustrated) disposed at the muzzle 33 (see FIG. 4) of the weapon 40, although other arrangements are known and used. While shotguns 40 are typically equipped with internal threads for the purpose of mounting a choke, these will only allow a very thin walled section of metal to intrude into the barrel 32.

A more durable and robust mounting arrangement, when desired, is effected via external threads (not illustrated) disposed outside of the muzzle 33 and adapted to mate to internal threads 21 disposed in the end cap 15. While either arrangement may be usefully employed, the illustrations and discussion contained herein are in terms of this thread arrangement, for clarity of illustration and ease of understanding. This might typically comprise a threaded section having 18 to 40 threads per inch disposed therein.

In one embodiment, this coupling was effected by machining the muzzle end 33 of a barrel to provide a one inch long cylindrical section having a uniform outside diameter of about one inch. A piece of 4140 steel was machined to have a length of about one inch, and an inside diameter of about one inch, i.e., to have an inside diameter comparable to the outside diameter of the machined barrel section. The forward portion of the 4140 steel (e.g., the first 0.875 inch) was machined to have an outside diameter of 1.125" and the rear portion was machined to have an outside diameter of about 1.375". Threads were machined onto the portion having an outside diameter of 1.125" and the composite assembly was tungsten-inert-gas or TIG welded to the Cr:Mo barrel material. This provides a robust muzzle 33 reducing stress on the barrel due to the mass of the suppressor 11, which in this prototype weighed about eight pounds. This also reduces probability of fracture of the muzzle 33 during normal use.

As used herein, the term "permanently attached" is used in the same sense as it is used by the Bureau of Alcohol, Tobacco and Firearms ("BATF"). The definition employed by BATF recognizes only three forms of permanent attachment for purposes of tax evaluation: (i) blind pinning (attachment to a barrel by metal pins, the head of each pin being below the surface of the attachment and covered by weld material); (ii) high temperature silver soldering at a temperature of 1100 degrees Fahrenheit or more and (iii) electric welding.

The outer shell 13 has a diameter 20 that is large enough to accommodate both a passage of the same diameter as the bore of the weapon that the suppressor 11 is intended to adapt to and to include expansion chambers distributed along a length of barrel contained therewithin. The outer shell 13 also includes internal threads 29 for threadedly engaging external threads 29' disposed about the periphery of end caps 15 and 17. This effectuates a rugged coupling of the end caps 15 and 17 to the outer shell 13 of the suppressor 11.

The outer shell 13 also usefully includes provisions for allowing sights, such as rear sight 16 and front sight 16', to be mounted thereto. Rear sight 16 and front sight 16' may be sights including tritium sights ("shotgun beads") such as those manufactured by Meprolight of Israil for convenience in operation of the shotgun 40 (see FIG. 4, *infra*) with the suppressor 11 coupled thereto, under conditions of reduced illumination, such as at night.

FIG. 2 is a simplified side view, in section, taken along section lines II—II of FIG. 1, of a portion 23 of the first preferred embodiment of the suppressor 11, in accordance with the teachings of the instant invention. The portion 23 illustrates a series of cone-shaped baffles 27 disposed along the length 12 of the suppressor 11, forming a series of chambers, generally isolated one from the other and coupled to the bore of the suppressor 11 via a collection of small openings 31 disposed in barrel segments 24 coupled to the cone-shaped baffles 27.

In one embodiment of the instant invention, the barrel segments 24 are fashioned from a single piece of material and form a continuous barrel segment 24 extending from a first of the end caps 15 to a second of the end caps 17, as exemplified by the barrel segment 24 shown extending past multiple baffles 27, in the right hand side of FIG. 2. In another embodiment, the barrel segments 24 comprise two or more pieces of material and may be fashioned from different materials. For example, a first barrel segment 24 may include one or more of the funnel-shaped baffles 27 and may be made from a durable material such as steel. A subsequent barrel segment 24 may include one or more of the baffles 27 and may be formed from a lighter weight material such as aluminum. In this way, the initial barrel segment 24 is able to contain the higher pressures encountered at that point in the path 12 of the advancing shot, while the overall weight of the suppressor 11 is reduced over what would have been required had the entire suppressor 11 been manufactured from steel, for example.

In one embodiment of the instant invention, the barrel segments 24 resemble funnel necks coupled to the baffle elements 27. In one preferred embodiment of the instant invention, each of cone-shaped baffles 27 and barrel segments 24 comprise single pieces of material resembling a funnel. In other words, each cone-shaped baffle 27 includes an attached barrel segment 24.

The composite assembly 30 (see FIGS. 3A and 3B, *infra*) is usefully fashioned from a single piece of material, such as Cr:Mo 4140 steel, 303 stainless steel or 316 stainless steel. Aluminum can be used after the first or later baffles because pressures at that point have been significantly reduced. The first or first several baffles 27 and bore segments 24 function as blast plates and are expected to experience higher pressures than subsequent baffles 27 and bore segments 24. It will be appreciated that the baffles 27 may be realized with shapes differing from that depicted, such as discs, reverse funnels etc., as long as the result is a series of chambers, largely decoupled from each other, each of which is coupled to the bore of the suppressor 11 via a series of openings such as openings 31.

In one preferred embodiment of the instant invention, the baffles 27 are equipped with flanges 27" disposed at the outer periphery of the baffles 27. The flanges 27" provide a seat for the optional support pieces 28. The optional support pieces 28 comprise, e.g., cylinders adapted to nest within the outer shell 13, and the support pieces 28 mate with the flanges 27" to provide continuous mechanical support for the baffles 27 along the length 12 of the suppressor 11.

The baffles 27, the optional flanges 27", the optional support pieces 28, the barrel segments 24 and the end caps 15 and 17 collectively cooperate (when present) to maintain alignment of the baffles 27 and the barrel segments 24 coaxially with the bore of the shotgun 40 (see FIG. 4 and associated text). When the optional flanges 27" and the optional support pieces 28 are employed, they desirably form a continuous support structure extending along the entire length of the suppressor between the end caps 15 and 17.

The bore 18 of the suppressor 11 is sized to accommodate the barrel and projectiles suitable to the bore of the shotgun 40 to which the suppressor 11 is intended to be coupled. Bore diameters for different popular gauges of shotgun are summarized below in Table I.

TABLE I

Bore diameters for different shotgun gauges.						
Gauge	10	12	16	20	28	410
Size	.775"	.725"	.665"	.615"	.545"	.410"

In another preferred embodiment the suppressor 11 (FIG. 1) includes barrel segments 24 fashioned from a length of, for example, shotgun barrel 32 (see FIG. 4, *infra*) such that the barrel segments 24 form a continuous piece of material extending largely along the length (as indicated by direction arrow 12) of the suppressor 11. In this embodiment, the baffles 27 are adapted to slip over the modified barrel segments 24 and are usefully contained in spaced relation to each other by the outer shell 13, the flanges 27", the support pieces 28 and the end caps 15 and 17.

FIG. 3A is a simplified side view, in section, taken along section lines II—II of FIG. 1, of a portion 30 of the suppressor 11, showing details of the first preferred embodiment of the suppressor, in accordance with the teachings of the present invention. The portion 30 includes portions 27' of the baffles 27 (see FIG. 2, *supra*) coupled to the barrel segments 24 and shows the openings 31 in more detail.

The openings 31 have a length 31', measured along the length of the bore (as shown by direction arrow 12), and a width 31", measured transverse to the bore (perpendicular to direction arrow 12), adapted to obstruct passage of the shot pellets 63 (see FIG. 6, *infra*) through the openings 31, but also adapted to permit passage of gasses and combustion products through openings 31, reducing muzzle blast from the weapon 40 (see FIG. 4) when it is discharged. The openings 31 cannot admit or pass the shot pellets 63 if either or both of dimensions 31' and 31" are smaller than the diameter of the shot pellets 63.

Prior art suppressors have incorporated large effective openings to the chambers of the suppressor, which leads to debunching of the shot 63, collision of the shot 63 with the baffles 27 and subsequently the outer shell 13 and tends to result in the destruction of the suppressor 11. This is undesirable, particularly if it results in shrapnel that could injure the operator of the weapon or others nearby. Prior art suppressors generally have failed to provide adequate performance in adaptation to shotguns 40, as noted in U.S. Pat. No. 5,479,736, entitled "Augmented Service Pistol And Ammunition Weapons System" and issued to Forrester (see col. 1, lines 55–56).

The openings 31 are optimally either orthogonal to the walls of the barrel segments 24 or are tilted such that the rearward wall 41' (i.e., the wall closest to the stock) forms

an acute angle of intersection θ_1 with the intended path of the projectile (see direction arrow 12) while the forward wall 41 (i.e., the wall closest to the muzzle) forms an obtuse angle of intersection θ_2 with the intended path of the projectile, as illustrated in FIG. 3B. FIG. 3B is a side view, in section, taken along section lines IIIB—IIIB of FIG. 3A, of portion 31' and FIG. 3B illustrates the preferred range of angles of intersection θ of the openings 31 in the barrel segments 24 with the forward wall 41 and the rearward wall 41' of the barrel segments 24.

The preferred range of angles of intersection θ_1 and θ_2 extends from about 90° to about 30° or less. It is generally undesirable to have an acute angle of intersection θ_2 , because then the edges of the openings 31 may tend to cause erosion of the wadding 72, the cup 74 and/or the optional end cap 76 containing and protecting the shot 63 (see FIG. 6, *infra*) as it travels through the barrel segments 24. It will be appreciated that the angles of intersection θ_1 and θ_2 need not be supplementary but that such a relationship may be an artifact of the methods employed to create the openings 31.

Obtuse angles of intersection θ_2 are preferred because they tend to adapt the pressure of the expanding gasses to provide anti-recoil forces. This arises because the pressures provided by the expanding gasses on the forward face 41 are greater than the pressures provided on the rearward face 41', even when the angles of intersection θ_1 and θ_2 are chosen to be 90° (because of the spatial relationship each wall 41, 41' has with the expanding gasses), and this tends to provide forward thrust for the suppressor 11, in opposition to the recoil forces generated by discharge of the weapon to which the suppressor 11 is attached. By providing a series of openings 31 that are distributed over a greater length of the barrel 32 than is the case with prior art recoil compensation devices, a more effective anti-recoil mechanism is provided.

In one preferred embodiment of the instant invention, the barrel segments 24 include chamfered ends 14 and 14' designed to nest together, such that the projecting portion of the chamfered end 14 of a first barrel segment 24 nests within the receptacle portion 14' of the subsequent barrel segment 24. This arrangement is further designed such that the projecting portion of the chamfered end 14 of the first barrel segment 24 is compressed into the receptacle portion of the chamfered end 14' of the second barrel segment 24 when the shot 63 passes through the series of barrel segments 24. It will be appreciated that other arrangements for employing the forces that naturally act on the barrel segments 24 to maintain their alignment may be usefully adapted for use with the instant invention.

For example, a spline fit between portions 14, 14' is but one of the many ways in which the barrel segments 24 may be maintained in spaced relation and in alignment with the bore of the shotgun 40 (see FIG. 4, *infra*). It is strongly desirable to maintain the integrity of the bore throughout the length of the suppressor 11, and the walls of the segments 24 must be of sufficient thickness 25 to preserve the segments 24 in their intended use, despite the presence of the openings 31.

Additionally, a portion of the chamfered end 14 desirably includes a reversed chamfer 14". This is to avoid erosion of the wadding 72, the cup 74 and/or the optional end cap 76 containing and protecting the shot 63 (see FIG. 6, *infra*) as it travels through the barrel segments 24. Desirably, the reverse chamfered region 14" is on the order of a millimeter long.

In a preferred embodiment of the instant invention, the openings 31 are symmetrically disposed in groups of twelve

(i.e., every 30°) about the circumference of the barrel segments 24. In this embodiment, the openings 31 are usefully chosen to have a width 31' of $\frac{5}{32}$ " and a length 31' of 0.5". When this geometry is employed for the openings 31, together with $\frac{1}{8}$ " of relief at either end of the openings 31, the total length of each of the barrel segments 24 is about 0.75".

FIG. 3C is a simplified side view, in section, taken along section lines II—II of FIG. 1, showing details of a second preferred embodiment 30" of the modified barrel segments 24 and a blast plate for the suppressor 11, in accordance with the teachings of the present invention. The modified barrel segments 24 include flanges 14A and 14B disposed at either end and adapted to mate with successive modified barrel segments 24.

Also illustrated in FIGS. 2 and 3C is a different arrangement of openings 31A. The openings 31A usefully comprise holes having a diameter of about one-eighth of an inch and spaced apart by a center-to-center distance of about three-eighths of an inch, although larger or smaller openings 31A and spacings may also be usefully employed.

In one embodiment of the instant invention, the first or the first few barrel segments 24 and baffles 27A are fashioned as shown in FIG. 3C (and FIG. 2) and these are fashioned from steel having a thickness 25 of about 0.125", while subsequent barrel segments and baffles 27 or 27" (e.g., as illustrated in FIG. 3A) are fashioned from aluminum, with these barrel segments incorporating a wall thickness 25 of, for example, 0.190".

FIG. 3D is a simplified side view, in section, taken along section lines IIID—IIID of FIG. 3C, illustrating a preferred embodiment 30A of the flanges 14A and sockets 14B for mating successive barrel segments 24 to one another, in accordance with the teachings of the instant invention. The flanges 14A are adapted to fit snugly into the sockets 14B in response to pressure from the end caps 15 and 17.

A suppressor 11 using these designs and, for example, eleven barrel segments 24 and baffles 27, could have an overall length of about eight to nine inches and a diameter 20 of about two to two and one-half inches or more. Suppressors 11 as described are useful in conjunction with shotguns 40, as described in association with FIG. 4, for suppressing muzzle blast, recoil and/or muzzle jump.

FIG. 4 is a simplified schematic illustration of a shotgun 40 in accordance with the teachings of the instant invention. The shotgun 40 includes an optional buttstock 37, trigger assembly 36, firing assembly 35, rear sight 16, barrel 32 having acceleration portion 34—34', travel portion 34", muzzle 33 and front sight 16'. In operation, the shotgun 40 detonates a shell 50 (see FIG. 5, infra) in the chamber (not illustrated) located within or near firing assembly 35. The shot 63 (see FIG. 6, infra) does not immediately begin to move; rather, the powder 71 (see FIG. 6, infra) burns, producing a large amount of gas within the small volume of the chamber. This results in substantial chamber pressure.

Peak chamber pressures of about 55,000 pounds per square inch are achieved in some rifles, however, peak chamber pressures of about 12,500 pounds per square inch are more common in shotguns. The peak chamber pressure and the bulk of the acceleration of the shot 63 are achieved while the shot 63 is still very close to the chamber, i.e., within the acceleration portion 34—34' of the barrel 32.

Travel portion 34" of the barrel 32 serves to "focus" the shot 63, with weapons that include relatively little travel portion 34" producing wider scatter of the shot 63 at closer distances than shotguns 40 that include relatively longer

travel portions 34". This focus is also affected by chokes that are often coupled to the muzzle 33 of the shotgun 40.

FIGS. 1 through 3 and associated text describe a suppressor 11 that mitigates the effects of muzzle blast. The sound that otherwise results from escape of gasses from the muzzle 33 of a shotgun 40 when it is discharged is substantially reduced in volume when a device such as the suppressor 11 is used in conjunction with the shotgun 40. However, this does not necessarily affect muzzle crack substantially.

By combining a suppressor 11 with a short-barreled shotgun 40, i.e., a shotgun 40 having a barrel 32 with the muzzle placed in the acceleration region (i.e., between 34 and 34'), the openings 24 in the suppressor 11 have opportunity to reduce peak chamber pressure and hence to influence muzzle velocity. This may allow reduction of both muzzle blast and muzzle crack without necessarily requiring modification of the shotgun shell 50 (see FIGS. 5 and 6, infra) that is fired from the shotgun 40. This combination of features provides a weapon 40 that is ideally suited to certain types of police work requiring deadly force at short range together with as little noise as possible.

The muzzle velocity can also be modified by alterations to the shotgun shells 50, 60. This is described in conjunction with FIGS. 5 and 6.

FIG. 5 is an enlarged and simplified side view of a shotgun shell 50, in accordance with the teachings of the instant invention. The shotgun shell 50 includes a metal portion 64, typically fashioned from brass and including a lip 65. The lip 65 facilitates ready ejection of spent shells 50 from the shotgun 40 (see FIG. 4). The shotgun shell 50 also includes an outer casing 61, which is usually made of plastic but that may be made from metal or paper. The outer casing 61 is typically crimped at one end 62 to contain the shot 63 (see FIG. 6) and wadding 72.

FIG. 6 is an enlarged and simplified side view, in section, taken along section lines VI—VI of FIG. 5, of a portion 60 of a shotgun shell 50, in accordance with the teachings of the instant invention. FIG. 6 illustrates a battery cup 66 centrally disposed in the brass 67 of the brass head 64. The battery cup 66 contains the primer and initiates the combustion of the powder 71 disposed between the brass head 64 and the wadding 72 when the shotgun 40 is discharged.

The wadding 72 includes openings 73, which allow for compression of the wadding 72 when the end 62 is crimped. The wadding 72 serves to contain the burning gasses and to seal the barrel opening during discharge of the weapon 40. The wadding 72 also includes a cup 74 filled with shot 63. The shot 63 is manufactured and is readily obtainable in a variety of sizes as summarized below in Table II.

TABLE II

Shot sizes for shotguns.							
Size	9	8	7.5	6	5	4	2 BB
Dia.	.08"	.09"	.095"	.11"	.12"	.13"	.15" .18"
Size	No. 4 buck	No. 3 buck	No. 2 buck	No. 0 buck	No. 00 buck		
Dia.	.24"	.25"	.30"	.32"	.33"		

The dimensions discussed above in conjunction with FIGS. 3A and B for openings 31 are consistent with usage of shot 63 down to at least number two shot. Smaller openings 31 (i.e., having a narrower width 31", see FIG. 3A) are generally consistent with usage of shot 63 comprising pellets having smaller diameters.

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Additionally, the present invention contemplates usage of a cup 76 disposed around the leading edge of the shot 63 and having an opening 77 disposed at the leading edge of the cup. In a preferred embodiment, the opening 77 is centrally located on the cup 76.

In operation, the cup 76 contains the shot 63 during passage through the barrel 32 and the suppressor 11, even when the shot 63 has dimensions smaller than those 31', 31" of the openings 31 (see FIG. 3A). Upon exiting from the end cap 17 of the suppressor 11, the opening 77 is intended to force separation of the cup 76 from the mass of shot 63 by allowing air pressure to be built up within the cup 76 and/or by allowing the shot 63 to pass through the opening 77 in response to air drag on the cup 76.

There are three basic ways to vary the muzzle velocity achieved when a shotgun 40 is discharged. When the mass of the shot 63 is increased, the muzzle velocity drops. When the dram equivalent of the powder 71 is reduced (e.g., by using less powder or a less combustible powder), the muzzle velocity drops. When the chamber pressure is reduced (e.g., by bleeding some of the combustion products from the chamber via an orifice), the muzzle velocity drops.

In order to eliminate muzzle crack, the muzzle velocity must be less than Mach 1, i.e., less than the speed of sound in air or less than about 760 miles per hour (about 1100+ feet per second). Most shotgun shells 50 are intended to provide muzzle velocities of between just over Mach 1 and Mach 2, in the range of 1150 to 1300 or 1400 feet per second, although higher velocities are not uncommon.

Muzzle velocity may be reduced to 1100 feet per second or less by (i) reducing the amount of powder 71 contained in the shell 50, (ii) increasing the mass of shot 63 contained in the shell 50 and/or (iii) bleeding some of the combustion products from the chamber via a small orifice. Methods (i) and (ii) require specially-manufactured shotgun shells 50, 60 while method (iii) requires permanent modification of the shotgun 40.

For example, a shotgun shell 50 prepared with 23 grains of Winchester 540 powder and loaded with one and one-half ounces of No. 4 shot (dia.=0.13") provides a muzzle velocity of about 1050 feet per second (i.e., less than Mach 1) when fired through a shotgun 40 having a barrel 32 of nine inches in length. Shotguns 40 originally manufactured with overall lengths of less than 26.5" or barrel lengths of less than 18" are required to be registered with BATF via procedures that BATF or suitable weapons dealers are familiar with. Barrel lengths of at least eight to nine inches are necessary in order to accommodate pump actions on pump style shotguns 40.

Methods for reducing or ameliorating both muzzle blast and muzzle crack in shotguns deploying shot loads have been described. Muzzle blast is reduced by coupling a series of chambers to the barrel in such a fashion that the shot load cannot escape from the barrel. Muzzle crack is reduced by reducing the muzzle velocity below that of the speed of sound. This is achieved by reducing the effective amount of powder or the peak chamber pressure or by increasing the mass of the shot load.

FIGS. 7 and 8 are directed to a second preferred embodiment of the instant invention. The second preferred embodiment is intended for use with a solid projectile.

FIG. 7 is a schematic illustration of a second preferred embodiment of a suppressor 70, in accordance with the teachings of the instant invention. The second preferred embodiment 70 includes an outer shell 13' (as discussed above with respect to FIGS. 1 and 2) adapted to accommodate end caps 17' and 19' having bores of diameter 18' disposed therein.

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Diameter 18' is intended to allow passage of a projectile as indicated by direction arrow 12. The rear end cap 15' is adapted to be attached to the muzzle end of a weapon, traditionally via threads (e.g., 1/2x20) disposed externally about the end of the muzzle that couple to internal threads 90 (see FIG. 8) disposed within the rear end cap 15', although other arrangements are known and useful.

FIG. 8 is a simplified side view, in section, taken along section lines VIII—VIII of FIG. 7, of a portion 80 of the second preferred embodiment of the suppressor, in accordance with the teachings of the instant invention. FIG. 8 illustrates an end cap 15', a first series of first baffles 86 and chambers 87 and a second series of second baffles 88 and chambers 87 disposed between the end cap 15' and another end cap 17'.

The second baffles 88 usefully comprise funnel-shaped baffle elements 83 and bore elements 84, shaped much like the neck of a funnel, attached thereto. The end caps 15' and 17', the spacers 85, the first 86 and second baffles 88 and the outer shell 13' cooperate to maintain the bore elements 84 in alignment such that a rapidly-moving projectile will pass through the bore elements 84 without colliding with the parts of the suppressor 70.

The bore elements 84, the first baffles 86, the second baffles 88 and the end caps 15' and 17' are kept in spaced relation (by, e.g., spacers 85 disposed between the baffles 86 and/or 88) such that the projectiles, in traveling as indicated by direction arrow 12, will obstruct at least one of the openings (such as those in bore elements 84), preventing forward escape of combustion products through the body of the suppressor 70. This arrangement forces combustion products into the chambers 87, allowing gradual and contained expansion of the gasses that give rise to muzzle blast.

This is accomplished by making spaces between one end of a baffle 86 and/or 88 or end cap 15' and/or 17' of width 81, where width 81 is chosen to be less than the length of the projectile. In this way, the projectile will always occupy and therefore block at least one of the bore elements 84 disposed along the length of the suppressor. The length 82 of the bore elements 84 is usefully chosen to be in the range of from one-eighth of an inch to one half of an inch, for example.

The bore elements 84 desirably also include openings 89. Openings 89 are intended to increase turbulence in the gasses escaping from suppressor 70 after passage of a projectile propelled by those gasses. This turbulence is believed to contribute to further reduce the temperature of the escaping gasses (which tends to reduce their velocity/pressure), thereby reducing muzzle blast. The openings 89 are desirably at least a few millimeters in diameter and may be spaced such that six such openings are provided about the circumference of the bore elements 84.

FIG. 9 is a simplified side view, in section, taken along section lines II—II of FIG. 1, of another embodiment of the suppressor, in accordance with the teachings of the instant invention. The embodiment illustrated in FIG. 9 includes end caps 15 and 17 coupled to an exterior shell 13, however, the baffles 103 and the blast plate 107 differ in design and concept from those of the earlier-described embodiments.

The baffles 103 and the blast plate 107 are fashioned, in one embodiment, from an aluminum outer ring 110 coupled to a steel inner ring 112. The baffles 103 and blast plate 107 are spaced so that two or more of the steel inner rings 112 are in contact with the shot load as it is being deployed, i.e., act as barrel segments. This serves two functions: (i) the shot load prevents burning or burnt propellant gasses from escaping through the suppressor 100 and (ii) the shot load is maintained in line with the openings in the inner rings 112.

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In one embodiment, the inner rings **112** may be constructed to include a first tapered section **114** and a second, non-tapered section **116**. The first, tapered section **114** serves to maintain the shot load in the central portion of the suppressor. The second, non-tapered section **116** serves to support the shot load and to maintain a pressure seal to prevent the burning propellant from escaping around the shot load.

Construction of the baffles **103** to provide large spaces **118** between the baffles allows the burning propellants to be expelled into the cavities or chambers between the baffles **103**. The burning and burnt propellants then exit from these chambers after the shot load has exited from the suppressor **100**, with substantially less report than is normally the case.

It will be appreciated that the functions of the inner and outer rings may be combined in one integral piece of metal, either a light and strong metal (e.g., titanium) where weight is at a premium, or a strong metal, such as steel, where weight is not an issue.

In either case, spaces between the baffles **103** may be filled with a material that allows the heat from the burning or burnt gasses to be dissipated, and that tends to introduce additional barriers to escape of gasses. Examples of such materials can include fiberglass or copper wool. Copper wool is commercially available under the ChoreBoy brand name.

FIG. **10** is a simplified side view, in section, taken along section lines II—II of FIG. **1**, of another embodiment of the suppressor, in accordance with the teachings of the instant invention. The embodiment of FIG. **10** is similar to that of FIG. **9** in some respects, however, an additional cavity **132** is included that is coupled to the bore through a different type of blast plate **134**. The blast plate **134** includes openings **136** that may be slots cut through a neck **138** of the blast plate **134**. In one embodiment, where the end cap **15** is adapted to be secured to the muzzle via threads, the openings **136** may be angled (see FIG. **11**, a sectional view taken along section lines II—II of FIG. **10**, showing eight openings **136**, although more or fewer may be employed) such that escaping propellant will cause pressures on the blast plate **134** that tend to tighten threads **137** coupling the suppressor **130** to the muzzle of the weapon to which the suppressor **130** is attached. The openings **136** may be offset from the centerline in a manner that promotes the swirling of propellant gasses in a common direction, i.e., clockwise or counterclockwise. The openings **136** may also be formed at an angle to the direction of travel **12** of the shot, as shown in FIG. **12**. In one embodiment, the openings are inclined at an angle of 45 degrees from the direction **12** to further promote swirling of propellant gasses. In one embodiment, an end **140** of the blast plate **134** distal from the muzzle forms a closed ring, i.e., the slots **136** do not extend to the end **140**, to provide support for the inner can **142** of FIG. **10**.

In one embodiment, the slots **136** are made to have a width of $\frac{3}{16}$ " and a length of less than one inch. The blast plate **134** may be made to have an outer diameter of 1.49" and an inner diameter of 0.73" to accommodate 12 gauge shot.

The inclusion of a first chamber **132** that is allowed to encompass the remainder of the suppressor is a type of suppressor **130** that is known as a "can in can" suppressor. The initial expansion chamber **132** serves a number of functions. A first function is that it allows the pressure of the burning propellant to be substantially reduced, by providing a large volume into which it can expand. A second is that it provides additional sound insulation between the subsequent baffles **103** and the area outside of the suppressor **130**.

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Experimental use shows that additional cooling of the burning propellant is possible by inclusion of a small amount of water in the suppressor **11**, **100** or **130**. This may be effected by wetting the components prior to assembly.

In the embodiments shown in FIGS. **9** and **10**, the inner ring **114** may be made slightly oversize with respect to the openings in which they are seated in the outer ring **112**. By heating the outer ring on a hot plate to a temperature of, for example, 100 to 300 degrees Centigrade, and cooling the inner ring **114**, the inner ring **114** may be slipped into the opening in the outer ring **112**. The inner ring **114** may be cooled, for example, by immersing the inner ring **114** in an isopropyl alcohol bath that also contains dry ice. A DELRIN plastic rod of the appropriate diameter may be inserted into the opening **116** to handle the inner ring **114** and to insert the inner ring **114** into the outer ring in order to join the two. Typically, the inner ring **114** would be made to be approximately 0.001" to 0.003" larger than the opening into which it is to be seated.

In other embodiments, the inner ring **114** may be secured to the outer ring by any process now known or which is subsequently discovered. For example, the inner ring **114** could be secured to the outer ring **112** by pressing it into the outer ring **112** using great force. Alternatively, the inner ring **114** could be threaded into the outer ring **112**. Outer portions of the threads could be subsequently modified to prevent the inner ring **114** from becoming inadvertently detached. Pins could be employed to secure the inner ring **114** to the outer ring **112**. Other forms of permanent or non-permanent attachment could be employed as well as is known to those of skill in the metalworking arts.

The foregoing detailed description of the instant invention for the purposes of explanation have been particularly directed toward suppression of long guns, such as rifles and shotguns. It will be appreciated that the invention is equally useful for suppressing other types of weapons, including pistols and the like. While Newton's laws do provide that for every action there shall be an equal and opposite reaction, the subject matter of the instant invention shows that the reaction or reactions may be modified to better suit the needs of persons operating weapons through appropriate choice of materials and construction techniques.

It will be appreciated that a system for suppressing muzzle blast and muzzle crack in shotguns, and muzzle blast in rifles, has been described that is readily and easily employed in conjunction with the operation of such weapons. The system may be included as an integral component of the weapon or may be a detachable unit adapted for ready coupling and decoupling to and from the weapon. The system may include modified ammunition in some cases.

It will be appreciated that need for a suppressed shotgun has been described along with methods for meeting that need. A novel suppressor element has been described that finds application in suppressing muzzle blast in a variety of different types of weapons.

Various changes and modifications to the embodiment herein chosen for purposes of illustration will readily occur to those skilled in the art. For example, bore diameters may be chosen as may be desired for a specific application. To the extent that such modifications and variations do not depart from the spirit of the invention, they are intended to be included within the scope thereof which is assessed only by a fair interpretation of the following claims.

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Having fully described the invention in such clear and concise terms as to enable those skilled in the art to understand and practice the same, the invention claimed is:

1. An apparatus for reducing muzzle blast upon discharge of one or more projectiles from a gun, said apparatus comprising:

- an outer shell;
- a first end cap adapted to be secured to a muzzle of the gun and including provisions for coupling to a first end of said outer shell;
- a second end cap adapted to be secured to a distal end of said outer shell; and
- a plurality of baffles disposed between said first end cap and said second end cap, wherein said plurality of baffles each comprise:
 - a bore section having an inner diameter no smaller than a bore of said muzzle; and
 - a baffle section coupled to said bore section, said baffle section extending from said bore section to said outer shell, wherein said bore sections include a forward edge having a bevel for maintaining alignment of a projectile and a rear edge without a bevel, wherein said bore sections are spaced such that a projectile will be in contact with at least two bore sections after the projectile completely enters the suppressor and before any portion of the projectile exits the suppressor.

2. An apparatus as claimed in claim 1, wherein said bore sections are formed from a first material and said baffle sections are formed from a second material.

3. An apparatus as claimed in claim 1, further comprising:

- a first sight; and
- a second sight, wherein said first and second sights are aligned with each other and are disposed at opposing ends of said outer shell.

4. An apparatus as claimed in claim 1, wherein said bore sections of said baffles collectively comprise a single piece of material.

5. An apparatus as claimed in claim 1, wherein said first end cap is configured to be permanently attached to the muzzle of the gun.

6. An apparatus as claimed in claim 1, wherein said first end cap is adapted to detach and reattach to a muzzle of the gun.

7. An apparatus for reducing muzzle blast upon discharge of one or more projectiles from a gun, said apparatus comprising:

- an outer shell;
- a first end cap adapted to be secured to a muzzle of the gun and including provisions for coupling to a first end of said outer shell;
- a second end cap adapted to be secured to a distal end of said outer shell; and
- a plurality of baffles disposed between said first end cap and said second end cap, wherein said plurality of baffles each comprise:
 - a bore section having an inner diameter no smaller than a bore of said muzzle; and
 - a baffle section coupled to said bore section, said baffle section extending from said bore section to said outer shell,

said baffle sections are formed from aluminum and said bore sections are formed from steel.

8. A suppressed shotgun comprising:

- a stock, trigger mechanism and chamber;

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a barrel disposed forward of said chamber, said barrel for containing and accelerating shot discharged from said chamber in response to said trigger; and

a suppressor disposed forward of said barrel, wherein said suppressor includes:

- a shell;
- a plurality of barrel segments having openings formed between them; and
- a series of baffles, each said baffle extending from a respective one of said plurality of barrel segments to said shell, wherein said plurality of barrel segments are formed from steel and said baffles are formed from aluminum.

9. A suppressed shotgun as claimed in claim 8, further comprising:

- a first sight; and
- a second sight, wherein said first and second sights are aligned with each other and are disposed at opposing ends of said outer shell.

10. A suppressed shotgun as claimed in claim 8, wherein said openings comprise spaces between said barrel segments.

11. A suppressor comprising:

- a plurality of baffles each comprising an outer ring coupled to an inner ring along an outer diameter of the inner ring, the plurality of baffles disposed in a spaced-apart arrangement, the inner rings each including an inner opening;
- a first tubular shell having an interior surface and an interior diameter, each of the outer rings having an outside diameter comparable to the interior diameter and coupled to a respective portion of the interior surface;
- a proximal end cap coupled to a proximal of the first tubular shell adapted to be coupled to a barrel of a weapon via a first central opening in the proximal end cap; and
- a distal end cap coupled to an end of the first tubular shell distal from the proximal end and having a second central opening aligned with the first central opening and with each of the inner rings, further including a blast plate disposed between the plurality of baffles and the proximal end cap, the blast plate comprising:

- an exterior ring; and
- an interior ring including a first opening, the interior ring coupled to a second opening formed in an interior of the exterior ring, wherein each of the inner openings are coaxially aligned with said first opening in the blast plate, wherein each of the inner rings and the interior ring each include:

a first tapered section tapering from a first interior diameter larger than a bore diameter to an interior diameter having substantially the bore diameter; and

a second non-tapered section having substantially the bore diameter, the second sections of all of the inner rings and the interior ring being coaxially aligned along a longitudinal axis of a bore, each of the baffles and the blast plate being spaced apart from each other so that two or more of the inner rings or at least one of the inner rings and the interior ring are in contact with a shot load when the shot load is being deployed along the longitudinal axis of the bore, wherein the outer rings are formed from aluminum and wherein the inner rings and the interior ring are formed of steel, the first, tapered section maintaining the shot load in a central

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portion of the suppressor and the second, non-tapered section serving to substantially prevent burning propellant from escaping around the shot load.

12. The suppressor of claim 11, wherein each of the inner rings includes:

a first tapered section tapering from a first interior diameter larger than a bore diameter to an interior diameter having substantially the bore diameter; and

a second non-tapered section having an interior diameter substantially equal to the bore diameter, the second sections of all of the inner rings and the interior ring being coaxially aligned along a longitudinal axis of a bore, each of the baffles being spaced apart from each other so that two or more of the inner rings are in contact with a shot load when the shot load is being deployed within the suppressor along the longitudinal axis of the bore.

13. The suppressor of claim 12, further comprising a permanent attachment securing an external surface of the first central opening to a barrel of the weapon with the first central opening aligned with the bore of the barrel to integrally suppress the weapon.

14. A suppressed shotgun comprising:

a stock, trigger mechanism and chamber;

a barrel having a first end coupled to the chamber, the barrel for containing and accelerating shot discharged from the chamber in response to operation of the trigger; and

a suppressor coupled to an end of the barrel distal from the first end, the suppressor comprising:

a first tubular shell having an interior surface and an interior diameter;

a proximal end cap coupled to a proximal end of the first tubular shell adapted to be coupled to the barrel of the shotgun via a first central opening in the proximal end cap;

a plurality of baffles each comprising an outer ring coupled to an inner ring along an outer diameter of the inner ring, each of the outer rings having an outside diameter comparable to the interior diameter and coupled to a respective portion of the interior surface, the plurality of baffles disposed within the first tubular shell in a spaced-apart arrangement, each of the inner rings being coaxially aligned with each other; and

a distal end cap coupled to an end of the first tubular shell distal from the proximal end and having a second central opening aligned with the first central opening,

wherein each of the inner rings includes:

a first tapered section tapering from a first interior diameter larger than a bore diameter of the shotgun to an interior diameter having substantially the bore diameter; and

a second non-tapered section having an interior diameter substantially equal to the bore diameter, the second sections of all of the inner rings and the interior ring being coaxially aligned along a longitudinal axis of a bore, each of the baffles and the blast plate being spaced apart from each other so that two or more of the inner rings or at least one of the inner rings and the interior ring are in contact with a shot load when the shot load is being deployed along the longitudinal axis of the bore, wherein the outer rings are formed from aluminum and wherein the inner rings are formed of steel, the first, tapered section

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maintaining the shot load in a central portion of the suppressor and the second, non-tapered section serving to support the shot load and to maintain a pressure seal to substantially prevent burning propellant from escaping around the shot load.

15. The suppressed shotgun of claim 14, further including a blast plate comprising:

an exterior ring; and

an interior ring coupled to a second opening formed in an interior of the exterior ring, the interior ring including the first opening.

16. The suppressed shotgun of claim 14, further comprising a permanent attachment securing an external surface of the first central opening to the barrel of the shotgun with the first central opening aligned with the bore of the barrel to integrally suppress the shotgun.

17. A suppressed shotgun comprising:

a stock, trigger mechanism and chamber;

a barrel having a first end coupled to the chamber, the barrel for containing and accelerating shot discharged from the chamber in response to operation of the trigger; and

a suppressor coupled to an end of the barrel distal from the first end, the suppressor comprising:

a first tubular shell having an interior surface and an interior diameter;

a proximal end cap coupled to a proximal end of the first tubular shell adapted to be coupled to the barrel of the shotgun via a first central opening in the proximal end cap;

a plurality of baffles each comprising an outer ring coupled to an inner ring along an outer diameter of the inner ring, each of the outer rings having an outside diameter comparable to the interior diameter and coupled to a respective portion of the interior surface, the plurality of baffles disposed within the first tubular shell in a spaced-apart arrangement, each of the inner rings being coaxially aligned with each other; and

a distal end cap coupled to an end of the first tubular shell distal from the proximal end and having a second central opening aligned with the first central opening, further including a blast plate comprising:

an exterior ring; and

an interior ring coupled to a second opening formed in an interior of the exterior ring, the interior ring including the first opening, wherein each of the inner rings and the interior ring each include:

a first tapered section tapering from a first interior diameter larger than a bore diameter of the shotgun to an interior diameter having substantially the bore diameter; and

a second non-tapered section having substantially the bore diameter, the second sections of all of the inner rings and the interior ring being coaxially aligned along a longitudinal axis of a bore, each of the baffles and the blast plate being spaced apart from each other so that two or more of the inner rings or at least one of the inner rings and the interior ring are in contact with a shot load when the shot load is being deployed along the longitudinal axis of the bore, wherein the inner rings and the interior ring are formed of steel, the first, tapered section maintaining the shot load in a central portion of the suppressor and the second, non-tapered section serving to support the shot load and to maintain a pressure seal to substantially prevent burning propellant from escaping around the shot load.

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18. A suppressor for a weapon, the suppressor comprising:
a plurality of baffles disposed in a spaced-apart arrangement and each comprising a disc including an opening, each opening including:
a first tapered section tapering from a first interior diameter larger than a bore diameter of the weapon to an interior diameter having substantially the bore diameter; and
a second non-tapered section having substantially the bore diameter, the second non-tapered sections of each of the baffles being coaxially aligned along a longitudinal axis of a bore;
a first tubular shell having an interior surface and an interior diameter, each of the baffles having an outside

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diameter comparable to the interior diameter and coupled to a respective portion of the interior surface;
a proximal end cap coupled to a proximal end of the first tubular shell adapted to be coupled to a barrel of a weapon via a first central opening in the proximal end cap; and
a distal end cap coupled to an end of the first tubular shell distal from the proximal end and having a second central opening aligned with the first central opening and with each of the second sections, wherein the baffles comprise titanium.

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