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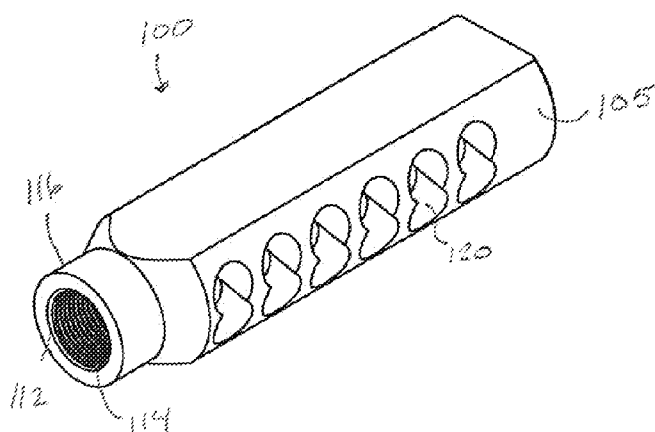


FIG. 1

(57) Abstract: A muzzle brake for a firearm includes ports bored or otherwise formed into side surfaces of the muzzle brake. The ports may be formed such that a central axis of each port may be present at an angle that is rearward of perpendicular to the through bore. In this manner, the exhaust opening of each port at the muzzle brake side surface is rearward of the intake opening that connects with the through bore. The ports are located in horizontally and symmetrically opposed pairs, one port in each pair extending through a sidewall on opposite sides of a vertical central plane of the muzzle brake. Each port may comprise two parallel bores. A centerline of each boar is tangent to the diameter of the through bore. The bottom of each port bore has a spheroid termination into the through bore and incidental intersection with adjacent ports results acute angles at each edge leading away from the through bore and into the ports.



MUZZLE BRAKE FOR FIREARM

FIELD OF THE INVENTION

[0001] The present invention relates to a muzzle brake for a firearm.

BACKGROUND OF THE INVENTION

[0002] When a firearm is fired, a jet of gas escapes from a firearm's muzzle after the bullet's "uncorking" event. This jet of gas is responsible for the large majority of the firearm's recoil force. For example, in the case of an AR-15 rifle, the gas jet can amount to >90% of the recoil force born by the shooter. Other factors that contribute to or otherwise affect recoil force include: firearm mass, bullet mass and velocity (energy), barrel length (time under pressure), and cartridge chambering (gun powder volume). A firearm, such as an AR-15 rifle chambered for 5.56 NATO or .223 Remington cartridges (or similar), can benefit greatly from a properly designed muzzle device that acts to attenuate the recoil force caused by the gas jet.

[0003] Prior muzzle brakes have recognized that such brakes may perform one of three functions performed by a brake. The first is flow. The brake can direct propellant gas to escape along a prescribed path. The second is foul. The device can simply catch or retard propellant gas or can serve to make the gas's escape or direction more inefficient. Third is scavenging. The brake serves to divert gas in any direction other than the bullet's direct linear path. Such brakes scavenging brakes use the bullet itself as an obstruction at each of a number of baffles formed in the brake.

[0004] Prior brakes may perform only one of these functions or may not effectively perform any of the functions. Accordingly, there is a need for a muzzle brake that effectively exploits all three functions of a muzzle brake.

BRIEF DESCRIPTION OF THE FIGURES

[0005] Advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings.

[0006] FIG. 1 is a perspective view of a muzzle brake in accordance with the embodiments of present invention showing the rear, top and right sides of the muzzle brake.

[0007] FIG. 2 is a perspective view of a muzzle brake in accordance with FIG. 1 showing the front, top and right sides of the muzzle brake.

[0008] FIG. 3 is a view the top of a muzzle brake in accordance with FIG. 1.

[0009] FIG. 4 is a view the rear of a muzzle brake in accordance with FIG. 1.

[0010] FIG. 5 is a view the side of a muzzle brake in accordance with FIG. 1.

[0011] FIG. 6 is a view the front of a muzzle brake in accordance with FIG. 1.

[0012] FIG. 7 is a view the side of a muzzle brake in accordance with embodiments of the invention.

[0013] FIG. 8 is a cross-sectional view along the line A-A as shown in FIG. 7.

[0014] FIG. 9 is a cross-sectional view along the line B-B as shown in FIG. 7.

[0015] FIG. 10 is a view the side of a muzzle brake in accordance with embodiments of the invention.

[0016] FIG. 11 is a cross-sectional view along the line C-C as shown in FIG. 10.

[0017] FIG. 12 is a cross-sectional view of the detail D as shown in FIG. 11.

[0018] FIG. 13 is a view the top of a muzzle brake in accordance with embodiments of the invention.

[0019] FIG. 14 is a perspective view as seen from the perspective line F-F as shown in FIG. 13.

[0020] FIG. 15 is a perspective view of the detail G as shown in FIG. 14.

[0021] FIG. 16 is a view the side of a muzzle brake in accordance with embodiments of the invention.

[0022] FIG. 17 is a cross-sectional view along the line H-H as shown in FIG. 16.

[0023] FIG. 18 is a perspective view of a muzzle brake in accordance with FIG. 16 showing the front, top and right sides of the muzzle brake.

DETAILED DESCRIPTION

[0024] Throughout this application, the directional references, such as forward, rearward, left, right, bottom and top, will be used. These and other such references are relative to the firing direction of the firearm, which fires in a forward direction. Such references are used for ease in describing the present invention and should not be construed as limiting the scope of the invention. As used in the description herein and throughout the claims, the following terms take the meanings explicitly associated herein, unless the context clearly dictates otherwise: the meaning of "a," "an," and "the" includes plural reference, the meaning of "in" includes "in" and "on." Also, reference designators shown herein in parenthesis indicate components shown in a figure other than the one being discussed.

[0025] The description of embodiments of the present invention set forth herein uses the term "bore" to refer to holes, chambers, cavities or the like formed in a solid body. Such bores

may be formed by a boring action, such as drilling, but they are not limited to being formed in any specific manner and may be formed by any other appropriate process as would be understood by one of ordinary skill in the art.

[0026] Embodiments of the present invention allow the propellant gasses to expand within an interior volume of the muzzle brake before escaping and being harnessed and directed to act on the surrounding atmosphere. Embodiments of the present invention may be designed to exploit all three functions of a muzzle brake. For example, the port and chamber geometry may allow for efficient flow of escaping gas, and present sufficient surface area as a blast baffle at each chamber to fowl escaping high-pressure gasses. Given the overall length and number of chambers arrayed in the brake design, the bullet may spend sufficient time within the brake structure for the brake to effectively scavenge residual energy from acting directly against the bullet. In addition, embodiments of the present invention may include geometry that is keyed to and unique to each caliber of ammunition.

[0027] As illustrated in FIGS. 1-6, embodiments of the present invention include a muzzle brake 100. The muzzle brake comprises a forward end 102 and a rearward end 104. The muzzle brake has a generally cylindrical surface extending along a central axis parallel and coaxially with a central axis of the barrel bore of the firearm with which the muzzle brake is used. The muzzle brake 100 outer surface 105 may include flattened upper 106 and lower 108 surfaces that separate curved side surfaces 105.

[0028] A central through bore 110 extends through the muzzle brake 100 along the central axis of the brake. The inside diameter of the through bore 110 may be from 0.030 to 0.060 inches larger than the outside diameter of the bullet being used by the firearm. More preferably, the inside diameter of the through bore 110 is from 0.015 to 0.030 inches larger than

the outside diameter of the bullet being used by the firearm. The diameter of the through bore is separated from an outside surface 105 of the muzzle brake by a sidewall 126.

[0029] The rearward end of the muzzle brake may comprise a mounting bore 112 extending into the body of the brake that is aligned with but larger than the through bore 110. The inside diameter of the mounting bore 112 may include threads 114 for engaging with threads formed on an outside diameter of a firearm barrel or muzzle to securely attach the muzzle brake to the firearm.

[0030] The rearward end 104 of the muzzle brake may also include a rear section 116 with an outer surface having a smaller diameter than the cylindrical outer side surfaces 105 of the remainder of the brake. A chamfered section 118 may transition between the rear section 116 and the remainder of the brake outer side surfaces 105. The diameter of the rear section 116 may be tangent with the upper 106 and lower 108 flattened surfaces so that when viewed from the side, the muzzle brake has continuous upper and lower profiles, as shown, for example, in FIG. 5.

[0031] As illustrated in FIGS. 7-14, ports 120 may be bored or otherwise formed into side surfaces 105 of the muzzle brake 100. The ports may be formed such that a central axis of each port may be present at an angle that is rearward of perpendicular to the through bore 110. In this manner, the exhaust opening 122 of each port at the muzzle brake side surface 105 is rearward of the intake opening 124 that connects with the through bore 110. In preferred embodiments, the angle is between 10 and 25 degrees rearward of perpendicular relative to the through bore. Though one of ordinary skill in the art would recognize that other angles could be used based upon various factors, including the type of firearm and ammunition being used.

[0032] Referring particularly to FIGS. 9, the ports 120 are located in horizontally and symmetrically opposed pairs, one port in each pair extending through a sidewall (126) on opposite sides of a vertical central plane 128 of the muzzle brake. Each port may comprise two parallel bores 130a, 130b. In embodiments of the muzzle brake, the parallel port bores 130a, 130b are formed symmetrically on opposite sides of a horizontal central plane 129 of the muzzle brake.

[0033] A centerline 132a, 132b of each boar is tangent to the diameter 111 of the through bore 110. The resultant 4-bore pattern may be repeated multiple times along the length of the brake body. In preferred embodiments, the 4-bore pattern is repeated between three and six times. FIGS. 7-8, for example, show the 4-bore pattern repeated six times.

[0034] The ports 120, each including two bores 130a, 130b, are formed such that their termination extends beyond the central plane 128 so that the bottom or terminal surfaces 134 of the ports will intersect. Preferably, the ports 120 extend between 0.000 inches and 0.020 inches past the central plane 128.

[0035] As shown, for example, in FIGS. 9 and 15, the diameter of the port bores 130a, 130b is larger than the distance between the central axes 132a, 132b of each bore. Accordingly, the port bores will intersect at the horizontal central plane 129 of the brake to form “figure 8” cavity 136 (FIG. 15).

[0036] The diameter of bores 130a, 130b of the ports 120 may be greater than the diameter of the through bore 110. In preferred embodiments, the diameter of the port bores is between 0.040 and 0.100 inches larger than the diameter of the through bore 110. For example .204-.260 caliber ammunition may use a bore diameter of $5/16^{\text{th}}$ of an inch, and .270-.338 caliber ammunition may use a bore diameter use a $3/8^{\text{th}}$ of an inch.

[0037] As can be seen, for example, in FIG. 12, the bottom of each port bore has a spherical surface 140. This spheroid termination 140 into the through bore 110 and incidental intersection with adjacent ports results in a chamber that allows for a 360 degree (radially symmetrical) “blow” of propellant gas. As this gas escapes, it encounters a positive “knife edge” or acute angles leading away in all directions from the through bore and into the ports 120. Such edges or acute angles are formed, for example, at the intersection 142 of port pairs formed on opposite sides of the muzzle brake (FIG. 11), at the intersection 144 between adjacent bores 130a, 130b in the same port (FIG. 15), at the intersection 146 between a port 120 and the through bore 110 (FIG. 8) and at the intersection 148 between the surface of the through bore 110 and the spherical ends 140 of two opposing ports 120 (FIG. 8).

[0038] The contour of the chambers formed by ports 120 is such that the escaping gas will flow away from the through bore 110 readily and efficiently. Also, the contour allows the escaping gas to accelerate before it escapes from the interior of the muzzle brake through the ports. The accelerated gas may act on the surrounding atmosphere and create rearward thrust that tends to propel the firearm forward in opposition to and thereby mitigating recoil forces.

[0039] FIGS. 7-15 are intended to show the geometry of embodiments of the present invention that is created by the intersection of ports 120 with through bore 110. In particular, FIG. 8 shows a cross-sectional view along the vertical central plane (128) of the muzzle brake 100. FIGS. 11 and 12 show a cross-sectional view along a vertical plain (illustrated by line C-C in FIG. 10) that is parallel to, but offset from, the vertical central plane (128). The plane of the cross-sectional view shown in FIGS. 11 and 12 extends parallel to the intersection between ports 120 and a surface of the through bore 110. FIGS. 14 and 15 show a perspective view parallel to the centerline (132a, 132b) of the bores 130a, 130b that form ports 120. Accordingly, FIGS. 14-

15 present a view directly into ports 120 but at an angle that is rearward of perpendicular to the through bore 110 as described above. Upon examination of the drawings, one of ordinary skill in the art will recognize additional features of the internal geometry of the muzzle brake.

[0040] As illustrated by FIGS. 16-18, embodiments of the present invention may comprise a scavenging tube 150. The scavenging tube comprises an extension of the through bore 110 beyond a forward end of the ports 120. The scavenging tube 150 may serve to increase the effectiveness of an array of ports 120 positioned nearer to or adjacent the muzzle of the firearm. The operational pressure and thus resultant effect of the nearer ports is highest. Accordingly, the extended tube of the scavenging tube serves to maintain positive pressure behind the bullet, and maintain a dwell time under pressure at the ports. This structure and its effect have been observed to enhance the brake's function. The scavenging tube may also reduce the amount of energy that is allowed to follow the bullet on its path of travel. Such energy retained behind the bullet, and in the same direction, would contribute to the recoil impulse of the rifle.

[0041] In the illustrative embodiments, ports 120 comprise two overlapping cylindrical bores 130a, 130b as described above. One of ordinary skill will recognize that various numbers of ports may be used and that more or fewer bores may be used within each port. It should also be recognized that other bore shapes may be used.

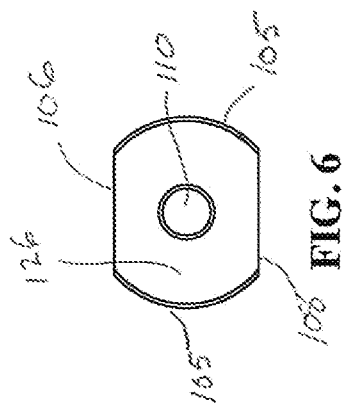
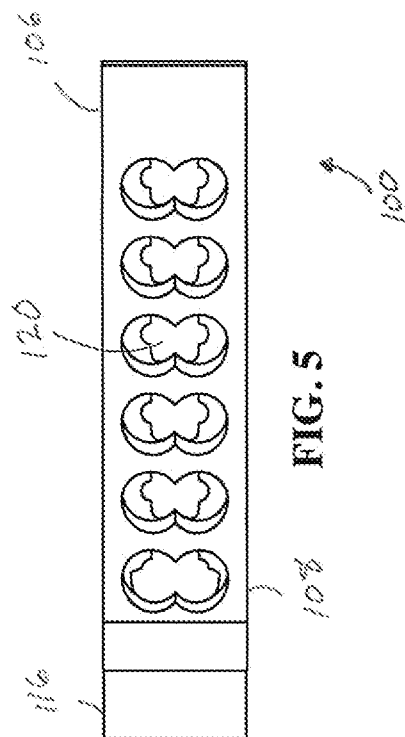
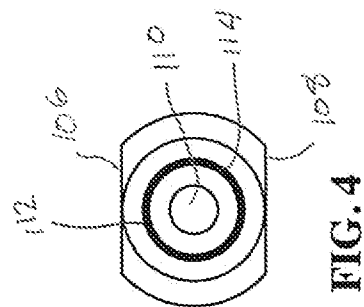
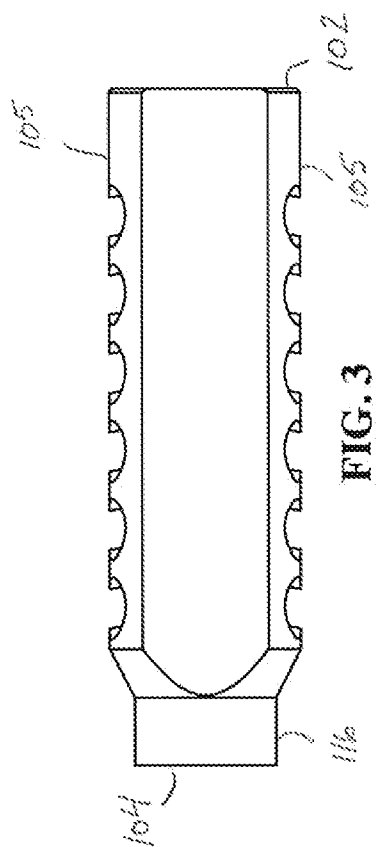
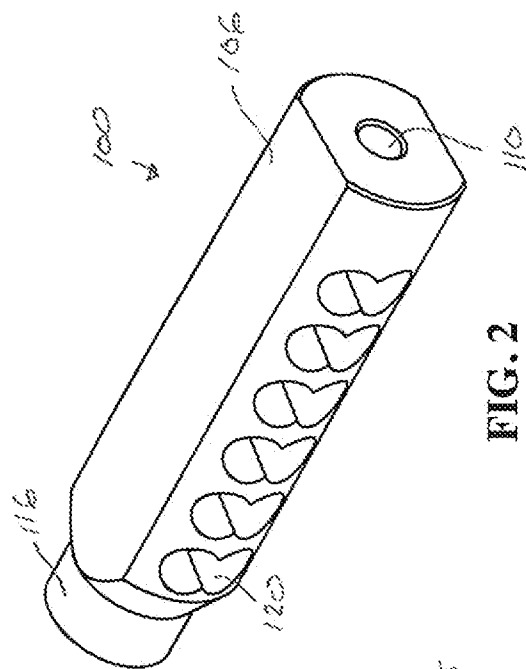
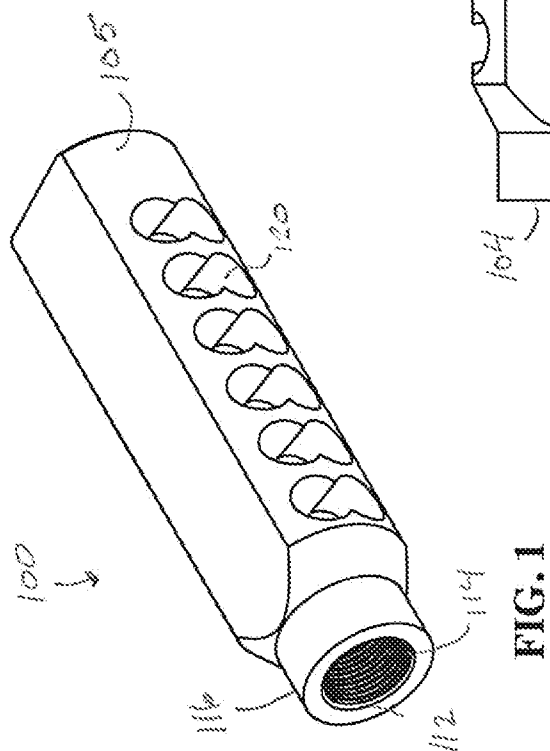
We claim:

1. A muzzle brake for a firearm comprising:
a rearward end that attaches to the barrel of a firearm;
a forward end;
a through bore that extends from the rearward end to the forward end along an axis of the muzzle brake;
an outer surface comprising a first side surface and a second side surface;
a first port extending from an exhaust opening at the first side surface to an intake opening at the through bore, wherein a central axis of the first port is formed at an angle that is rearward of perpendicular to an axis of the through bore such that the exhaust opening is rearward of the intake opening.
2. The muzzle brake of claim 1 wherein the angle is between 10 and 25 degrees rearward of perpendicular to the axis of the through bore.
3. The muzzle brake of claim 1 wherein an intersection between a sidewall of the first port and a sidewall of the through bore form an acute angle.
4. The muzzle brake of claim 1 wherein a diameter of the first port is greater than a diameter of the through bore.
5. The muzzle brake of claim 1 further comprising a second port, the second port comprising a central axis extending parallel to the central axis of the first port.
6. The muzzle brake of claim 5 wherein a diameter of the first and second ports is larger than the distance between the central axes the ports such that the ports intersect.
7. The muzzle brake of claim 6 wherein the central axis of the first port is tangent to a diameter of the through bore on a first side and the central axis of the second port is tangent to a diameter of the through bore on a second side.

8. The muzzle brake of claim 5 further comprising a third port extending from an exhaust opening at the second side surface to an intake opening at the through bore.
9. The muzzle brake of claim 5 further comprising a fourth port extending through the second side surface, wherein the first and second ports form a first port pair extending through the first side surface and the third and fourth ports form a second port pair extending through the second side surface.
10. The muzzle brake of claim 9 wherein the first port pair and second port pair are horizontally opposed.
11. The muzzle brake of claim 5 wherein a termination of the first port extends beyond the axis of the through bore and a termination of the third port extends beyond the axis of the through bore such that a terminal surface of the first port intersects with a terminal surface of the third port.
12. The muzzle brake of claim 11 wherein at least a portion of the first port terminal surface comprises a spherical shape.
13. The muzzle brake of claim 12 wherein a sidewall of the first port intersects with a sidewall of the second port forming an acute angle between the inside surface of the first port and an inside surface of the second port.
14. The muzzle brake of claim 13 wherein at least a portion of the third port terminal surface comprises a spherical shape such that the first port and the third port intersect forming an acute angle between an inside surface of the first port terminal surface and an inside surface of the third port terminal surface.
15. The muzzle brake of claim 1 wherein at least a portion of the outer surface comprises a

cylindrically shaped surface.

16. The buffer assembly of claim 15 wherein the cylindrically shaped portion of the outer surface comprises a first section having a first diameter and a second section having a second diameter that is smaller than the first diameter.
17. A muzzle brake for a firearm comprising:
 - a rearward end that attaches to the barrel of a firearm;
 - a forward end;
 - a through bore that extends from the rearward end to the forward end along an axis of the muzzle brake;
 - an outer surface comprising a first side surface and a second side surface;
 - a first port comprising a central axis and extending from an exhaust opening at the first side surface to an intake opening at the through bore;
 - a second port comprising a central axis that extends parallel to the central axis of the first portwherein a diameter of the first and second ports is larger than the distance between the central axes the ports such that the ports intersect.
18. The muzzle brake of claim 17 wherein the central axis of the first port is formed at an angle that is rearward of perpendicular to an axis of the through bore such that the exhaust opening is rearward of the intake opening.
19. The muzzle brake of claim 17 wherein the first and second side surfaces are lateral side surfaces and the outer surface further comprises a top surface and a bottom surface.
20. The muzzle brake of claim 19 wherein the first and second side surfaces comprise substantially cylindrically shaped surfaces and the top and bottom surfaces comprise substantially planar surfaces.



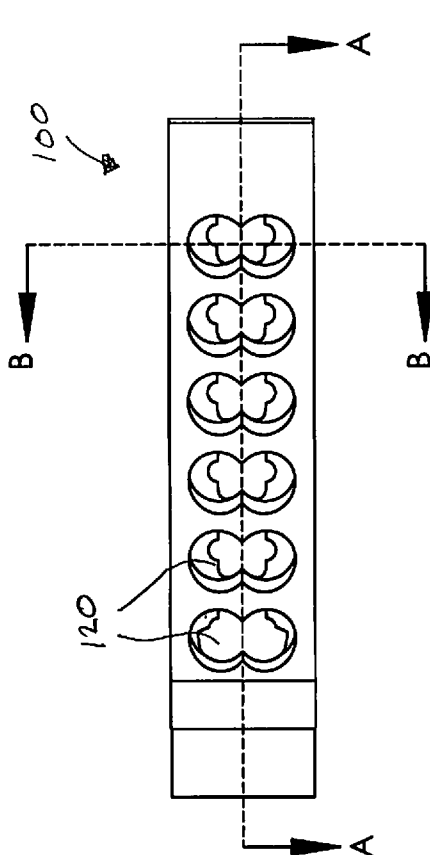


FIG. 7

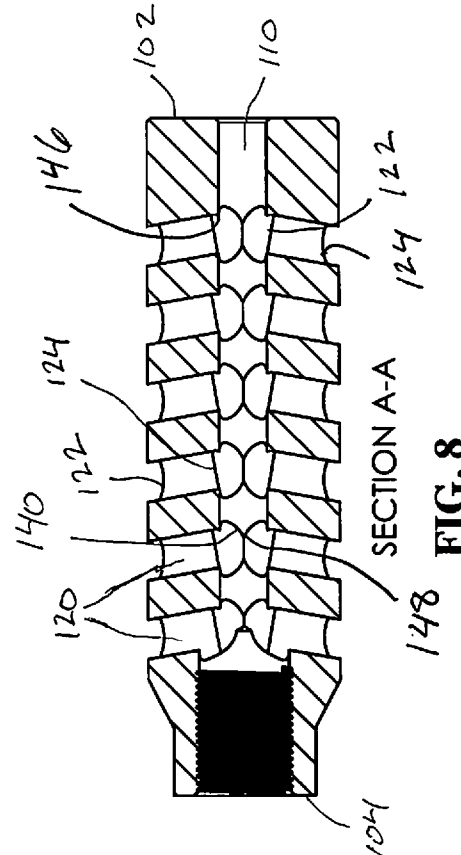


FIG. 8

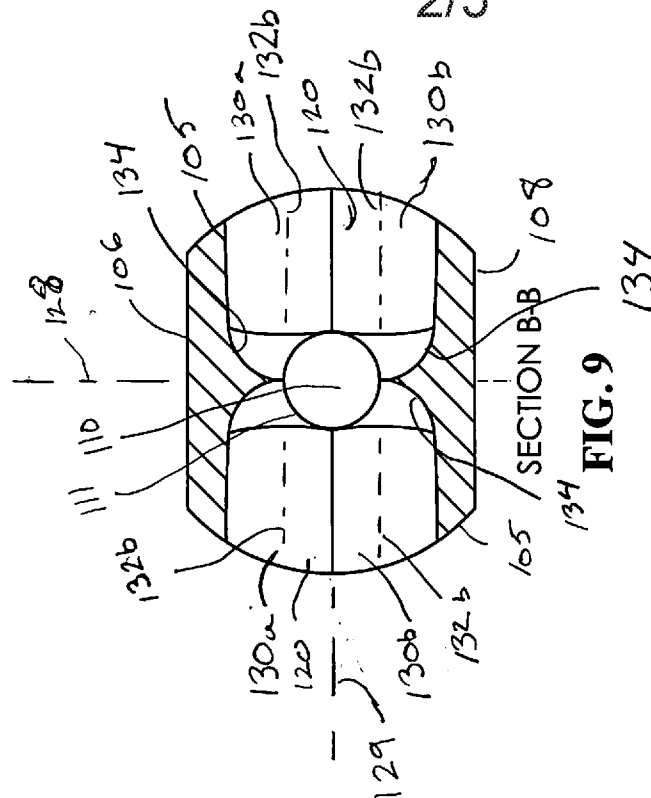


FIG. 9

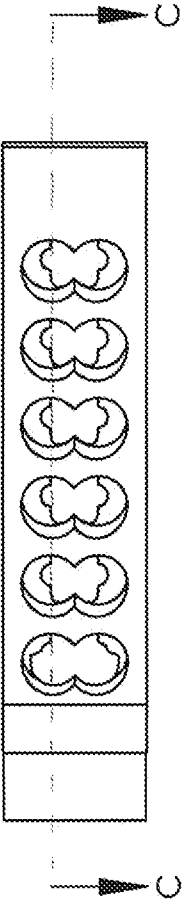
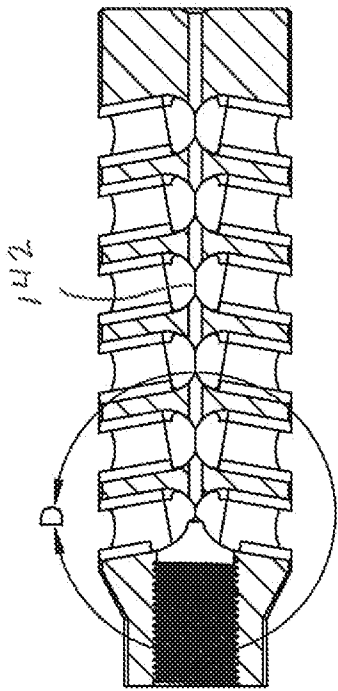
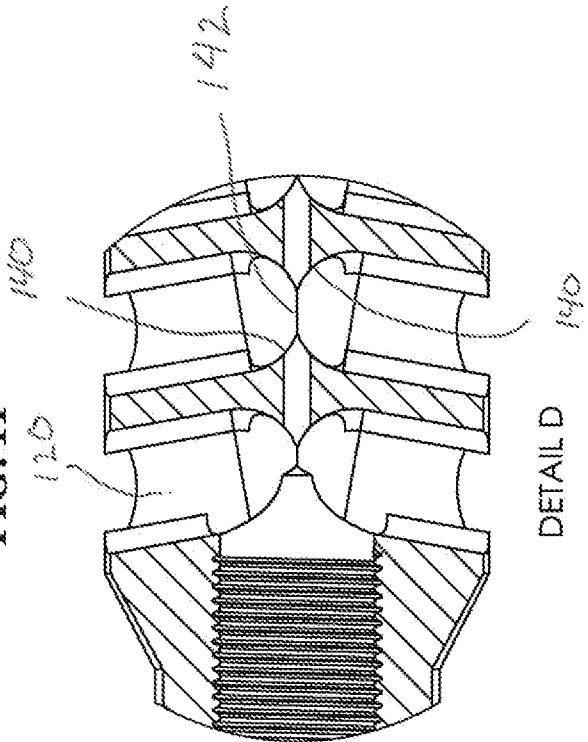


FIG. 10



SECTION C-C

FIG. 11



DETAIL D

FIG. 12

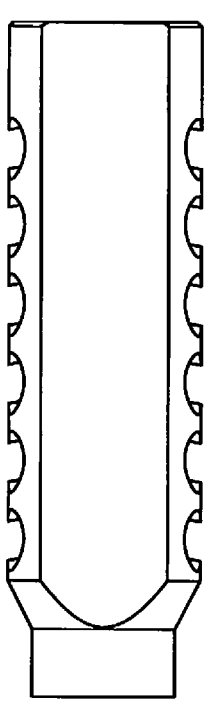
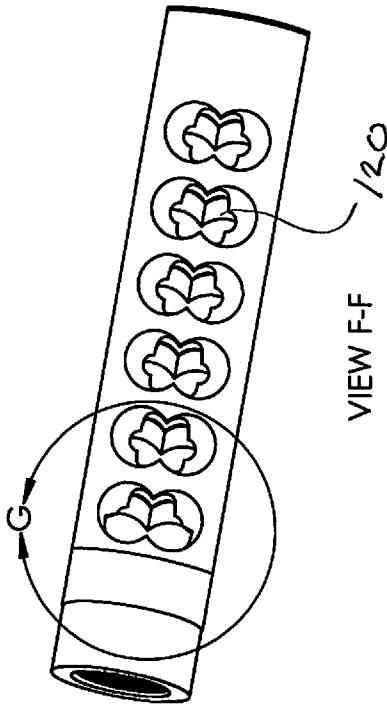
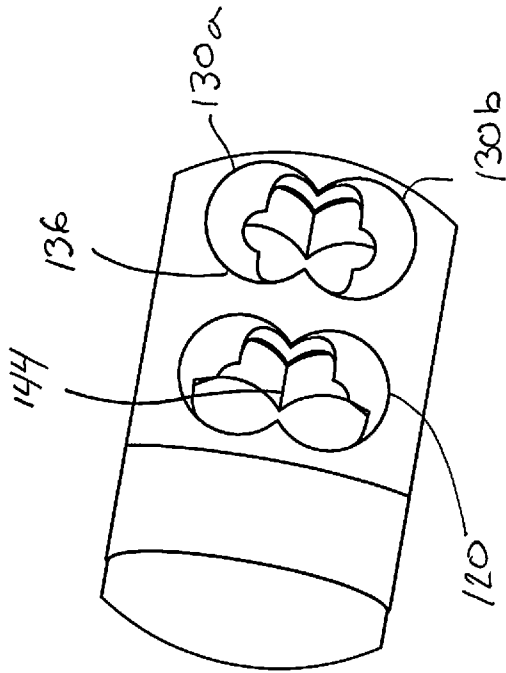


FIG. 13



VIEW F-F

FIG. 14



DETAIL G

FIG. 15

