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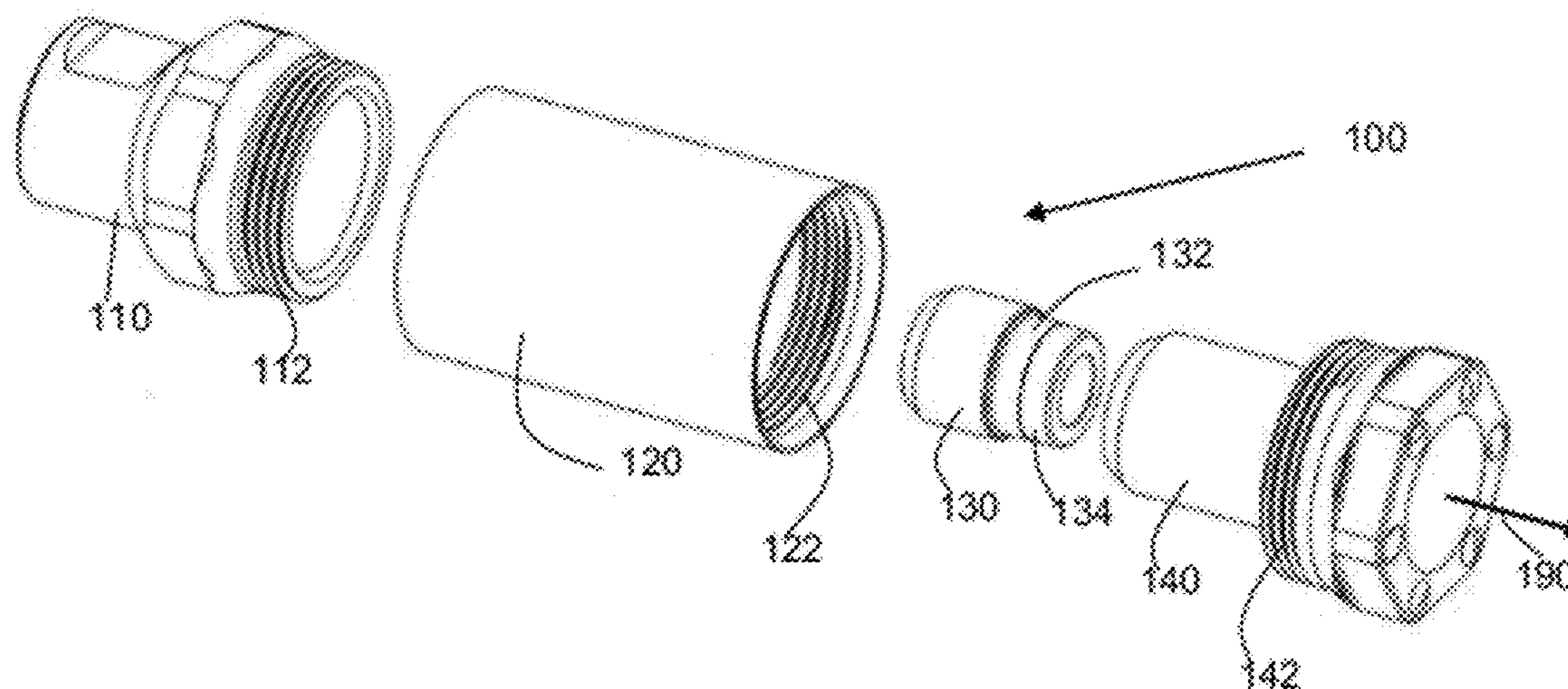
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(57) **ABSTRACT**

At least one exemplary embodiment is directed to a flash suppressor comprising at least one gas channel where a portion of the gases exhausted from a barrel when a projectile is emitted is directed into the at least one gas channel, where the at least one gas channel has a channel axis that is at a non-zero angle with respect to a bore axis, and where the at least one gas channel directs a gas portion to an ambient environment surrounding the flash suppressor.

Related U.S. Application Data

(60) Provisional application No. 61/377,979, filed on Aug. 29, 2010.



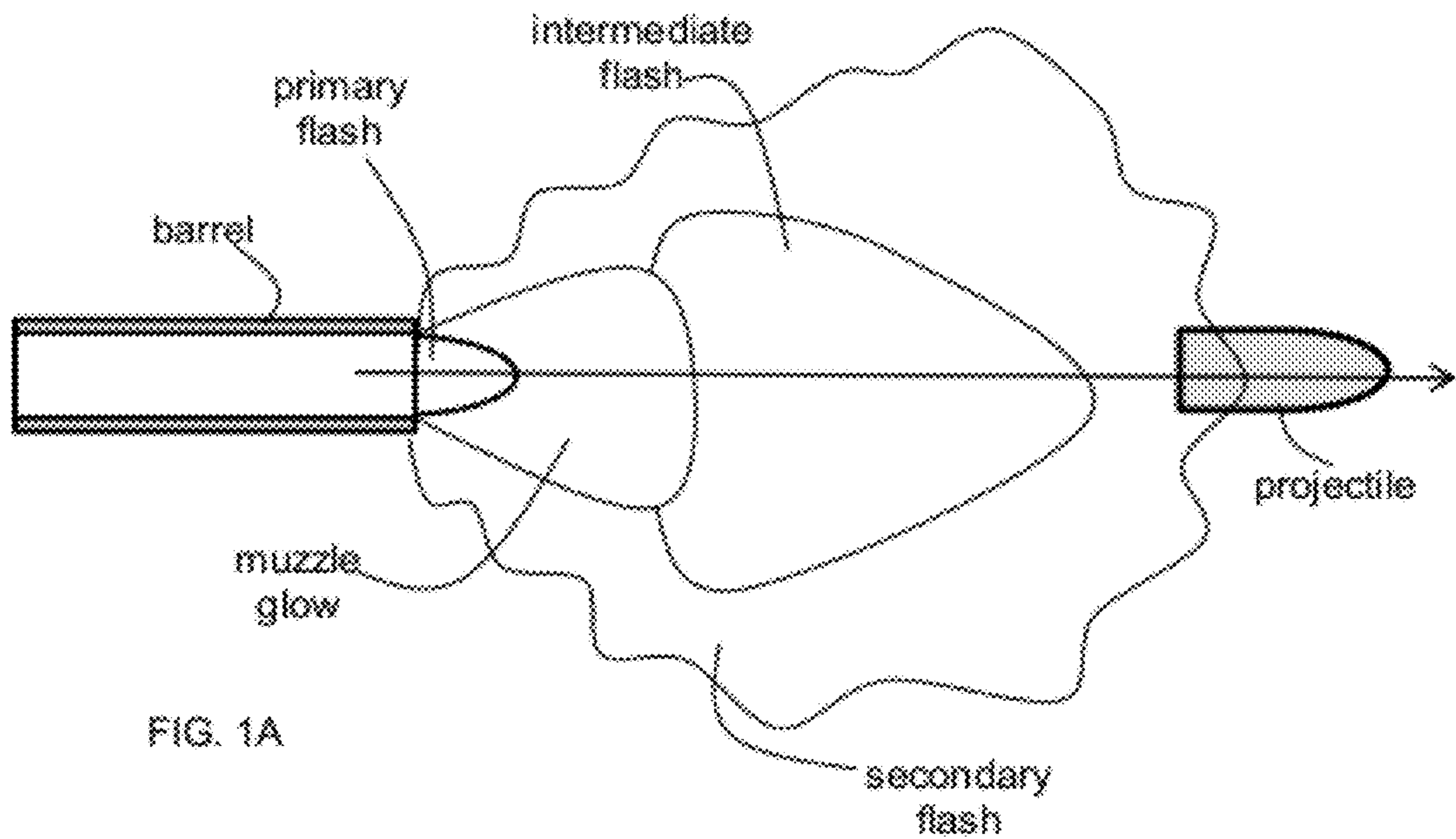


FIG. 1A

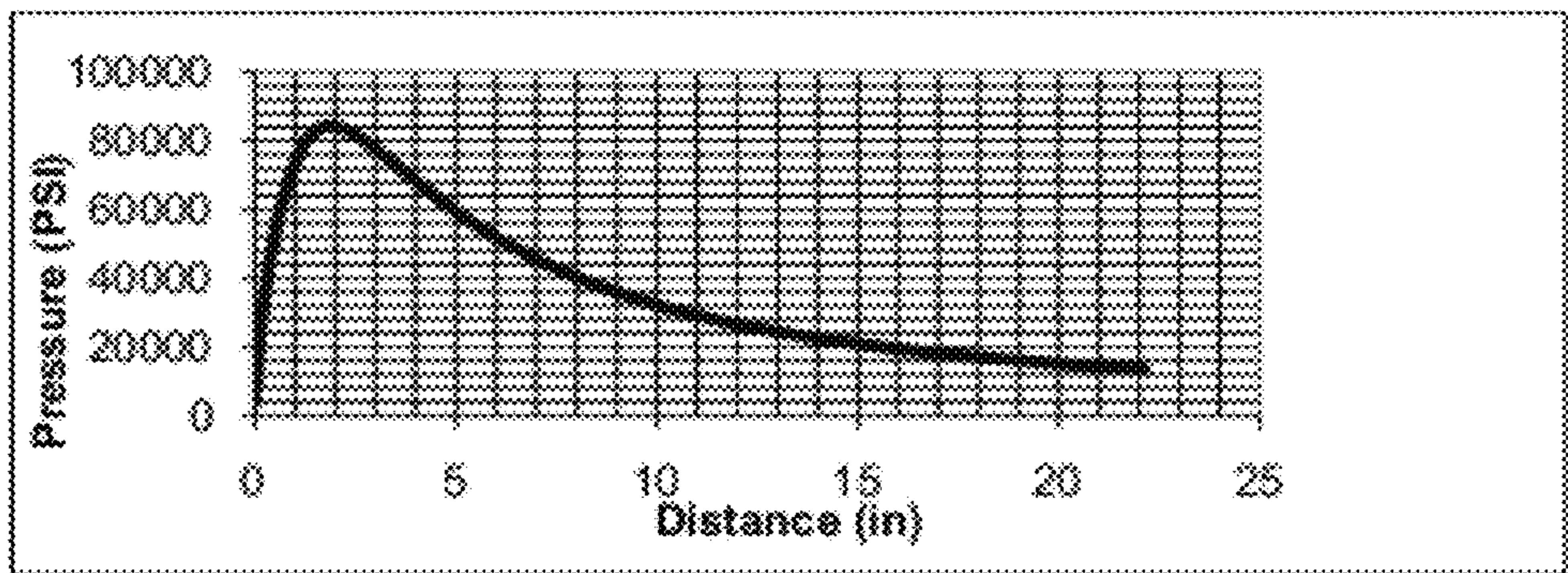


FIG. 1B

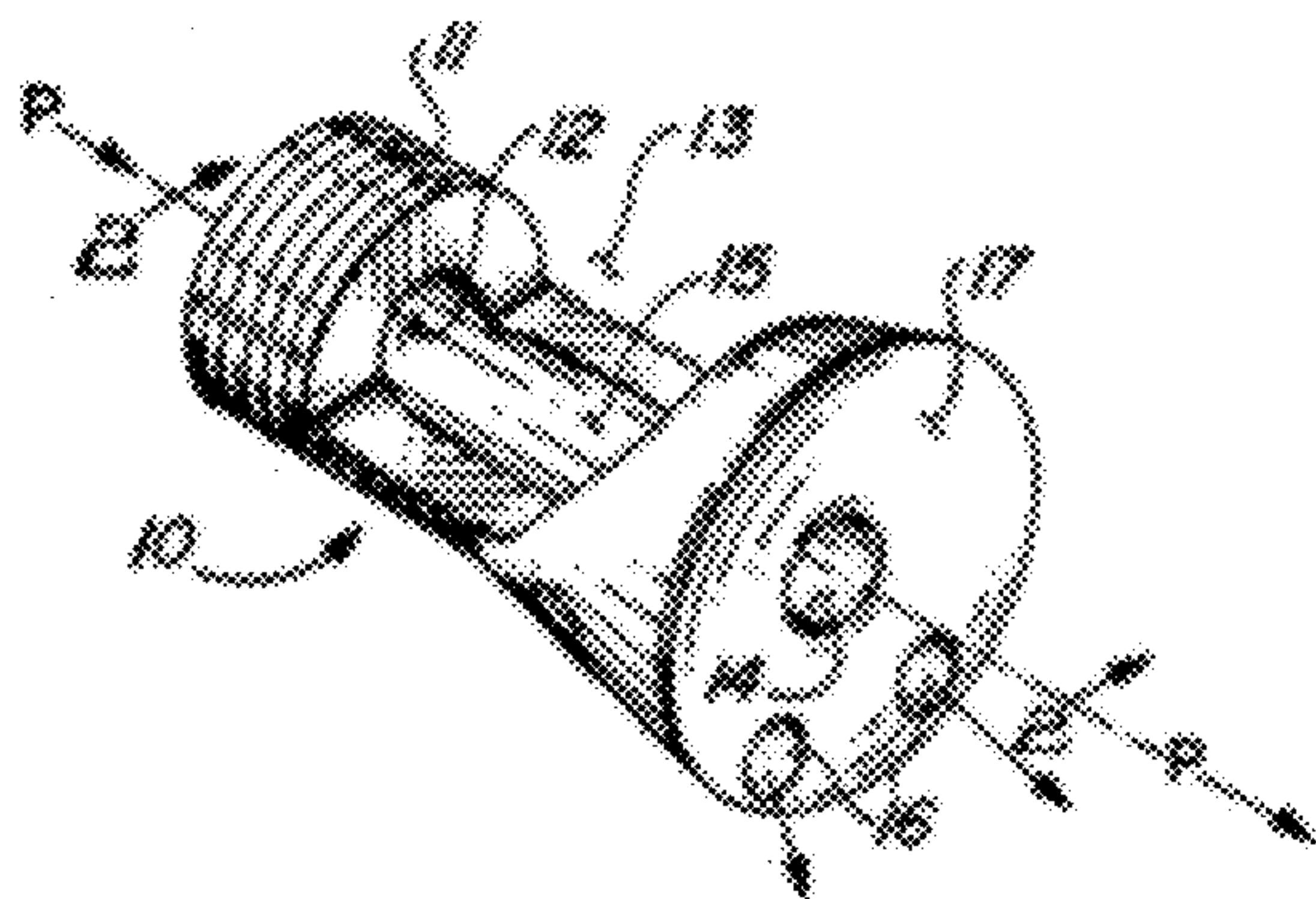


FIG. 2A
RELATED ART

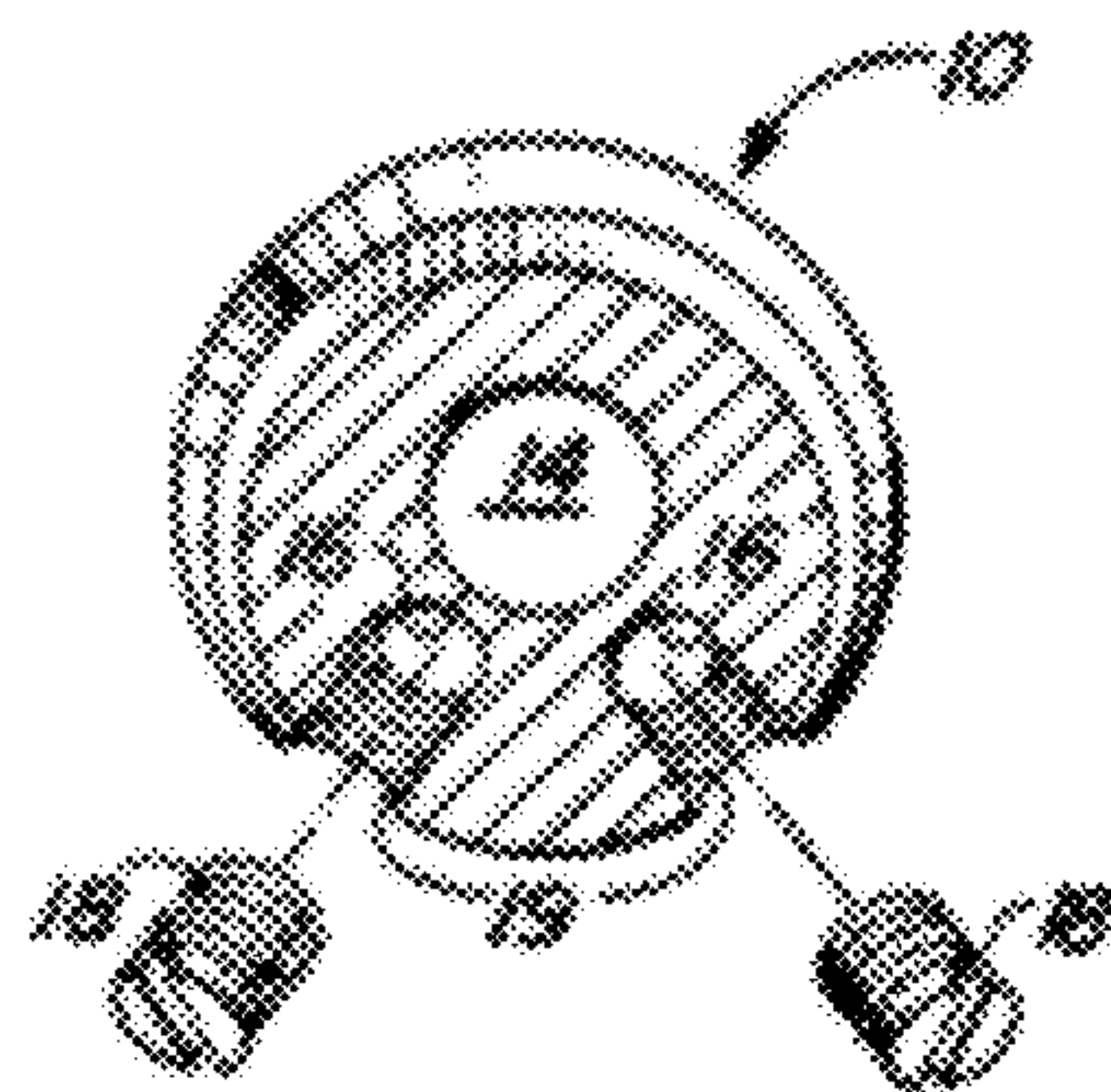
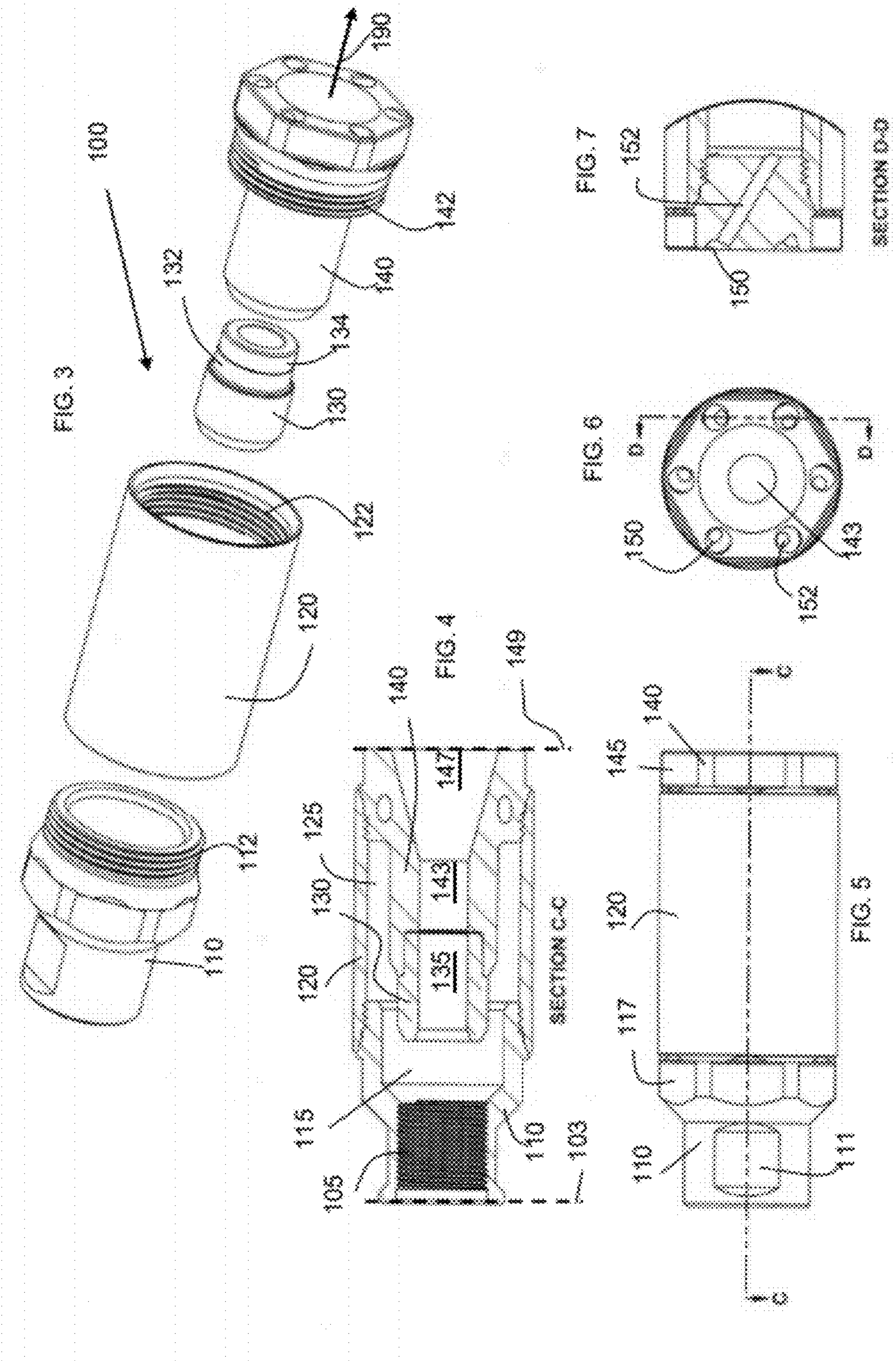
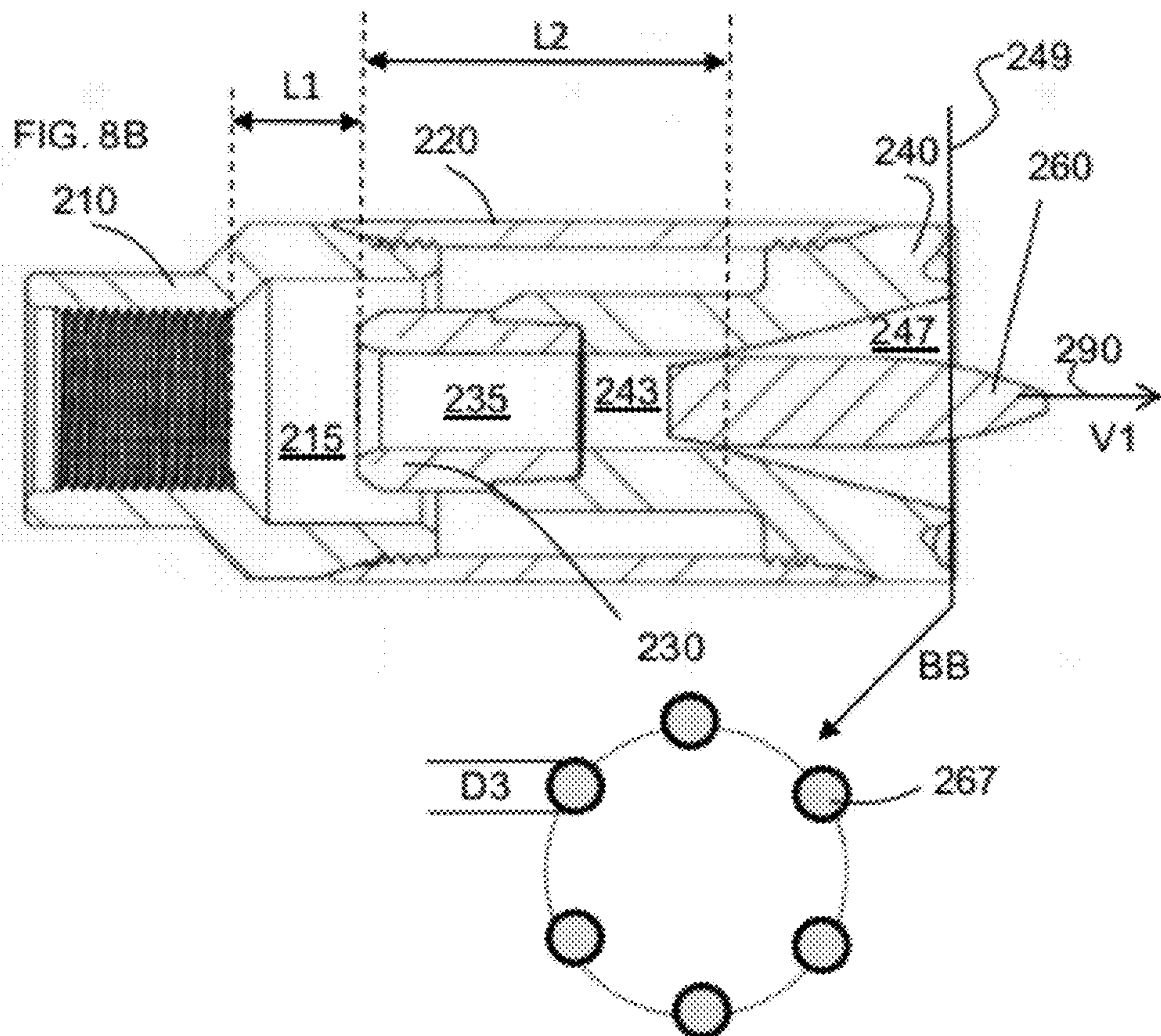
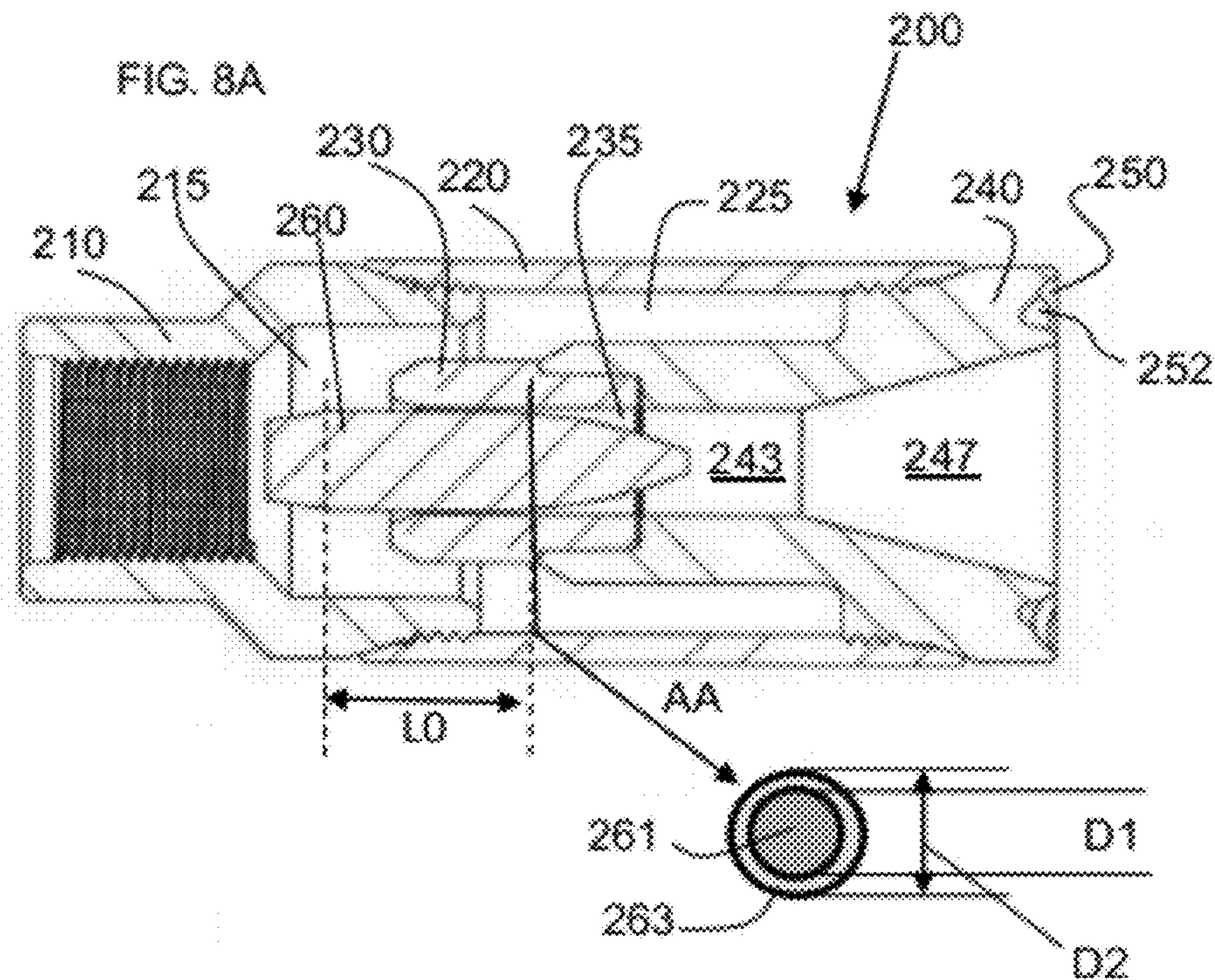
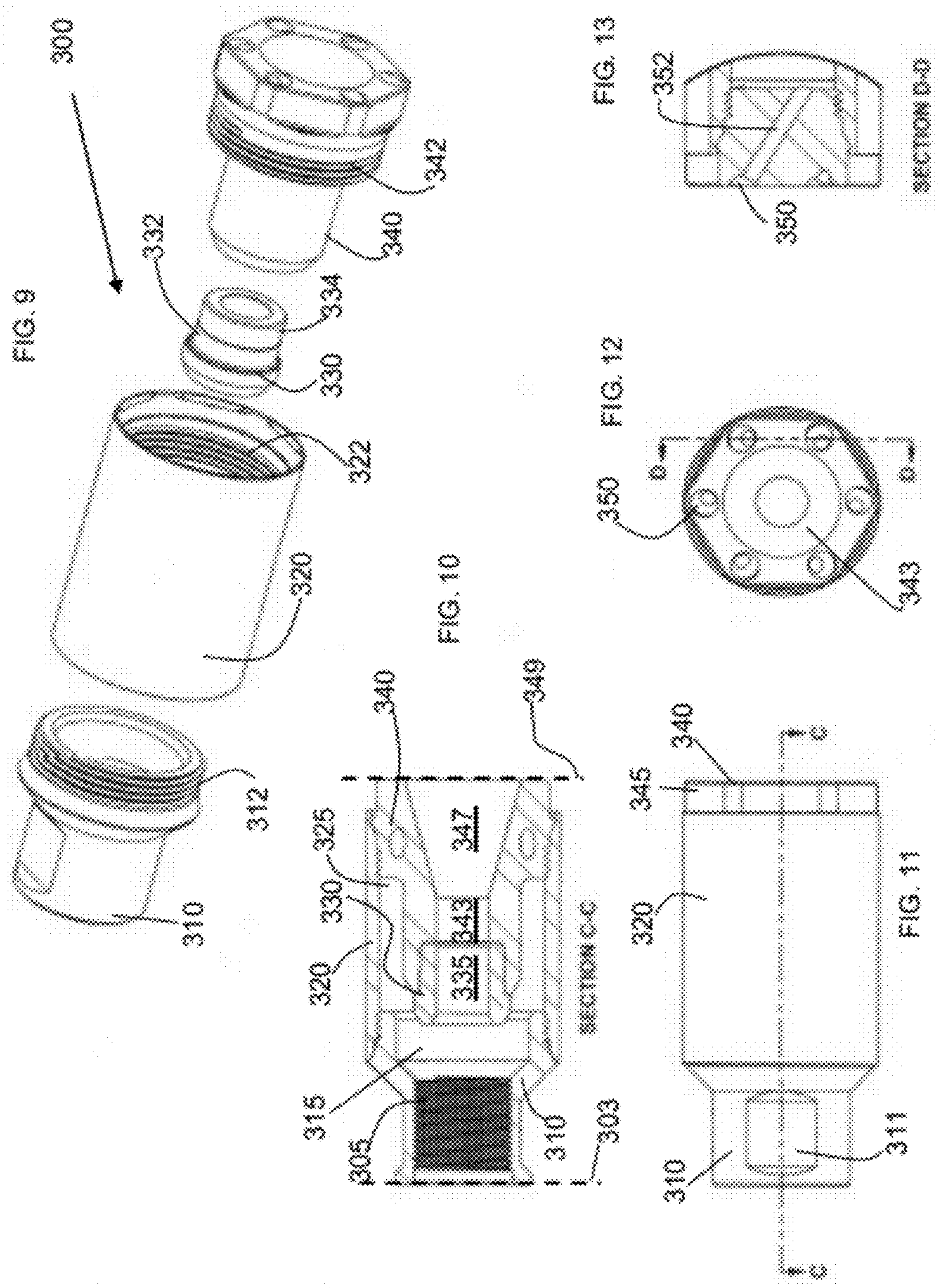
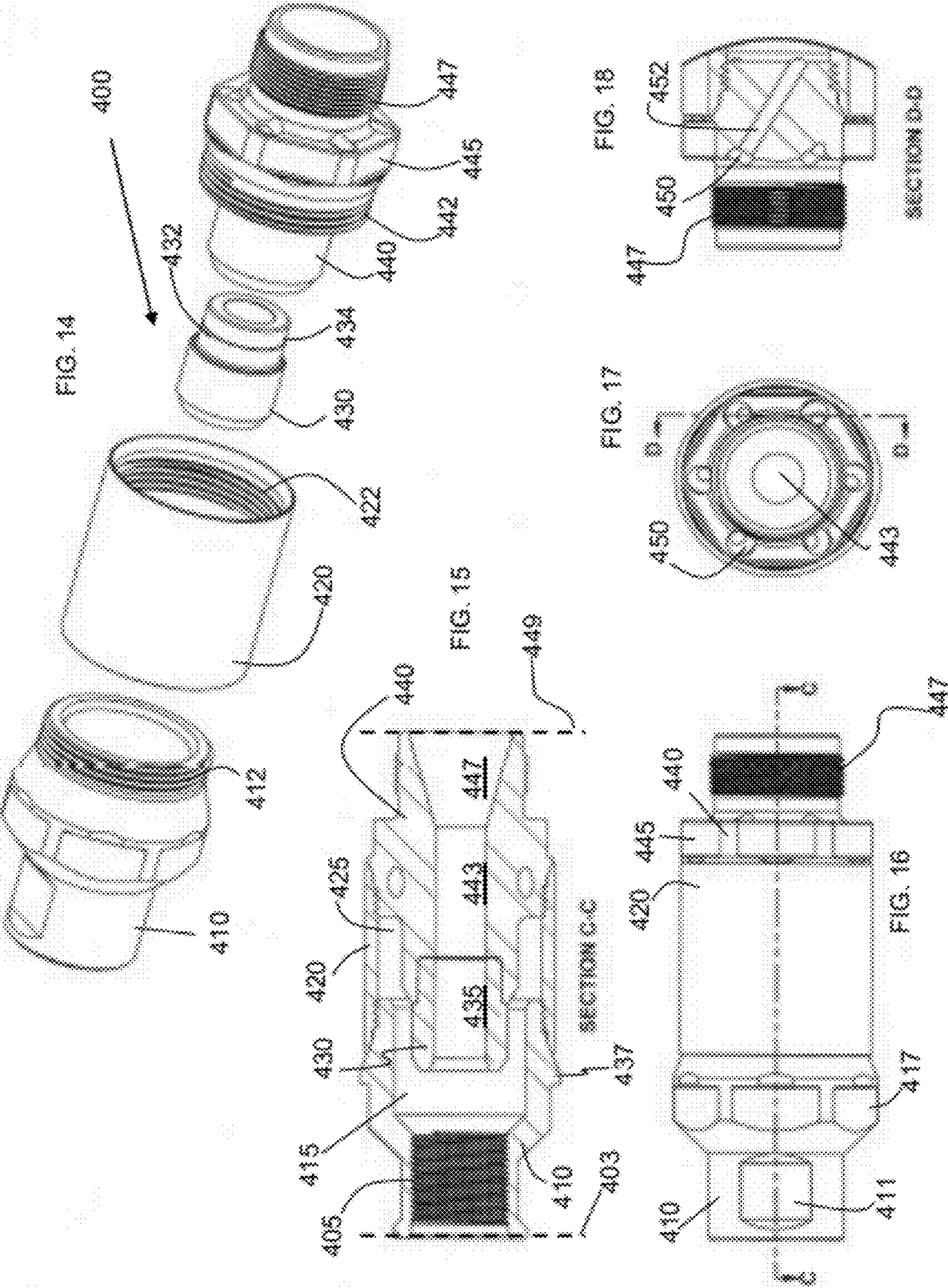


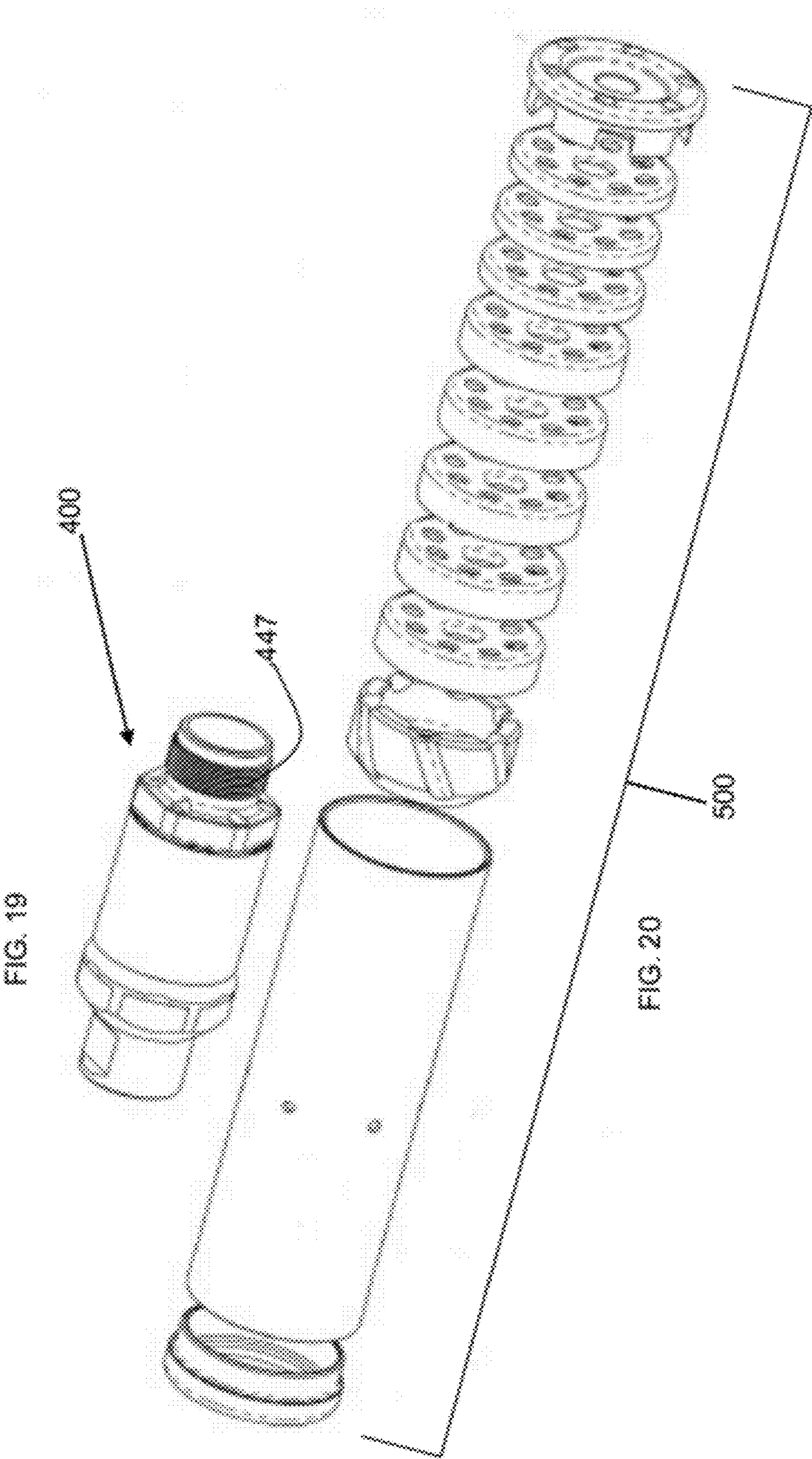
FIG. 2B
RELATED ART

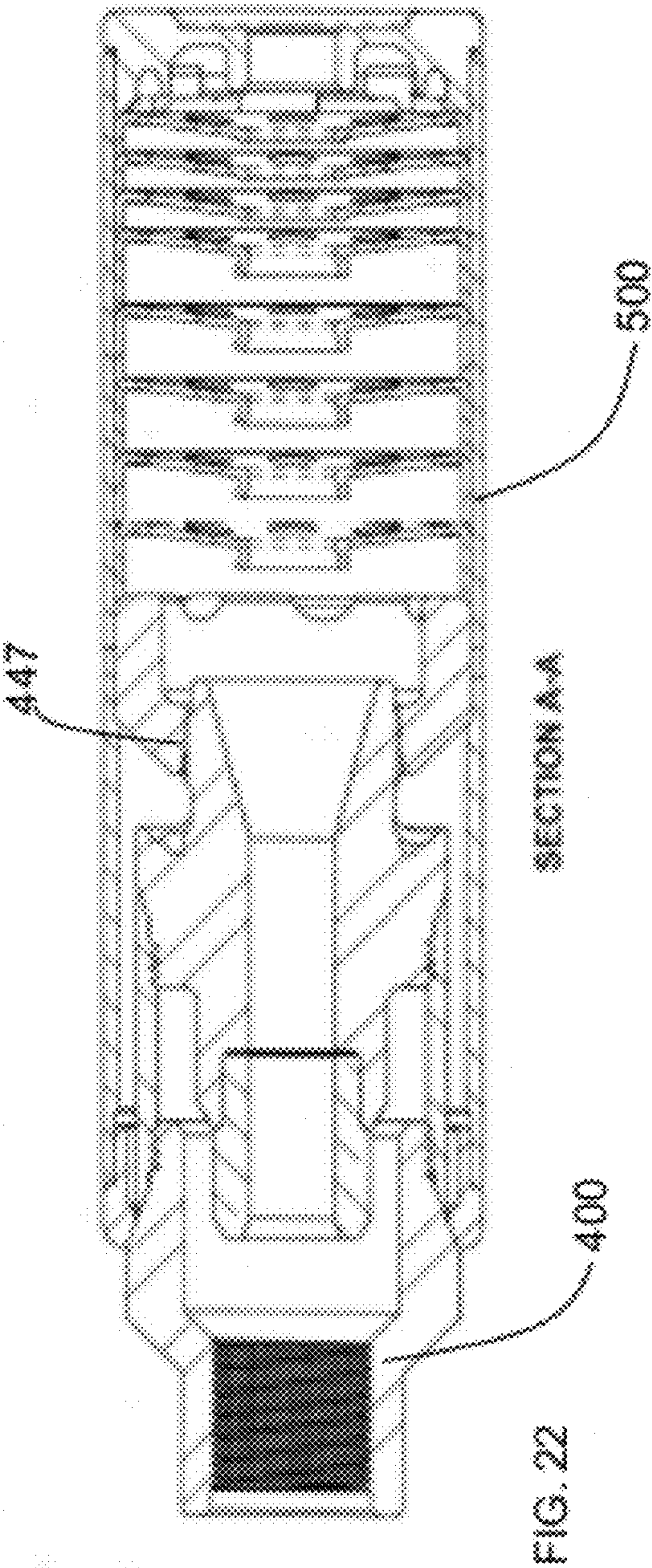
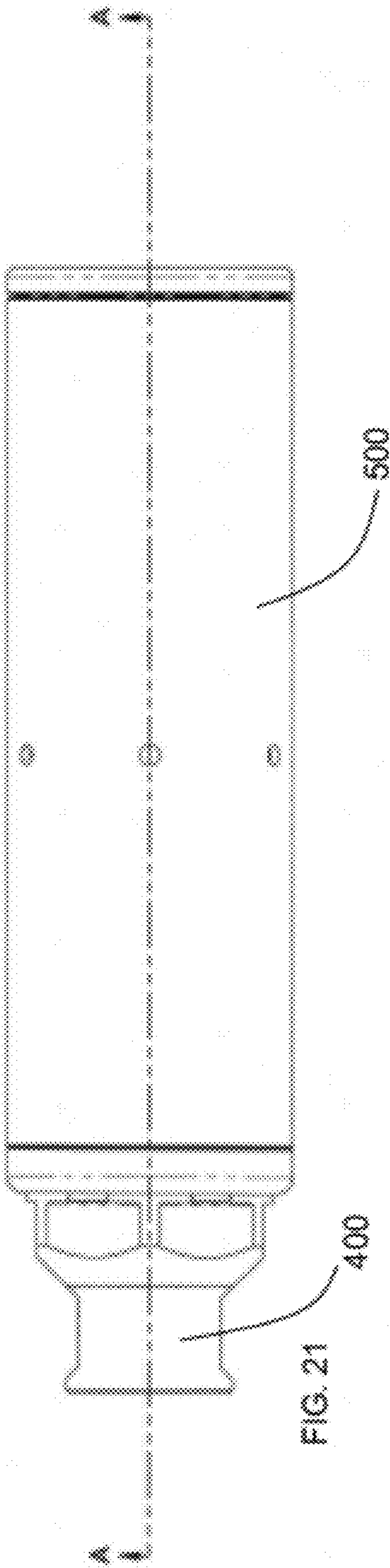












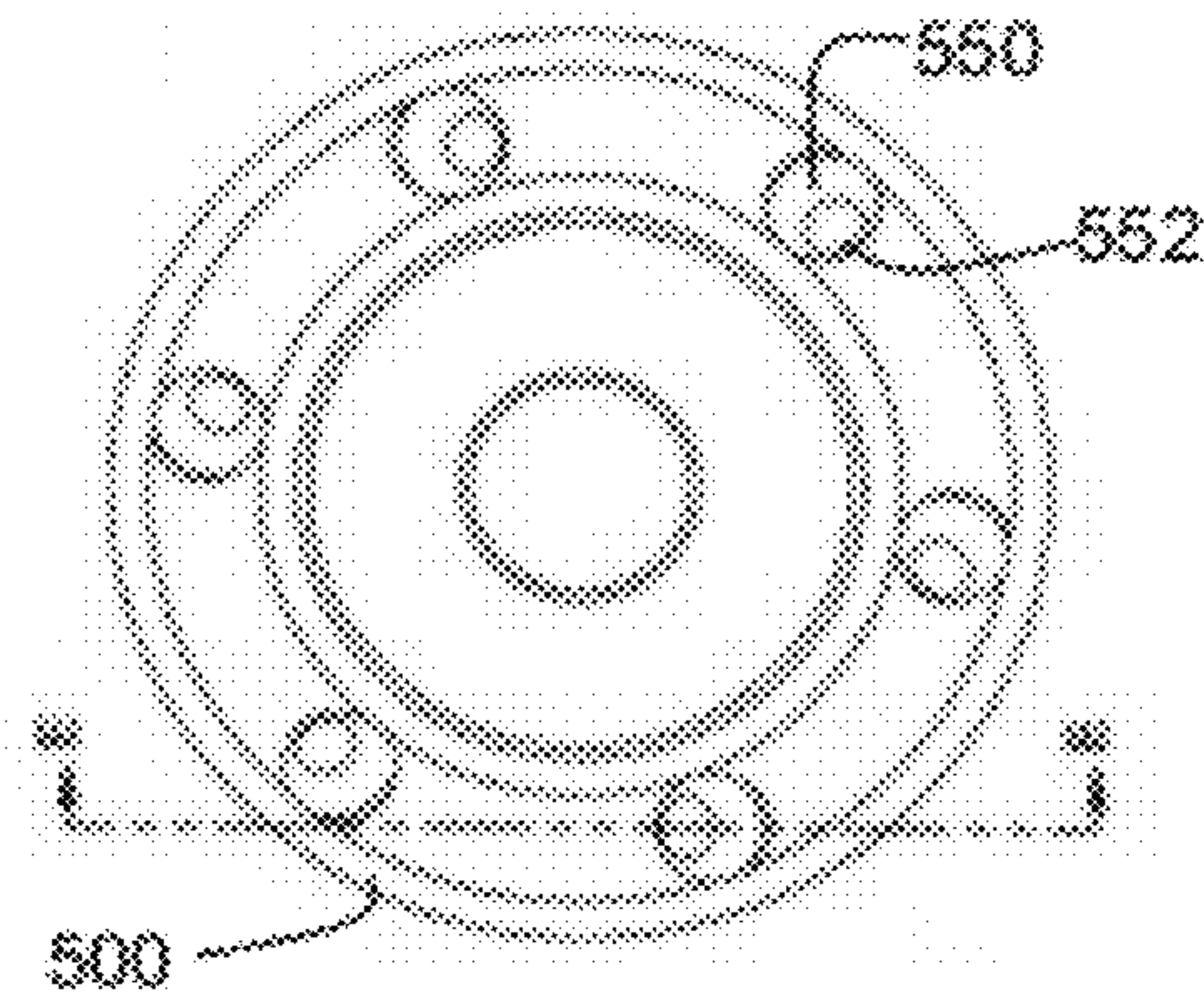
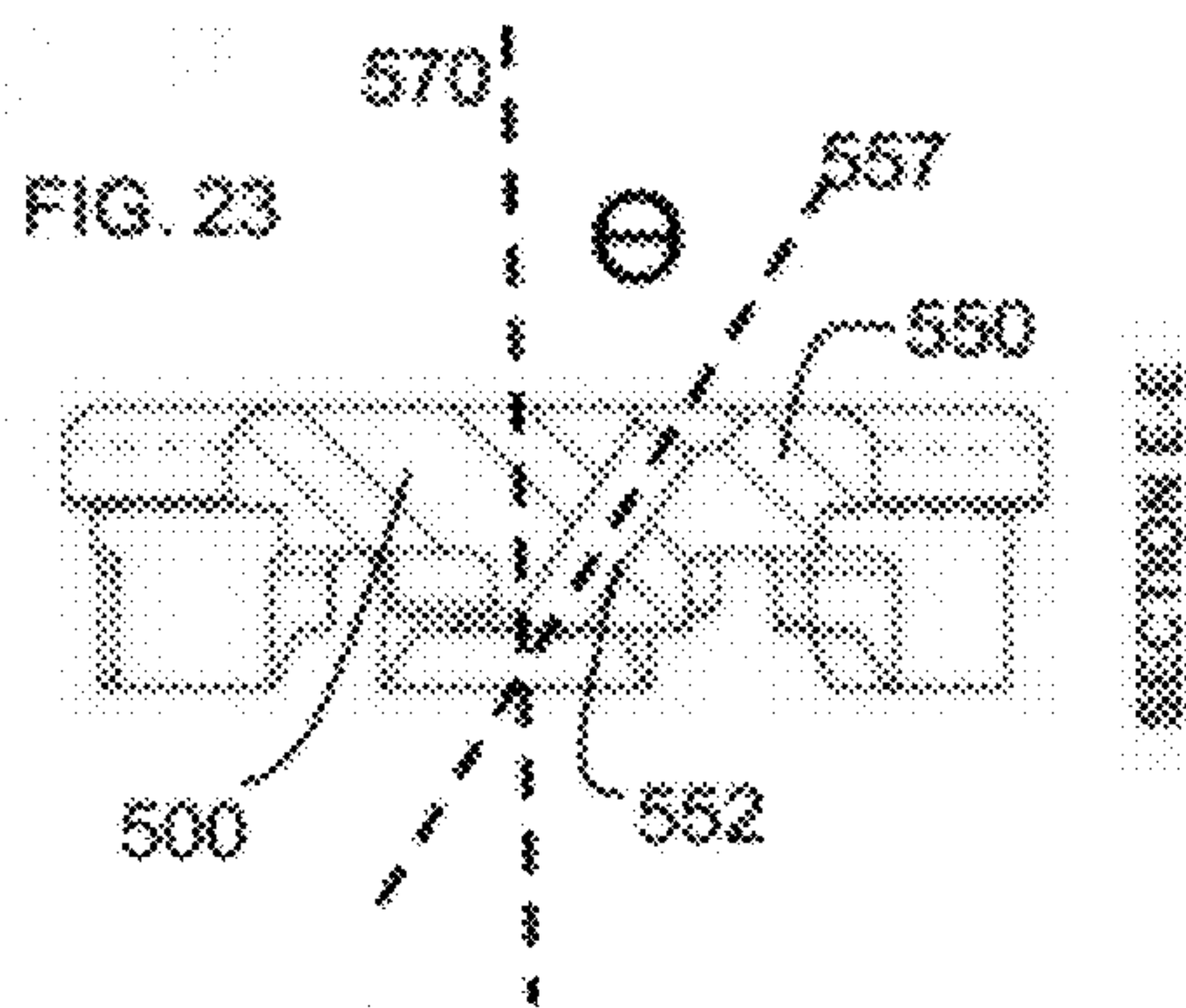
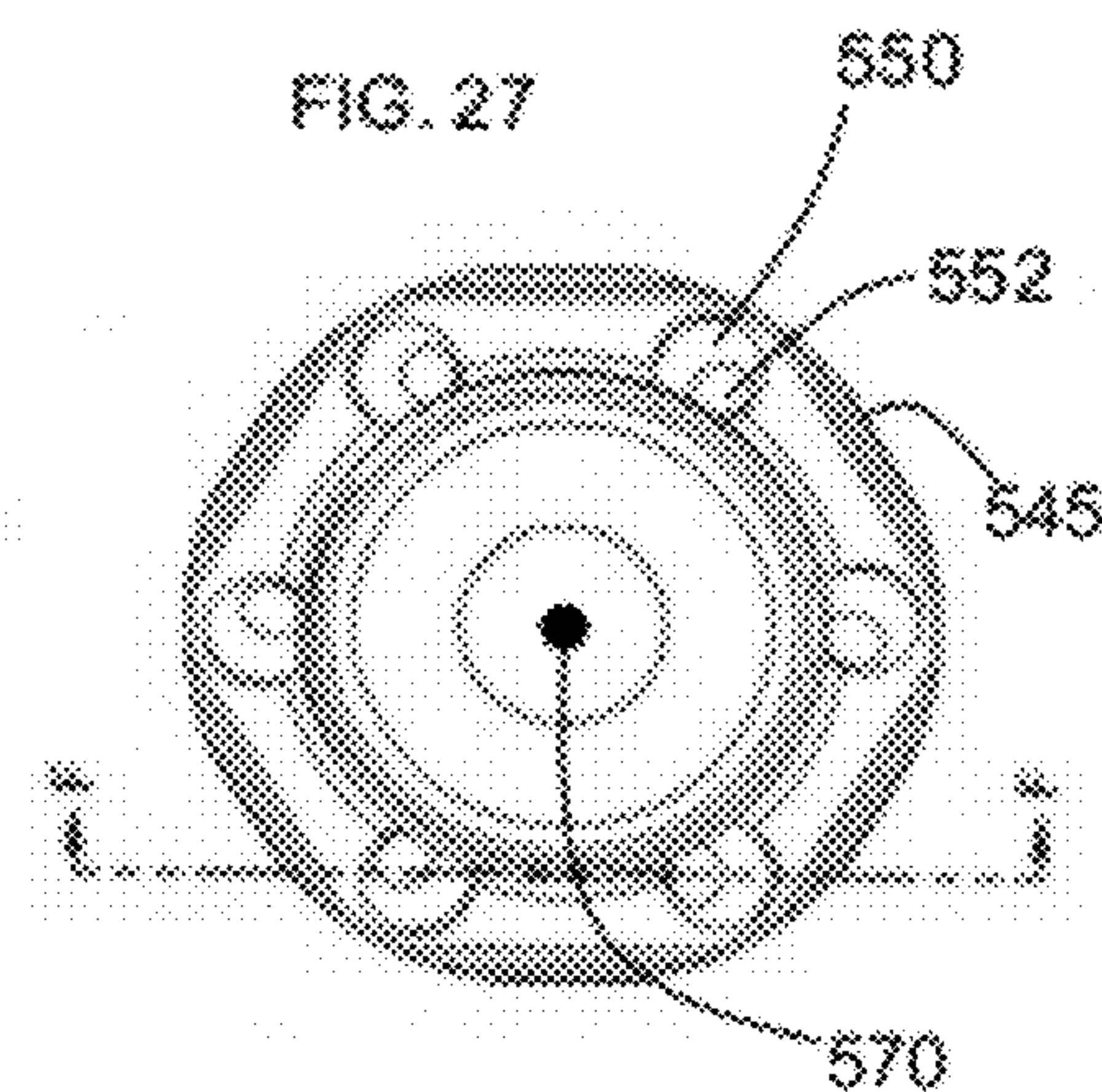
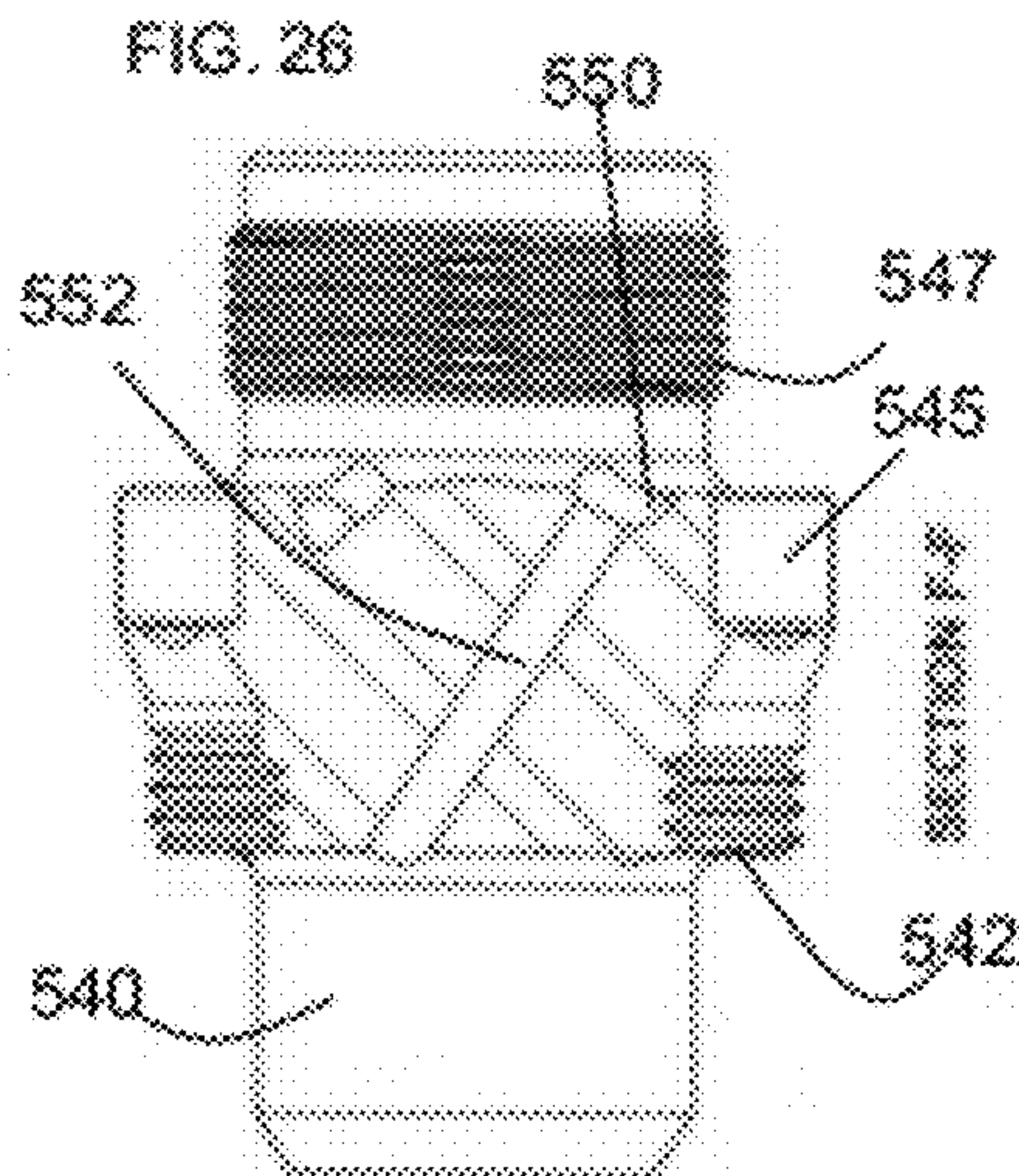
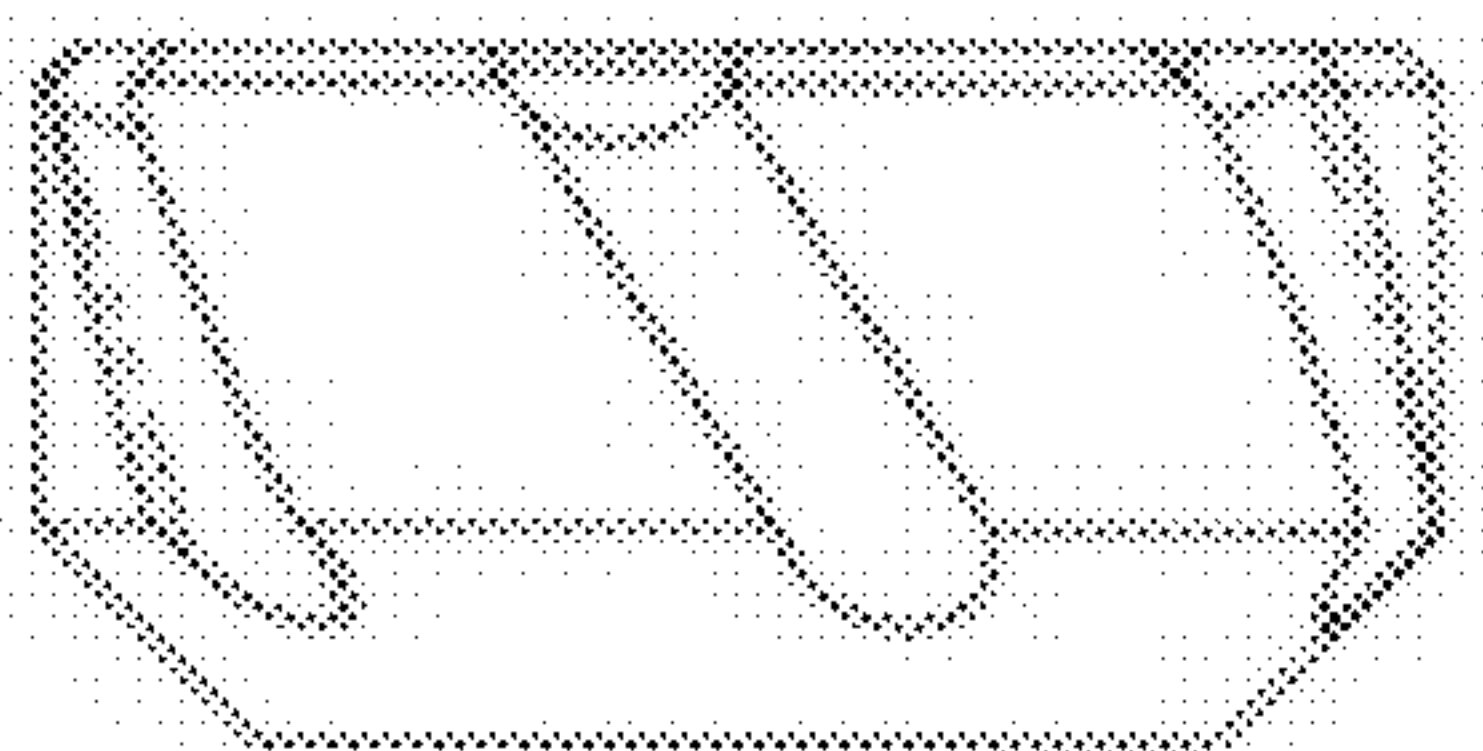
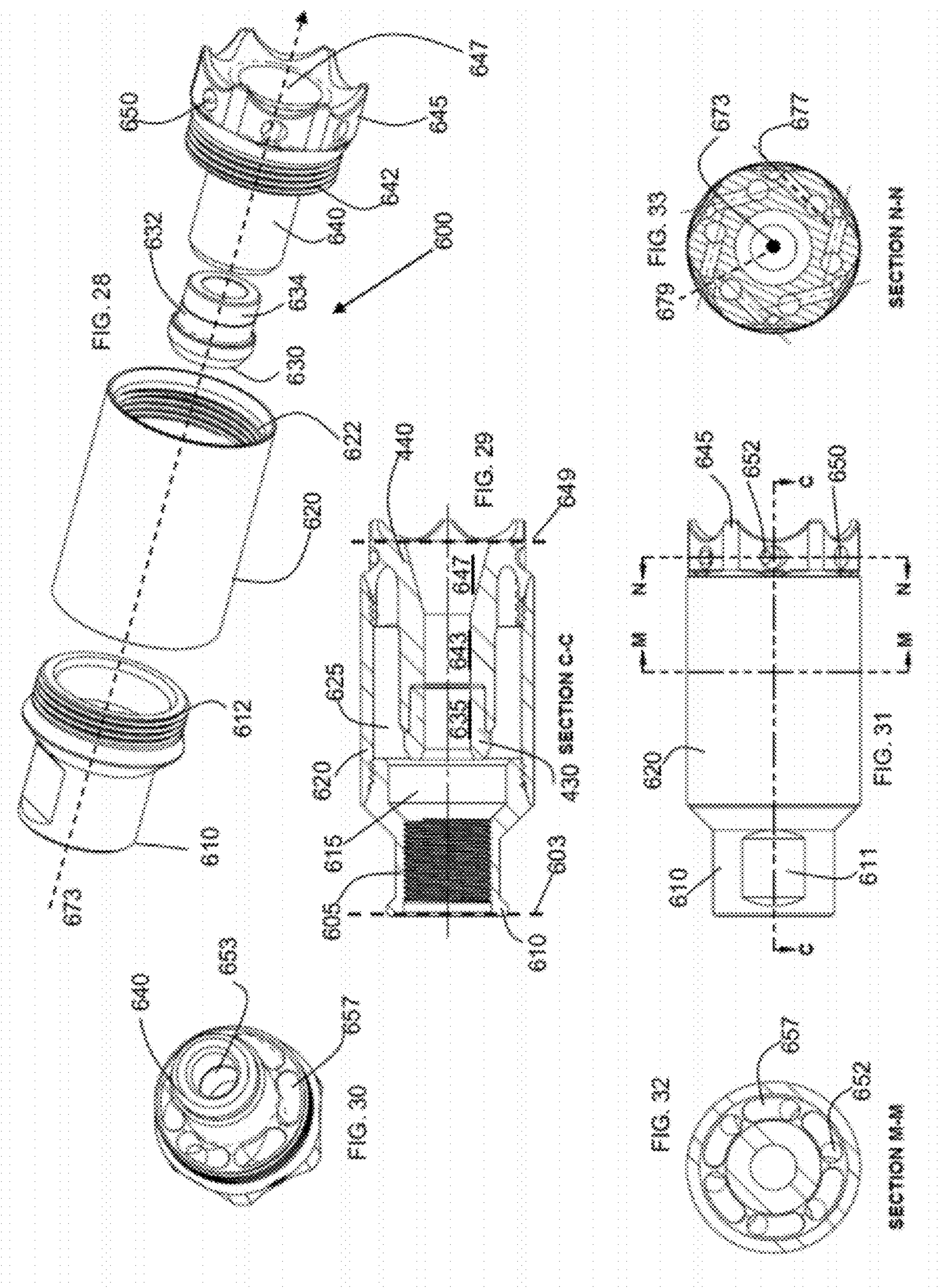
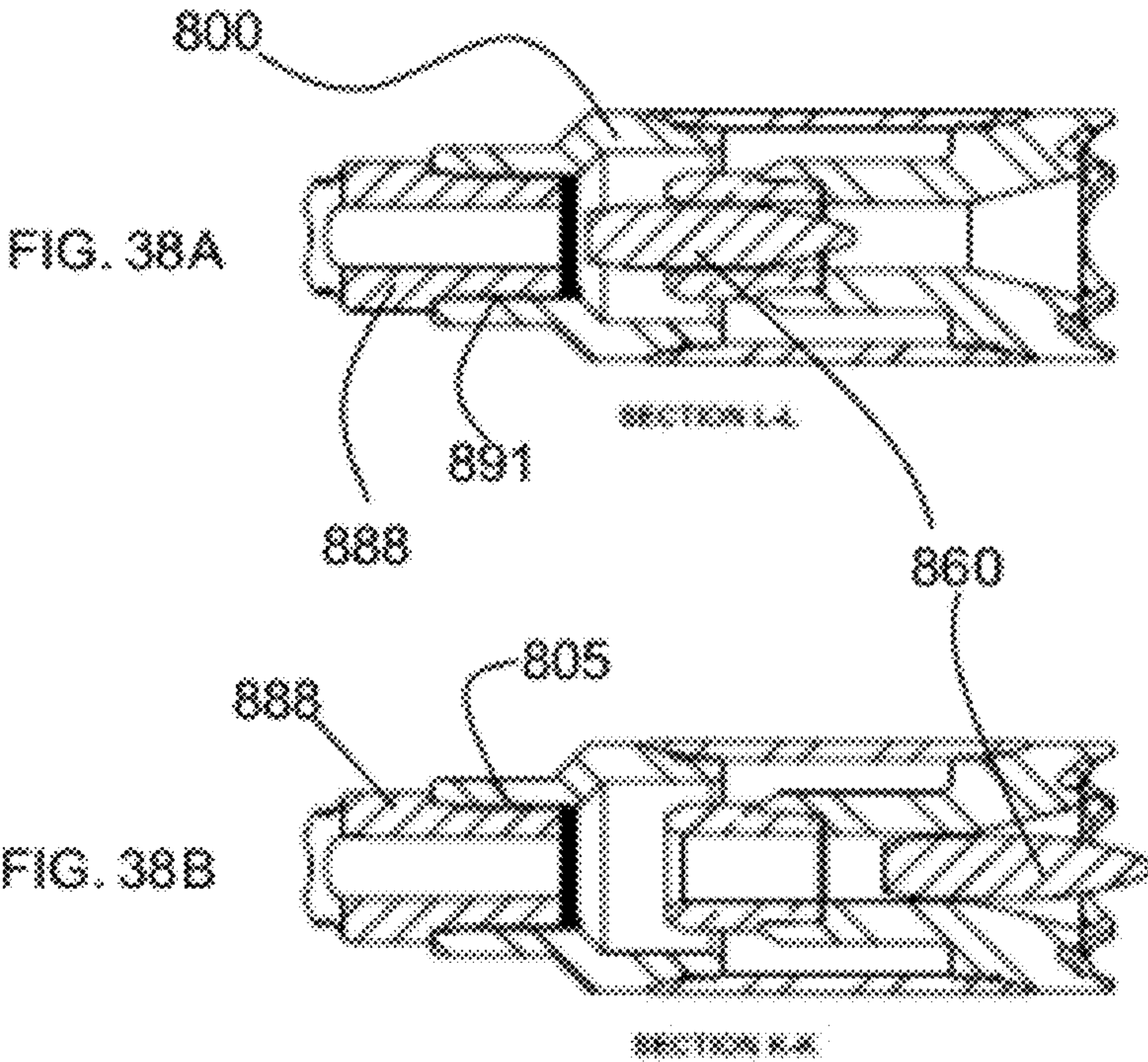
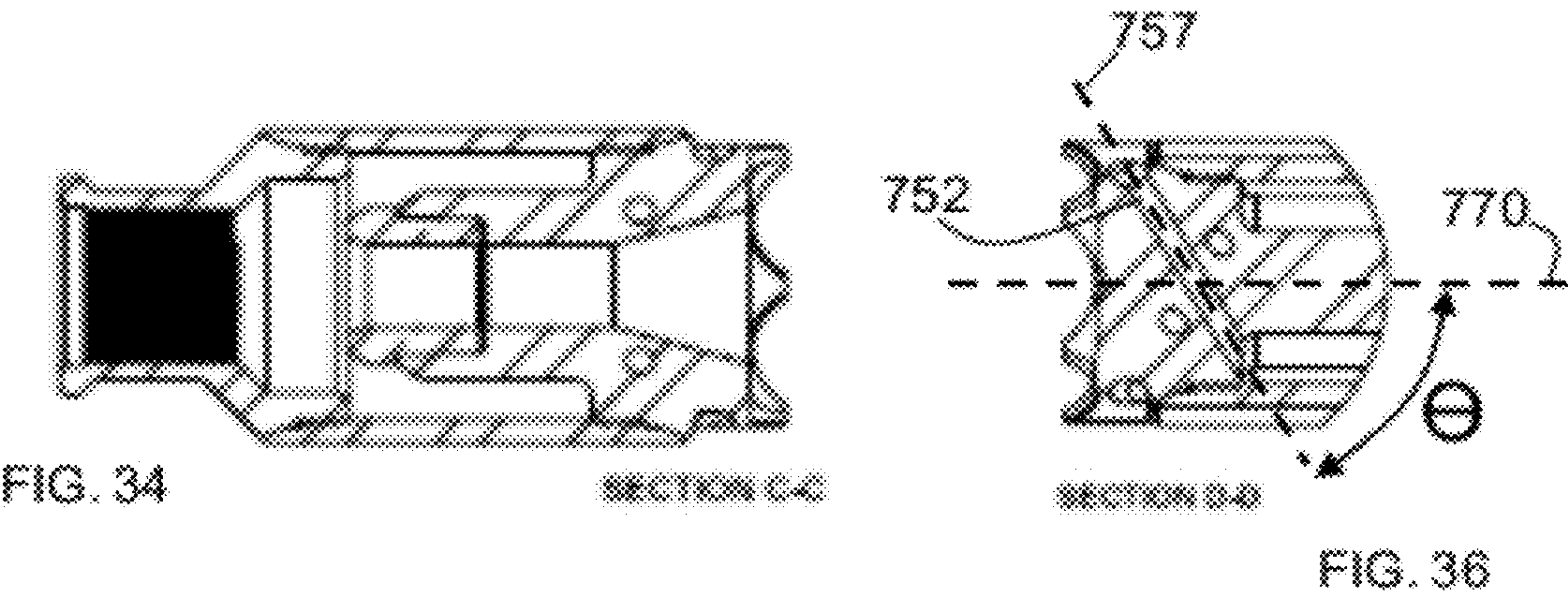


FIG. 25







FLASH SUPPRESSOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. provisional patent application No. 61/377,979 filed 29 Aug. 2010. The disclosure of which is incorporated herein by reference in its entirety.

FIELD OF INVENTION

[0002] The present invention is relates to rifle technology, and more particularly to a device that suppresses muzzle flash.

BACKGROUND

[0003] The basic enabler of firearms is the generation of gas behind a projectile, propelling the projectile down a rifled barrel. Modern firearms uses a cartridge, which is essentially is a load of smokeless powder placed into a casing (typically brass or steel), or shell, where the projectile is seated in a friction fit at the open end of the casing. Contained within the casing is the smokeless powder. The primer does not come out of the casing during the firing of the cartridge.

[0004] In modern firearms, when the firing pin of the firearm strikes the cartridge's primer, the primer ignites the smokeless powder within the shell, causing a rapid pressure increase, which causes the projectile to dislodge from the shell's open end, driving the projectile down the barrel of the firearm and out the end of the muzzle toward its target. The generation of gas is a fast exothermic chemical reaction that occurs in a constant volume as the contents of the smokeless powder react. This constant volume expansion causes both a pressure increase and a temperature increase within the system. It is the large and rapid pressure increase during the chemical reaction of the smokeless powder that generates the force necessary to accelerate the projectile down the barrel.

[0005] The energy of a typical firearm combustion is converted into several forms, about 32% is converted into projectile motion, 34% into heated gases, 30% into heating the barrel, about 2% energy loss in barrel friction (note this can be as high as 25% of the energy since friction also accounts for heating of the barrel), and about 1% of the initial energy is still resident in unburned propellant (Thermodynamic Efficiency of the 0.300 Hawk Cartridge, [http://www.z-hat.com/Efficiency % 20of % 20the % 20300% 20Hawk.htm](http://www.z-hat.com/Efficiency%20of%20the%20300%20Hawk.htm)).

[0006] As the high temperature gases follow the bullet down the bore of the barrel, the temperature of the barrel raises significantly. With sufficient time the barrel will cool. However for rapid fire rifles, the barrel does not have sufficient time to cool between shots.

[0007] One problem resulting from this combination of high pressure and temperature is an increase in the wear of the barrel, and as a result, reduced barrel life. Because pressure is greatest at the breach end (gas volume increases linearly while the physical volume increases exponentially and pressure is equal to gas volume divided by physical volume), the deterioration occurs more rapidly at the breach end of the barrel. This problem is exacerbated with higher pressure cartridges. Thus, heat dissipation is most beneficial to barrel life in the breech end of the barrel. Upon the projectile exit a flash (muzzle flash) can be observed (discussed later).

[0008] A typical muzzle flash lasts 0.5 milliseconds, (e.g., AK-47, "Signal-to-Solar Clutter Calculations of AK-47

Muzzle Flash at Various Spectral Bandpass Near the Potassium D1/D2 Doublet", Karl K. Klett, ARL-RP-0292, June 2010).

[0009] When a weapon fires, only about 30% of the chemical energy released from the propellant is converted into the useful kinetic energy of actually moving the projectile down the barrel. The remaining energy is primarily contained in the propellant gas-particle mixture that escapes from the muzzle of the barrel in the few milliseconds before and after shot ejection. A significant portion of this remaining energy is dissipated in the bright "muzzle flash" seen when the weapon fires.

[0010] There are three most visual components to muzzle flash and they are: the primary flash, the intermediate flash, and the secondary flash. The primary flash is typically of small spatial extent and low luminosity. The primary flash is an extension of the radiating high pressure in-bore flow. Farther from the muzzle, the intermediate flash is a more extensive region of greater luminosity which is separated from the primary flash by a supersonic flow region where the gas density is low so that the radiation is extinguished. The intermediate flash is induced by shock heating. Following the intermediate flash, a very luminous secondary flash occurs further downstream and is the result of an afterburning process. The afterburning process is the result of common solid weapon propellant containing more fuel than oxidizer and undergoing afterburning after leaving the muzzle after mixing with oxygen turbulently in the ambient air.

[0011] Muzzle flash actuality consists of five components (FIG. 1): 1) Muzzle Glow; 2) Primary Flash; 3) Intermediate Flash; 4) Secondary Flash; and 5) Sparks.

[0012] 1) Muzzle Glow is usually a reddish white glow or tongue of flame at the muzzle that appears just prior to shot ejection and persists after shot ejection until the chamber pressure drops significantly. The initial glow is usually the result of hot, highly compressed gases (unburned propellants) leaking past the projectile driving band and is brightest in a worn weapon.

[0013] 2) Primary Flash occurs after the projectile has exited the muzzle and is caused by those propellant gases exiting the muzzle behind the projectile. These are hot enough to emit large amounts of visible radiation but cool rapidly as they expand away from the muzzle.

[0014] 3) Intermediate Flash consists of a reddish disc, slightly dished towards the weapon. Intermediate Flash occurs at the time of shot ejection and persists until the chamber pressure drops. It is brightest at the edge nearest the weapon and gradually fades as the distance from the muzzle increases. This flash is due to a Mach shock wave created by the escaping gasses and projectile which, with its attendant pressure rise, causes the propellant gases to attain a temperature almost equal to the chamber temperature and so become self-luminescent.

[0015] 4) Secondary Flash appears beyond the zone of the intermediate flash and is a rather ragged vortex of yellowish white flame. This is a result of the ignition of the combustible mixture of propellant gases and atmospheric oxygen caused by the turbulent mixing occurring at the boundary of the gas jet as it leaves the muzzle. The ignition of this mixture would appear to be initiated by its exposure to the high temperature of the intermediate flash.

[0016] 5) Sparks are a common feature of the flash for small arms. These can arise from the ejection of incompletely burnt powder particles or by the ejection of white-hot acid or metallic particles.

[0017] Of these five components, the intermediate and secondary flashes are the greatest contributors visually to muzzle flash. Most of the radiated energy occurs during the secondary flash and this can be greatly reduced by attaching a flash reducing device to the weapon muzzle. These are commonly known as “Flash Suppressors” and appear on many military-style small arms and automatic weapons. These attachments act by modifying the gas glow pattern such that there is no region or a greatly reduced region in which the inflammable mixture of air and muzzle gases is sufficiently hot enough to ignite. It should be realized that there are other kinds of Flash Suppressors which do not modify the gas flow patterns in this manner but instead work by directing part of the muzzle gasses away from the shooter. These kinds of Flash Suppressors and the simpler “Flash Hider” muzzle attachments are intended primarily to reduce or block the muzzle flash from the vision of the shooter in order to maintain his night vision, they do little to reduce the size of the flash itself.

[0018] In addition to muzzle flash, another problem is the recoil of the high-pressure, heavy bullet systems in use today. Recoil is essentially the equal and opposite force a shooter feels when a bullet is expelled from the barrel of a rifle. Recoils are not only sometimes uncomfortable or even damaging to the shooter, but greatly affect accuracy, target reacquisition, and sight realignment between shots.

[0019] In addition to muzzle flash, a very loud sound is created upon shooting, the loudness of which can make the shooter flinch prior to a shot, in anticipation of the loud, harmful sound, causing a decrease in the marksmanship of the shooter.

[0020] Some developments have occurred to attempt to remedy some of the above-described problems. Baffle muzzle breaks, for example, work on the principle of redirecting gases that would otherwise exit the muzzle in the direction of the projectile. In such cases, their performance is proportional to the percentage of gas they deflect. Many such muzzle breaks redirect expanding gases in a direction substantially perpendicular to the longitudinal axis of the bore of the firearm, or in an angled, rearward direction at an acute angle with respect to the longitudinal axis of the bore of the firearm. In such cases, noise and debris is directed toward the shooter’s face. Problems with this scenario are also obvious, not the least of which is increased potential for damage to the shooter’s, or nearby person’s, eardrums, and pronounced shooter’s flinch resulting in a further degradation of marksmanship.

[0021] Recoil is the reactive force against the weapon barrel applied by the moving bullet and propellant. A substantial component of this reactive force is created by the forward ejection of the propellant out the muzzle. The recoil force is applied at a point above the center of gravity of the firearm and this, combined with the torque reaction generated by the rapidly spinning projectile, tends to pull the muzzle upward and to the right upon firing. The ratio of kinetic energy imparted to a shooter and imparted to a bullet during recoil is inversely related to the ratio of the masses of the bullet to the shooter. Hence the recoil energy decreases as the shooter mass increases and/or the bullet velocity decreases.

[0022] Projectile stability is affected by the exiting propellant gas that passes and surrounds the projectile immediately

beyond the muzzle. The velocity of the propellant is roughly twice the velocity of the projectile, so that at exit some propellant moves around and in front of the projectile. The propellant immediately slows down in the air, causing drag on the projectile. More significantly, in the case of a firearm with a rifled barrel, the propellant exerts a force that makes the spinning projectile wobble or “yaw”, thereby causing the projectile to take longer to stabilize and decreasing the accuracy of the firearm.

[0023] FIGS. 2A and 2B illustrate a method muzzle braking and flash hider described by U.S. Pat. No. 5,092,223. FIG. 2A illustrates a muzzle brake, and FIG. 2B illustrates the same muzzle brake illustrated in FIG. 2A along a different view. FIGS. 2A and 2B illustrate channels 16, whereby the combustion gases can escape. Note the non-symmetric nature of the channels about the barrel axis, resulting in a net force away from the axis of the barrel, throwing off aim.

[0024] Muzzle flash can be detected via machines or by the human eye. The human eye focuses light on the retina, comprised of rods and cones. Rods detect light in night conditions in black, white and gray. Rods amplify light more than cones and can detect as few as one photon.

SUMMARY

[0025] At least one exemplary embodiment is directed to a flash suppressor comprising: a first gas region, where the first gas region can be enclosed by first solid portion, where the first solid portion is configured so that the first solid portion can be operatively attached to a barrel; a second gas region, where the second gas region can be enclosed by a second solid portion, where the second solid portion is operatively attached to the first solid region; a bore region, where the bore region can be enclosed by a third solid portion, where the bore region is configured to facilitate the passage of a projectile through the bore region, where the bore region has a bore axis that is parallel to an axis of a bore of the barrel; and at least one gas channel, where the at least one gas channel passes through a fourth solid portion, where the fourth solid region is operatively attached to the third solid portion, where the fourth solid portion is operatively attached to the second solid portion, where the first gas region is configured to accept at least a first portion of the gases exhausted from the barrel when a projectile is exhausted from the barrel, where first gas region is configured to direct the first portion of gases into the second gas region, where the second gas region is configured to direct a second portion of the a first portion of the gases exhausted into the at least one gas channel, where the at least one gas channel has a channel axis that is at a non-zero angle with respect to the bore axis, and where the at least one gas channel directs at least a third portion of the second gas portion to an ambient environment surrounding the flash suppressor.

[0026] At least one exemplary embodiment is directed to a method of flash suppression comprising: directing a portion of the gases exhausted from a barrel along a first path, where the portion of gases takes a first time to travel along the first path; and directing a projectile along a second path where the projectile takes a second time to travel along the second path, where the second time is less than the first time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] Exemplary embodiments of present invention will become more fully understood from the detailed description and the accompanying drawings, where:

[0028] FIG. 1A illustrates the general components of a muzzle flash;

[0029] FIG. 1B illustrates a pressure curve along a barrel using a test round (about 25% larger than a standard load);

[0030] FIGS. 2A and 2B illustrate a related art muzzle brake;

[0031] FIG. 3 illustrates a flash suppressor in accordance with at least one exemplary embodiment;

[0032] FIG. 4 illustrates a cross section of a flash suppressor as illustrated in FIG. 5 in accordance with at least one exemplary embodiment;

[0033] FIG. 6 illustrates a front view of the flash suppressor illustrated in FIG. 5;

[0034] FIG. 7 illustrates a cross sectional view of a front cap in accordance with at least one exemplary embodiment;

[0035] FIGS. 8A and 8B illustrates various cross sectional views of the passage of a projectile through a flash suppressor in accordance with at least one exemplary embodiment;

[0036] FIG. 9 illustrates a flash suppressor in accordance with at least one exemplary embodiment;

[0037] FIG. 10 illustrates a cross section of a flash suppressor as illustrated in FIG. 11 in accordance with at least one exemplary embodiment;

[0038] FIG. 12 illustrates a front view of the flash suppressor illustrated in FIG. 11;

[0039] FIG. 13 illustrates a cross sectional view of a front cap in accordance with at least one exemplary embodiment;

[0040] FIG. 14 illustrates a flash suppressor in accordance with at least one exemplary embodiment;

[0041] FIG. 15 illustrates a cross section of a flash suppressor as illustrated in FIG. 16 in accordance with at least one exemplary embodiment;

[0042] FIG. 17 illustrates a front view of the flash suppressor illustrated in FIG. 16;

[0043] FIG. 18 illustrates a cross sectional view of a front cap in accordance with at least one exemplary embodiment;

[0044] FIG. 19 illustrates the flash suppressor of FIG. 14, and a sound suppressor (FIG. 20) as a non-limiting example of what can be attached to the flash suppressor of at least one exemplary embodiment;

[0045] FIGS. 21 and 22 illustrate side and cross sectional view of a sound suppressor attached to the flash suppressor illustrated in FIG. 14;

[0046] FIG. 23 illustrates a sectional view of a sound suppressor coupling element illustrated in FIG. 25 in accordance with at least one exemplary embodiment;

[0047] FIG. 24 illustrates a sound suppressor coupling element in accordance with at least one exemplary embodiment;

[0048] FIG. 26 illustrates a front cap cross sectional view in accordance with at least one exemplary embodiment;

[0049] FIG. 27 illustrates a front view of the front cap illustrated in FIG. 26;

[0050] FIG. 28 illustrates a flash suppressor in accordance with at least one exemplary embodiment;

[0051] FIG. 29 illustrates a cross section of a flash suppressor as illustrated in FIG. 31 in accordance with at least one exemplary embodiment;

[0052] FIG. 30 illustrates a barrel end view of the rear cap illustrated in FIG. 28;

[0053] FIG. 32 illustrates a first sectional view of the flash suppressor illustrated in FIG. 31 in accordance with at least one exemplary embodiment;

[0054] FIG. 33 illustrates a second sectional view of the flash suppressor illustrated in FIG. 31 in accordance with at least one exemplary embodiment;

[0055] FIG. 34 illustrates a cross section of a flash suppressor as illustrated in FIG. 35 in accordance with at least one exemplary embodiment;

[0056] FIG. 36 illustrates a front cap cross sectional view in accordance with at least one exemplary embodiment;

[0057] FIG. 37 illustrates a front view of the front cap illustrated in FIG. 36; and

[0058] FIGS. 38A and 38B illustrates various cross sectional views of the passage of a projectile through a flash suppressor in accordance with at least one exemplary embodiment.

DETAILED DESCRIPTION

[0059] The following description of exemplary embodiment(s) is merely illustrative in nature and is not intended to limit the invention, its application, or uses.

[0060] Processes, techniques, apparatus, and materials as known by one of ordinary skill in the art may not be discussed in detail but are intended to be part of the enabling description where appropriate. For example specific manufacturing methods for example milling, drilling, pressing, may not be discussed, however one of ordinary skill in the manufacturing of rifles would be able, without undue experimentation, to manufacture exemplary embodiments given the enabling disclosure herein.

[0061] Notice that similar reference numerals and letters refer to similar items in the following figures, and thus once an item is defined in one figure, it may not be discussed or further defined in the following figures.

[0062] In all of the examples illustrated and discussed herein, any specific values, should be interpreted to be illustrative only and non-limiting. Thus, other examples of the exemplary embodiments could have different values.

[0063] While the specification concludes with claims defining the features of the embodiments of the invention that are regarded as novel, it is believed that the method, system, and other embodiments will be better understood from a consideration of the following description in conjunction with the drawing figures.

Non-Limiting Exemplary Embodiments

[0064] When a rifle cartridge ignites the pressure build up in the chamber can be as high as 80000+ psi (FIG. 1B). The temperatures can reach 1000+ degrees. The gas pressures decrease as they travel down the barrel behind the projectile that is pushed ahead of the chamber pressure, see plot FIG. 1B. The gases in the chamber include uncombusted propellant that ignites upon exhaustion into the ambient environment generating muzzle flash as discussed in the background section. A method of reducing the flash is to disperse the exhaust gases, reduce the exhausted temperature of the gases, and directing the exhaust gases away from the projectile motion (reducing the occurrence of shock heating).

[0065] Three non-limiting exemplary embodiments are discussed in the figures, with respect to gas channel inclined angles. For example FIGS. 3-27, and 38A and 38B, illustrates gas channel inline angles of about 30 degrees (e.g., between 5 and 46 degrees). While FIGS. 28-33 illustrates non-limiting exemplary embodiments with gas channels inclined about 90 degrees (e.g., between 70 and 130). While FIGS. 34-38B

illustrates non-limiting exemplary embodiments with gas channel inclined angles of about 60 degrees (e.g., between 45 and 71). The examples discussed are not limitative of the scope of exemplary embodiments. Other exemplary embodiment can have variable inclined angles, and/or inclined angles outside of the ranges discussed.

[0066] FIG. 3 illustrates a flash suppressor 100 in accordance with at least one exemplary embodiment. The non-limiting example of at least one exemplary embodiment is comprised of several elements, for example a rear cap 110, a coupler 120, an insert 130 and a front cap 140. Note that the elements can include various materials for example steel alloys, aluminum alloys, nickel alloys, titanium alloys, and various other alloys (with or without coatings and layers) used for rifle manufacturing as known by one of ordinary skill in the art of rifle manufacturing. Some non-limiting examples of materials used can include inconel 718, 4130, 4140 and 4150 barrel steel.

[0067] The rear cap 110 can be operatively attached to the front cap 140, for example via the coupler 120. The coupler 120 can itself be coupled to the rear cap via various fasteners (e.g., threads, bolts, welds, pins, screws, and other fastening methods as known by one of ordinary skill in bonding and fastening metal and/or rifle parts). FIG. 3 illustrates a non-limiting method of fastening (e.g., 112, 122, 142) by threads (e.g., 18, 24, 28 threads/inch). The insert 130 can be operatively attached to the rear cap 110, for example the insert can be fastened (e.g. press fitted) to the front cap 140, which in turn can be fastened or attached (e.g. threadily, i.e., by screwing via threads) to the coupler, which in turn can be attached (e.g., threadily) to the rear cap 110. The rear cap 110 can be attached or fastened to the barrel (e.g., threadily via threads 105). The flash suppressor 100 can be fastened to various barrel sizes (e.g., pistol, rifles) to reduce flash production by dispersing the exhausted gas, decreasing the temperature of the exhausted gases. Note press fitting can include pressing a piece into a tight opening of another piece, but can also include heating one or both pieces (e.g., the front cap 240, to increase the opening then press the insert 230 into the expanded opening). Additionally the insert 230 and the front cap 240 can be made of different materials with different thermal coefficient of expansion. For example the front cap 240 can be heated and the insert 230 can be cooled, and the insert 230 inserted into the front cap 240. If the thermal expansion coefficient of the insert 230 is larger than the front cap 240 then when both are heated the insert will expand more becoming tighter during operation of the flash suppressor.

[0068] FIG. 4 illustrates a cross section of a flash suppressor as illustrated in FIG. 5 and FIG. 3 in accordance with at least one exemplary embodiment. The flash suppressor 100 has a barrel side 103 facing or attached to the barrel, and a flash side 149 facing a flash region. The exhausted gases from the barrel pass through the barrel side 103 and into a rear cap gas region 115, enclosed by the inside of at least a portion of the rear cap 110. The projectile, upon partially leaving the barrel, obstructs a portion of an insert bore region 135 as the projectile passes through the insert 130. A majority of the non-obstructed gases pass into the rear cap gas region 115 and then into a coupler gas region 125. The coupler gas region 125 can be enclosed by the inside of at least a portion of the coupler 120. The gas then passes through the coupler gas region 125 into and through the gas channel(s) 152 into the ambient environment. There can be any number of gas channel(s) 152 and each gas channel 152 can include a gas channel

recess 150 that aids in manufacturing gas channel(s) 152 inclined at an angle (e.g., inclined angle of about 0 degrees to 180 degrees) with respect to the projectile direction 190. The incline angle can be measured between a channel vector parallel to an axis running through the center of the gas channel and a vector running parallel to the projectile direction 190.

[0069] The flash suppressor 100 can be fastened to the barrel, for example by tightening via twisting a wrench using the rear cap barrel side wrench indent 111 and/or the rear cap barrel side second wrench indent 117 and/or front cap flash side wrench indent 145. FIGS. 38A and 38B illustrate at last one exemplary embodiment of a flash suppressor 800 attached to a barrel 888.

[0070] FIG. 6 illustrates a front view of the flash suppressor 100 illustrated in FIG. 5. The view looks into a gas channel recess 150, of which the non-limiting example illustrates six gas channel recesses 150, where there is at least one exemplary embodiment with various number of gas channel(s) 152 with or without gas channel recesses 150. FIG. 7 illustrates a cross sectional view of a front cap in accordance with at least one exemplary embodiment, showing the inclined gas channel(s) 152.

[0071] FIGS. 8A and 8B illustrates various cross sectional views of the passage of a projectile through a flash suppressor in accordance with at least one exemplary embodiment. FIGS. 8A and 8B illustrates a cross section of a flash suppressor in accordance with at least one exemplary embodiment. The projectile 260, after passing through the insert 230, passes through the front cap bore region 243 into the front cap expansion region 247, and out of the flash suppressor 200 along the projectile direction 290 through the flash side 249. When a projectile 260 is fired the exhausted gases from the barrel pass into the rear cap gas region 215, enclosed by the inside of at least a portion of the rear cap 210. The projectile 260, upon partially leaving the barrel, obstructs a portion of an insert bore region 235 as the projectile passes through the insert 230. A majority of the non-obstructed gases pass into the rear cap gas region 215 and then into a coupler gas region 225. The coupler gas region 225 can be enclosed by the inside of at least a portion of the coupler 220. The gas then passes through the coupler gas region 225 into and through the gas channel(s) 252 into the ambient environment. There can be any number of gas channel(s) 252 and each gas channel 252 can include a gas channel recess 250 that aids in manufacturing gas channel(s) 252 inclined at an angle (e.g., inclined angle of about 0 degrees to 180 degrees, and more particularly between an incline angle of about 10 degrees to about 10 degrees) with respect to the projectile direction 290. The incline angle can be measured between a channel vector parallel to an axis running through the center of the gas channel and a vector running parallel to the projectile direction 290. The projectile 260, after passing through the insert 230, passes through the front cap bore region 243 into the front cap expansion region 247, and out of the flash suppressor 200 along the projectile direction 290.

[0072] In at least one exemplary embodiment the rear cap (e.g., 210) and the coupler (e.g., 220) can be fabricated as one unitary element (e.g., machined and/or molded as one piece). Thus one physical part would include 210 and 220.

[0073] In at least one exemplary embodiment the front cap (e.g., 240) and the insert (e.g., 230) can be fabricated as one unitary element (e.g., machined and/or molded as one piece). Thus one physical part would include 230 and 240.

[0074] In at least one exemplary embodiment a first unitary element (e.g., **210** combined with **220**) can be fastened to a second unitary element (e.g., **230** combined with **240**). Further one of the unitary elements (e.g. the first unitary element) can be configured to be fastened to a barrel.

[0075] FIG. 8A illustrates the passage of the projectile **260** through the flash suppressor. In this particular non-limiting example the projectile enters the insert bore region **235** and obstructs a majority of the exhaust gas from entering the insert bore region, instead a majority of the exhaust gas passes into the rear cap region **215** and then the coupler gas region **225** before passing through the gas channels. The projectile **260** will travel a projectile path length in a projectile transit time through the flash suppressor while the exhaust gas moves from the barrel to a gas channel exit in a gas transit time along a gas path length. In at least one non-limiting example the gas transit time is less than or equal to the projectile transit time. At least one non-limiting exemplary embodiment is designed so that the gas transit time is greater than the projectile transit time. Thus in at least one non-limiting exemplary embodiment the projectile is ejected first from the flash suppressor and the exhaust gas afterwards so that the gas ejected does not interfere with the projectile. In at least one further non-limiting exemplary embodiment the gas transit time can be less than the projectile transit time while the projectile path length is less than the gas path length. In yet a further exemplary embodiment, if the path lengths are about the same, since the gas speed is greater than the projectile speed, the gas will be exhausted prior to the projectile being ejected. In at least one exemplary embodiment the gas channel inclined angle is such that a portion of the exhaust gas is directed away from the projectile direction **290**. For example if a projectile vector along the projectile direction is the reference direction and 0 angle, and a vector representing the direction of the center of the gas exhausted from a gas channel **252** is the gas vector, then the inclined angle is the angle of intersection between the projectile vector and the gas vector. The inclined angle can be from 0 to 180 degrees, more specifically in at least one non-limiting example the angular range can be between about 10 and about 160 degrees. For example if the inclined angle were about 180 degrees then the exhaust gas would be directed in a direction opposite to the projectile direction **290**, reducing the recoil of the rifle due to the projectile. In addition to the recoil due to the projectile being emitted (projectile recoil), the exhausted gas is normally emitted from the end of the barrel in the direction of the projectile. The exhausted gas also results in recoil (gas recoil). If the gas is redirected then the gas recoil can be reduced. For example if the incline angle is about 180 degrees then the recoil due to gas is reduced and in actuality if at least a portion of the exhausted gases (e.g., the inclined angle is greater than 90 degrees) are directed opposite to the projectile motion, helping to reduce projectile recoil.

[0076] The projectile motion illustrated in FIGS. 8A and 8B illustrates that the projectile **260** has a large diameter portion of length **L0** (projectile effective sealing length). In the non-limiting example illustrated the projectile effective sealing length **L0** is greater than an insert offset distance **L1**, thus the end of the projectile **250** passes out of the barrel after the projectile **260** has sealed the insert **230**. By sealed what is meant is that only a portion of the insert bore region **235** is available for exhaust gas to pass through the insert **230** (for example which can be operatively attached to the front cap **240**), while a larger portion of area is available for the exhaust

gas to pass into the rear cap gas region **215**. For example the projectile cross section **261** seals an area of the insert bore region **235**, while a portion **263** of the insert bore region **235** is substantially free for the exhaust gases to pass around the projectile **260**. The gas that passes into the rear cap gas region **215** and then into the coupler gas region **225** exhausts out of the gas channel **252** through gas channel exhaust area **267**. In at least one exemplary embodiment the total gas channel exhaust area (number of gas channel exhausts, e.g., six illustrated in FIG. 8B, times the gas channel exhaust area **267**) is larger than the area portion **263**.

[0077] FIG. 9 illustrates a flash suppressor **300** in accordance with at least one exemplary embodiment. The non-limiting example of at least one exemplary embodiment is comprised of several elements, for example a rear cap **310**, a coupler **320**, an insert **330** and a front cap **340**. Note that the elements can include various materials for example steel alloys, aluminum alloys, nickel alloys, titanium alloys, and various other alloys (with or without coatings and layers) used for rifle manufacturing as known by one of ordinary skill in the art of rifle manufacturing.

[0078] The rear cap **310** can be operatively attached to the front cap **340**, for example via the coupler **320**. The coupler **320** can itself be coupled to the rear cap via various fasteners (e.g., threads, bolts, welds, pins, screws, and other fastening methods as known by one of ordinary skill in bonding and fastening metal and/or rifle parts). FIG. 9 illustrates a non-limiting method of fastening (e.g., **312**, **322**, **342**) by threads (e.g., right or left hand threads, 18, 24, 28 threads/inch). The insert **330** can be operatively attached to the rear cap **310**, for example the insert can be fastened (e.g. press fitted) to the front cap **340**, which in turn can be fastened or attached (e.g. threadily, i.e., by screwing via threads) to the coupler, which in turn can be attached (e.g., threadily) to the rear cap **310**. The rear cap **310** can be attached or fastened to the barrel (e.g., threadily via threads **305**). The flash suppressor **300** can be fastened to various barrel sizes (e.g., pistol, rifles) to reduce flash production by dispersing the exhausted gas, decreasing the temperature of the exhausted gases. Note at least one exemplary embodiment one can use right hand threads as fasteners where when the gas is exhausted the system is torque to tighten the fastening of the various parts.

[0079] FIG. 10 illustrates a cross section of a flash suppressor as illustrated in FIG. 11 and FIG. 9 in accordance with at least one exemplary embodiment. The flash suppressor **300** has a barrel side **303** facing or attached to the barrel, and a flash side **349** facing a flash region. The exhausted gases from the barrel pass through the barrel side **303** and into a rear cap gas region **315**, enclosed by the inside of at least a portion of the rear cap **310**. The projectile, upon partially leaving the barrel, obstructs a portion of an insert bore region **335** as the projectile passes through the insert **330**. A majority of the non-obstructed gases pass into the rear cap gas region **315** and then into a coupler gas region **325**. The coupler gas region **325** can be enclosed by the inside of at least a portion of the coupler **320**. The gas then passes through the coupler gas region **325** into and through the gas channel(s) **352** into the ambient environment. There can be any number of gas channel(s) **352** and each gas channel **352** can include a gas channel recess **350** that aids in manufacturing gas channel(s) **352** inclined at an angle (e.g., inclined angle of about 0 degrees to 180 degrees) with respect to the projectile direction **190**. The incline angle can be measured between a channel vector parallel to an axis running through the center of the gas

channel and a vector running parallel to the projectile direction **190**. The projectile **260**, after passing through the insert **330**, passes through the front cap bore region **343** into the front cap expansion region **347**, and out of the flash suppressor **300** along the projectile direction **190** through the flash side **349**.

[0080] The flash suppressor **300** can be fastened to the barrel, for example by tightening via twisting a wrench using the rear cap barrel side wrench indent **311** and/or front cap flash side wrench indent **345**.

[0081] FIG. **12** illustrates a front view of the flash suppressor **300** illustrated in FIG. **11**. The view looks into a gas channel recess **350**, of which the non-limiting example illustrates six gas channel recesses **350**, where there is at least one exemplary embodiment with various number of gas channel(s) **352** with or without gas channel recesses **350**. FIG. **13** illustrates a cross sectional view of a front cap in accordance with at least one exemplary embodiment, showing the inclined gas channel(s) **352**.

[0082] The non-limiting exemplary embodiment illustrated in FIGS. **9-13**, illustrate a shorter version of a flash suppressor as compared to the non-limiting example illustrated in FIGS. **3-7**. For example a shorter version can be used in smaller rifles or pistols. Note that although six gas channel exhaust areas **267** are illustrated, any number can be used in exemplary embodiments. Additionally although the areas **267** are symmetrically arranged (as measured from angular projections of the gas channel axes on a plane substantially perpendicular to the projectile direction **190**, where symmetrically arrange gas channels have equally angular spread around point representing the projectile direction **190** intersecting the substantially perpendicular plane) about the projectile direction **190**, the area(s) **267** can also be arranged asymmetrically about the projectile direction **190**.

[0083] FIG. **14** illustrates a flash suppressor **400** in accordance with at least one exemplary embodiment. The non-limiting example of at least one exemplary embodiment is comprised of several elements, for example a rear cap **410**, a coupler **420**, an insert **430** and a front cap **440**. Note that the elements can include various materials for example steel alloys, aluminum alloys, nickel alloys, titanium alloys, and various other alloys (with or without coatings and layers) used for rifle manufacturing as known by one of ordinary skill in the art of rifle manufacturing.

[0084] The rear cap **410** can be operatively attached to the front cap **440**, for example via the coupler **420**. The coupler **420** can itself be coupled to the rear cap via various fasteners (e.g., threads, bolts, welds, pins, screws, and other fastening methods as known by one of ordinary skill in bonding and fastening metal and/or rifle parts). FIG. **14** illustrates a non-limiting method of fastening (e.g., **412**, **422**, **442**) by threads (e.g., 18, 24, 28 threads/inch). The insert **430** can be operatively attached to the rear cap **410**, for example the insert can be fastened (e.g. press fitted) to the front cap **440**, which in turn can be fastened or attached (e.g. threadily, i.e., by screwing via threads) to the coupler, which in turn can be attached (e.g., threadily) to the rear cap **410**. The rear cap **410** can be attached or fastened to the barrel (e.g., threadily via threads **405**). The flash suppressor **400** can be fastened to various barrel sizes (e.g., pistol, rifles) to reduce flash production by dispersing the exhausted gas, decreasing the temperature of the exhausted gases. The front cap **440** includes a front cap flash side wrench indent **445** and a fastener **447** adapted to connect to a sound suppressor. Thus FIGS. **14-18** illustrate a

non-limiting exemplary embodiment that is configured to attach to a sound suppressor or other rifle devices that can be attached to the fastener **447**.

[0085] FIG. **15** illustrates a cross section of a flash suppressor as illustrated in FIG. **16** and FIG. **14** in accordance with at least one exemplary embodiment. The flash suppressor **400** has a barrel side **403** facing or attached to the barrel, and a flash side **449** facing a flash region. The exhausted gases from the barrel pass through the barrel side **403** and into a rear cap gas region **415**, enclosed by the inside of at least a portion of the rear cap **410**. The projectile, upon partially leaving the barrel, obstructs a portion of an insert bore region **435** as the projectile passes through the insert **430**. A majority of the non-obstructed gases pass into the rear cap gas region **415** and then into a coupler gas region **425**. The coupler gas region **425** can be enclosed by the inside of at least a portion of the coupler **420**. The gas then passes through the coupler gas region **425** into and through the gas channel(s) **452** into the ambient environment. There can be any number of gas channel(s) **452** and each gas channel **452** can include a gas channel recess **450** that aids in manufacturing gas channel(s) **452** inclined at an angle (e.g., inclined angle of about 0 degrees to 180 degrees) with respect to the projectile direction **190**. The incline angle can be measured between a channel vector parallel to an axis running through the center of the gas channel and a vector running parallel to the projectile direction **190**. The projectile **260**, after passing through the insert **430**, passes through the front cap bore region **443** into the front cap expansion region **447**, and out of the flash suppressor **400** along the projectile direction **190** through the flash side **449**.

[0086] The flash suppressor **400** can also include a registration protrusion **437** for a sound suppressor. The flash suppressor **400** can be fastened to the barrel, for example by tightening via twisting a wrench using the rear cap barrel side wrench indent **411** and/or front cap flash side wrench indent **445**.

[0087] FIG. **17** illustrates a front view of the flash suppressor **400** illustrated in FIG. **16**. The view looks into a gas channel recess **450**, of which the non-limiting example illustrates six gas channel recesses **450**, where there is at least one exemplary embodiment with various number of gas channel(s) **452** with or without gas channel recesses **450**. FIG. **18** illustrates a cross sectional view of a front cap in accordance with at least one exemplary embodiment, showing the inclined gas channel(s) **452**.

[0088] The exemplary embodiment discussed herein refer to a flash suppressor which can include a method or apparatus of attachment (e.g., threads **447** (for example right and/or left handed threads), FIG. **22**) by which other devices can be attached to (e.g., at end or sides) of the flash suppressor. For example FIG. **19** illustrates the flash suppressor of FIG. **14**, and a sound suppressor **500** (FIG. **20**) as a non-limiting example of what can be attached to the flash suppressor of at least one exemplary embodiment. The sound suppressor **500** can be attached (e.g., via screwing the sound suppressor onto the thread **447**) to the flash suppressor **400**. FIGS. **21** and **22** illustrate side and cross sectional view of the sound suppressor **500** attached to the flash suppressor **400** illustrated in FIG. **19**. Although a sound suppressor is illustrated as being attached to the flash suppressor **400**, other devices can be attached or likewise the flash suppressor attached to other devices.

[0089] FIGS. 23-27 illustrate the front cap 440 as illustrated in FIG. 14. FIG. 23 illustrates a sectional view of a front cap 540 extension illustrated in FIG. 25 in accordance with at least one exemplary embodiment. FIG. 23 illustrates a cross-section E-E of FIG. 25. As illustrated a gas channel 552 and a gas channel recess 550 can have a channel axis 557 that is inclined (θ) with respect to a reference axis 570. A gas channel axis is produced at an inclined angle θ with respect to the front cap axis 570. As previously discussed the inclined angle can vary, for example the inclined angle can lie between 0 and 180 degrees, and more particularly for the particular non limiting exemplary embodiment the inclined angle is about 30 degrees (for example between 5 and 46 degrees). Note that at least one exemplary embodiment can have individual gas channel 552 have different inclined angles. For example if there are six gas channel(s), three can have an inclined angle of 30 degrees and the remaining three can have 60 degrees. Note that any number of gas channels and inclined angles fall within the scope of at least one exemplary embodiment. For example there can be one gas channel, two gas channels, and so on, where the gas channels can be distributed at equal angles (symmetrically) or non symmetric. Each gas channel 552 can have uniform cross sections or non symmetric cross sections, for example the cross sectional area of the channels can be designed to modify any Mach level flows in the channel. Each gas channel 552 can have a non-tubular shape (e.g., the cross section can narrow or broaden along the gas channel axis). Additionally a gas channel 552 can deviate from a straight line, for example form an "C" shape of other curved shape, or even straight line deviations (e.g., a "V" shape). Each gas channel 552 can also be unique in shape an inclined angle about the front cap axis 570.

[0090] FIG. 24 illustrates a portion cutout of a sound suppressor coupling element in accordance with at least one exemplary embodiment. FIG. 26 illustrates a front cap 540 in accordance with at least one exemplary embodiment, illustrating fasteners 542 and 547 (e.g., threadily fastenable), a gas channel 552 cross section, a gas channel recess 550, and an optional front cap flash side wrench indent 545. FIG. 26 illustrates cross section F-F of FIG. 27.

[0091] FIG. 28 illustrates a flash suppressor 600 in accordance with at least one exemplary embodiment. The non-limiting example of at least one exemplary embodiment is comprised of several elements, for example a rear cap 610, a coupler 620, an insert 630 and a front cap 640. Note that the elements can include various materials for example steel alloys, aluminum alloys, nickel alloys, titanium alloys, and various other alloys (with or without coatings and layers) used for rifle manufacturing as known by one of ordinary skill in the art of rifle manufacturing.

[0092] The rear cap 610 can be operatively attached to the front cap 640, for example via the coupler 620. The coupler 620 can itself be coupled to the rear cap via various fasteners (e.g., threads, bolts, welds, pins, screws, and other fastening methods as known by one of ordinary skill in bonding and fastening metal and/or rifle parts). FIG. 28 illustrates a non-limiting method of fastening (e.g., 612, 622, 642) by threads (e.g., 18, 24, 28 threads/inch). The insert 630 can be operatively attached to the rear cap 610, for example the insert can be fastened (e.g. press fitted) to the front cap 640, which in turn can be fastened or attached (e.g. threadily, i.e., by screwing via threads) to the coupler, which in turn can be attached (e.g., threadily) to the rear cap 610. The rear cap 610 can be attached or fastened to the barrel (e.g., threadily via threads

605). The flash suppressor 600 can be fastened to various barrel sizes (e.g., pistol, rifles) to reduce flash production by dispersing the exhausted gas, decreasing the temperature of the exhausted gases.

[0093] FIG. 29 illustrates a cross section of a flash suppressor as illustrated in FIG. 31 and FIG. 28 in accordance with at least one exemplary embodiment. The flash suppressor 600 has a barrel side 603 facing or attached to the barrel, and a flash side 649 facing a flash region. The exhausted gases from the barrel pass through the barrel side 603 and into a rear cap gas region 615, enclosed by the inside of at least a portion of the rear cap 610. The projectile, upon partially leaving the barrel, obstructs a portion of an insert bore region 635 as the projectile passes through the insert 630. A majority of the non-obstructed gases pass into the rear cap gas region 615 and then into a coupler gas region 625. The coupler gas region 625 can be enclosed by the inside of at least a portion of the coupler 620. The gas then passes through the coupler gas region 625 into and through the gas channel(s) 652 into the ambient environment. There can be any number of gas channel(s) 652 and each gas channel 652 can include a gas channel recess 650 that aids in manufacturing gas channel(s) 652 inclined at an angle of about 90 degrees in the non exemplary illustrated (e.g., inclined angle between 70 degrees to 130 degrees) with respect to the projectile direction 673. The incline angle can be measured between a channel vector parallel to an axis running through the center of the gas channel and a vector running parallel to the projectile direction 673. The projectile 260, after passing through the insert 630, passes through the front cap bore region 643 into the front cap expansion region 647, and out of the flash suppressor 600 along the projectile direction 673 through the flash side 649.

[0094] The flash suppressor 600 can be fastened to the barrel, for example by tightening via twisting a wrench using the rear cap barrel side wrench indent 611 and/or front cap flash side wrench indent 645.

[0095] FIG. 33 illustrates a front view of the flash suppressor 600 illustrated in FIG. 5. The view looks into a gas channel recess 650, of which the non-limiting example illustrates six gas channel recesses 650, where there is at least one exemplary embodiment with various number of gas channel(s) 652 with or without gas channel recesses 650.

[0096] FIG. 30 illustrates an isometric view of the front cap 640, which illustrates front cap bore region 653, and a slot intake 657 (see also FIG. 32) to the gas channel 652. FIG. 33 illustrates at least one exemplary embodiment that illustrates a gas channel axis 677 at angular inclined with respect to a reference axis 679, substantially perpendicular to projectile direction 673. Note that the gas channels 652, illustrated in FIG. 33 appear at a right angle with respect to axis 673. However the gas channels 652 can be at various angles from about 0 to 180 degrees, more specifically in at least one non-limiting exemplary embodiment 10 to 160 degrees. For example one exemplary embodiment can direct the gases backwards (greater than 90 degrees), which can be used to reduce the total recoil.

[0097] FIG. 34 illustrates a cross section of a flash suppressor as illustrated in FIG. 35 in accordance with at least one exemplary embodiment, where FIG. 36 illustrates a front cap cross sectional view in accordance with at least one exemplary embodiment and FIG. 37 illustrates a front view of the front cap illustrated in FIG. 36. In the non-limiting exemplary

embodiment the gas channel **752** can have a channel axis **757** that is inclined (θ) with respect to a reference axis (e.g., front cap axis **770**).

[0098] The gas channel axis **757** is produced at an inclined angle θ with respect to the front cap axis **770**. As previously discussed the inclined angle can vary, for example the inclined angle can lie between about 1 and about 179 degrees, and more particularly for the exemplary embodiment illustrated about 60 degrees (e.g., between about 45 and 71 degrees). Note that at least one exemplary embodiment can have individual gas channel **752** have different inclined angles. In the non-limiting exemplary embodiment illustrated in FIG. **36** the inclined angle is about 60 degrees. Note that any number of gas channels and inclined angles in presented examples are non-limiting examples only.

[0099] FIGS. **38A** and **38B** illustrate various cross sectional views of the passage of a projectile **860** through a flash suppressor **800** in accordance with at least one exemplary embodiment. In the non-limiting example a fastener (e.g., threads **805**) can be used to attach the flash suppressor **800** to a barrel **888** via a barrel fastener (e.g., threads **891**).

[0100] At least one exemplary embodiment is directed to a flash suppressor comprising: a first gas region (e.g., rear cap gas region **115**), where the first gas region can be enclosed by first solid portion (e.g., a portion of the rear cap **110**), where the first solid portion is configured so that the first solid portion can be operatively attached to a barrel (e.g., by threaded portion **105** screwed onto a similar threaded portion on a barrel); a second gas region (e.g., coupler gas region **125**), where the second gas region can be enclosed by a second solid portion (e.g., a portion of coupler **120**), where the second solid portion is operatively attached to the first solid region (e.g., attaching coupler **120** to the rear cap **110** by threads **112** screwed into similar threads in the coupler **120**); a bore region (e.g., insert bore region **135**), where the bore region can be enclosed by a third solid portion (e.g., a portion of insert **130**), where the bore region is configured to facilitate the passage of a projectile through the bore region (e.g., clearance enough for a projectile **260**), where the bore region has a bore axis that is parallel to an axis of a bore of the barrel; and at least one gas channel (e.g., **152**), where the at least one gas channel passes through a fourth solid portion (e.g., a portion of the front cap **140**), where the fourth solid region is operatively attached to the third solid portion (e.g., the insert **130** press fitted into a portion of the front cap **140**), where the fourth solid portion is operatively attached to the second solid portion (e.g., attaching the front cap **140** to the coupler **120** by threads **122** screwed into similar threads in the front cap **140**), where the first gas region is configured to accept at least a first portion of the gases exhausted from the barrel when a projectile is exhausted from the barrel. For example when the projectile is emitted from the barrel, combustion gas follows the projectile.

[0101] The projectile blocks a majority of the gas from entering the insert bore region (e.g., **135**) so that a larger portion of the gas flows into the rear cap gas region (e.g., **115**). The first gas region is configured to direct the first portion of gases into the second gas region. For example the portion of gas flowing into the rear cap gas region (e.g., **115**) is also directed into the coupler gas region (e.g., **125**). The second gas region is configured to direct a second portion of the first portion of the gases exhausted into the at least one gas channel (e.g., **152**). For example the gas flowing into the coupler gas region **125** can be directed into the gas channel(s) (e.g., **152**).

The at least one gas channel has a channel axis that is at a non-zero angle with respect to the bore axis. For example in at least one exemplary embodiment the gas channels are directed parallel to the projectile direction **190**, however the gas channel axis can have a non-zero value, as stated, with regards to the projectile direction **190**, for example 30 degrees and/or 60 degrees (note that any non zero angle can be used). The at least one gas channel directs at least a third portion of the second gas portion to an ambient environment surrounding the flash suppressor. For example the end of the gas channel **152** terminates at the ambient environment.

[0102] In at least one exemplary embodiment the second and fourth solid portions are part of a unitary machined element. For example the insert **130** and front cap **140** are fabricated from a single inconel element.

[0103] In at least one further exemplary embodiment the first and third solid portions are part of a unitary machined element. For example the rear cap **110** and the coupler **120** are fabricated from a single piece of steel. In at least one further exemplary embodiment the unitary machined element is fastened to the first solid portion, and where the first solid portion is configured to be attached to a barrel. For example an insert **130** and front cap **140** fabricated from a single material can be attached (e.g., threadily attached) to the rear cap **110** and coupler **120** fabricated, from a single material, where the rear cap **110** is attached to the barrel (e.g., threadily attached). In at least one further exemplary embodiment the first solid portion is fastened to the barrel by at least one of a threaded portion, a weld, a latch, a bolt, press fitted, and a pin. For example the rear cap **110** can be attached by screwing a threaded portion **105** into a similar threaded portion on a barrel. At least other further exemplary embodiments can have the rear cap **110** attached by welding the rear cap **110** onto the barrel, by latching the rear cap **110** to the barrel (e.g., by a rotating a portion onto a key onto the barrel to lock the rear cap **110** onto the barrel, or a simple latch), by a bolt or pin pressed through a groove in the barrel and a matching groove in a portion of the inserted rear cap **110**, by press fitting the barrel into the rear cap **110**, or by other fastening methods as would be known by one of ordinary skill in rifle manufacturing. Note that other elements of the flash suppressor can be fastened to other elements by fastening methods already discussed.

[0104] Note that elements of the flash suppressor (e.g., rear cap **110**, front cap **140**, insert **130** and coupler **120**) can be fabricated from a variety of material for example titanium and titanium alloys, steel and steel alloys, aluminum and aluminum alloys, nickel and nickel alloys and chromium alloys (e.g., inconel) or other materials used in rifle manufacturing as known by one of ordinary skill in rifle and pistol fabrication.

[0105] At least one exemplary embodiment can have multiple gas channels, and the gas channels can be arranged symmetrically about the projectile direction **190** or non symmetric.

[0106] At least one exemplary embodiment has a first gas channel (e.g., **152**) that has a first channel axis (e.g., **677**), where the second gas channel has a second channel axis, where the first channel axis is inclined a first angle (e.g., θ) with respect to the bore axis (e.g., **570**), where the second channel axis is inclined a second angle with respect to the bore axis, where the first angle is non-zero and where the second angle is non-zero. For example the two gas channels can be inclined at different angles with respect to bore axis.

The gas channels can be variously shaped for example the gas channel can be a straight channel, a curved channel (e.g., “V” shape, “C” shape, gradually curved shape), with varying cross sectional areas or uniform cross-sectional areas. The exhausted gas directed along and out of the gas channels can be directed in the direction of the projectile direction or in other direction as measured from the projectile direction.

[0107] In at least one exemplary embodiment the time that it takes the projectile to leave the barrel and exit the flash suppressor end (i.e. projectile transit time) is shorter than the time it takes the exhaust gases to leave the barrel and exit the end of a gas channel (i.e. gas transit time). In at least one exemplary embodiment the projectile transit time is longer than or equal to the gas transit time. Thus, in at least one exemplary embodiment the gas channels are designed to direct the exhausted gas away from the projectile path, and in at least one exemplary embodiment to increase the gas transit time.

[0108] At least one exemplary embodiment has a projectile path length through the flash suppressor (e.g., **100**) that is shorter than the path length of the majority of exhaust gas passing through the flash suppressor and out the gas channel exits.

[0109] In at least one exemplary embodiment the projectile **260** enters the insert **130** sealing the insert **130** before the exhaust gases exit the barrel. The projectile **260** has an effective sealing length (i.e., a non tapered portion that is uniform and can seal a channel). In at least one exemplary embodiment the sealing length is longer than the offset distance from the end of the barrel to the entrance of the insert **130**.

[0110] At least one exemplary embodiment is directed to the method of diverting the exhaust gases along a path length longer than the projectile path length through the flash suppressor, while also dispersing the exhaust gases in a different direction than the projectile motion, decreasing both the exhaust gas pressure and temperature, reducing muzzle flash.

[0111] While a sample of exemplary embodiments of the invention have been illustrated and described, it will be clear that the embodiments of the invention are not so limited. Numerous modifications, changes, variations, substitutions and equivalents will occur to those skilled in the art without departing from the spirit and scope of the present embodiments of the invention as defined by the appended claims.

What is claimed is:

1. A flash suppressor comprising:

- a first gas region, where the first gas region is enclosed by a first solid portion, where the first solid portion is configured so that the first solid portion can be operatively attached to a barrel;
- a second gas region, where the second gas region is enclosed by a second solid portion, where the second solid portion is operatively attached to the first solid portion;
- a bore region, where the bore region is enclosed by a third solid portion, where the bore region is configured to facilitate the passage of a projectile through the bore region, where the bore region has a bore axis that is parallel to an axis of a bore of the barrel; and
- at least one gas channel, where the at least one gas channel passes through a fourth solid portion, where the fourth solid portion is operatively attached to the third solid portion, where the fourth solid portion is operatively attached to the second solid portion, where the first gas region is configured to accept at least a first portion of the

gases exhausted from the barrel when a projectile is exhausted from the barrel, where first gas region is configured to direct the first portion of gases into the second gas region, where the second gas region is configured to direct a second portion of the a first portion of the gases into the at least one gas channel, where the at least one gas channel has a channel axis that is at a non-zero angle with respect to the bore axis, and where the at least one gas channel directs at least a third portion of the second gas portion to an ambient environment surrounding the flash suppressor.

2. The flash suppressor of claim **1**, where the third and fourth solid portions are part of a unitary machined element.

3. The flash suppressor of claim **1**, where the first and third solid portions are part of a first unitary machined element.

4. The flash suppressor of claim **1**, where the second, third, and fourth solid portions are part of a unitary machined element.

5. The flash suppressor of claim **1**, where the second and fourth solid portions are part of a second unitary machined element.

6. The flash suppressor of claim **5**, where the first unitary machined element is fastened to the second unitary machined element, and where the first unitary machined element is configured to be attached to a barrel.

7. The flash suppressor of claim **1**, where the first solid portion is fastened to the barrel by at least one of a threaded portion, a weld, a latch, a bolt, press fitted, and a pin.

8. The flash suppressor of claim **7**, where the second solid portion is fastened to the fourth solid portion by at least one of a threaded portion, a weld, a latch, a bolt, press fitted, and a pin.

9. The flash suppressor of claim **8**, where the fourth solid portion is fastened to the third solid portion by at least one of a threaded portion, a weld, a latch, a bolt, press fitted, and a pin.

10. The flash suppressor according to claim **9** where at least a first portion of the first solid portion is fabricated from at least one of an aluminum alloy, steel alloy, titanium alloy, and a nickel alloy.

11. The flash suppressor according to claim **10**, where the at least one gas channel comprises at least a first and a second gas channel.

12. The flash suppressor according to claim **11**, where the first gas channel has a first channel axis, where the second gas channel has a second channel axis, where the first channel axis is inclined a first angle with respect to the bore axis, where the second channel axis is inclined a second angle with respect to the bore axis, where the first angle is non-zero and where the second angle is non-zero.

13. The flash suppressor according to claim **12**, where the first angle and the second angle are between about 1 degrees and about 179 degrees.

14. The flash suppressor according to claim **12**, where the first channel axis and the second channel axis lie in a plane about 90 degrees to the bore axis.

15. The flash suppressor according to claim **13**, where the first channel is tubular and directs a first exhaust gas along the first channel axis when the barrel exhausts a projectile.

16. The flash suppressor according to claim **15**, where the second channel is tubular and directs a second exhaust gas along the second channel axis when the barrel exhausts a projectile.

17. The flash suppressor according to claim **16**, where at least a portion of the first exhaust gas is directed in the forward direction, where the forward direction is along the bore axis in the direction of an exhausted projectile.

18. The flash suppressor according to claim **17**, where at least a portion of the second exhaust gas is directed in the forward direction.

19. The flash suppressor according to claim **18** where the first and second channels are symmetrically arranged about the bore axis.

20. The flash suppressor according to claim **19**, where the first portion of the gases exhausted from the barrel travel from an exit of the barrel to the exit of the first channel along a first path length, where the projectile travels from the exit of the barrel to an exit of the flash suppressor along a projectile path, where the first path length is greater than the projectile path.

21. The flash suppressor according to claim **20**, where a second portion of the gases exhausted from the barrel travel from an exit of the barrel to the exit of the second channel along a second path length, where the second path length is greater than the projectile path.

22. The flash suppressor according to claim **21**, where the projectile has a sealing length, where there is an offset dis-

tance from an entrance of the bore region to the barrel exit, where the sealing length is greater than the offset distance.

23. The flash suppressor according to claim **22**, where the first path length is greater than 1.1 times the projectile path.

24. The flash suppressor according to claim **23**, where the second path length is greater than 1.1 times the projectile path.

25. The flash suppressor according to claim **24**, where the first path length is at least a distance so that gas is exhausted from the exit of the first channel into the ambient environment after the projectile passes the exit of the flash suppressor.

26. The flash suppressor according to claim **25**, where the second path length is at least a distance so that gas is exhausted from the exit of the first channel into the ambient environment after the projectile passes the exit of the flash suppressor.

27. A method of flash suppression comprising:

directing a portion of the gases exhausted from a barrel along a first path, where the portion of gases takes a first time to travel along the first path; and

directing a projectile along a second path where the projectile takes a second time to travel along the second path, where the second time is less than the first time.

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