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(54) **SILENCER WITH EXPANSION CHAMBERS
AND MANUFACTURING METHOD
THEREOF**

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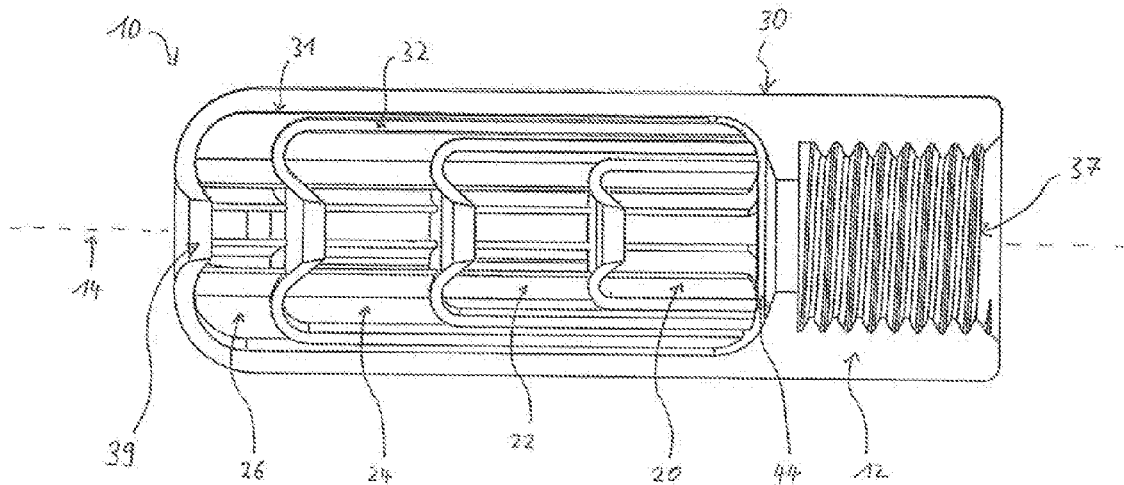
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(57) **ABSTRACT**

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Firearm silencers and processes for the production thereof in
a layered structure as one single-piece body having at least
one expansion chamber.

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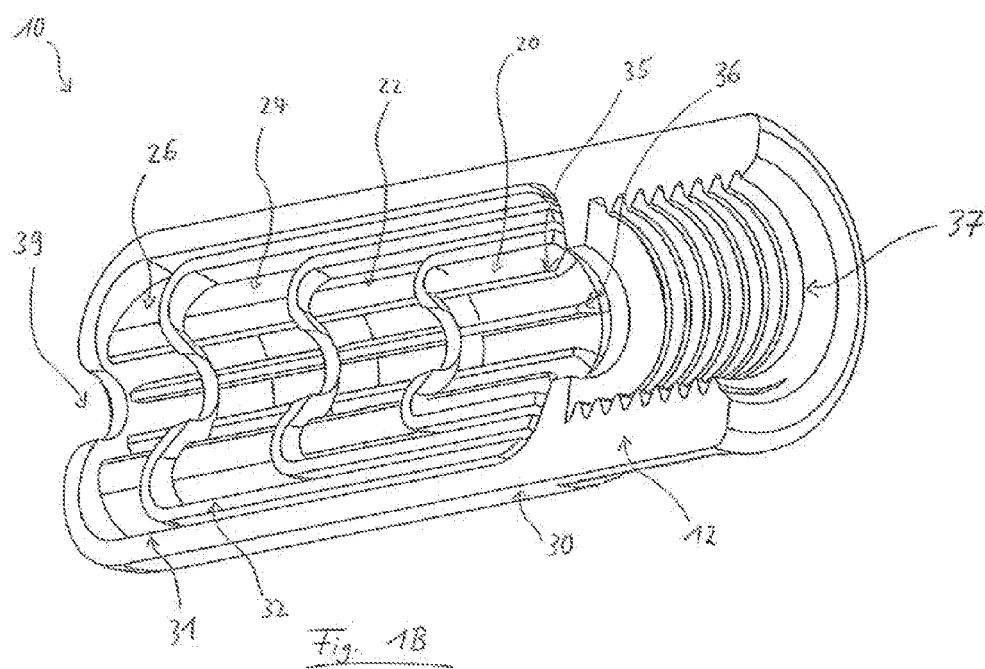
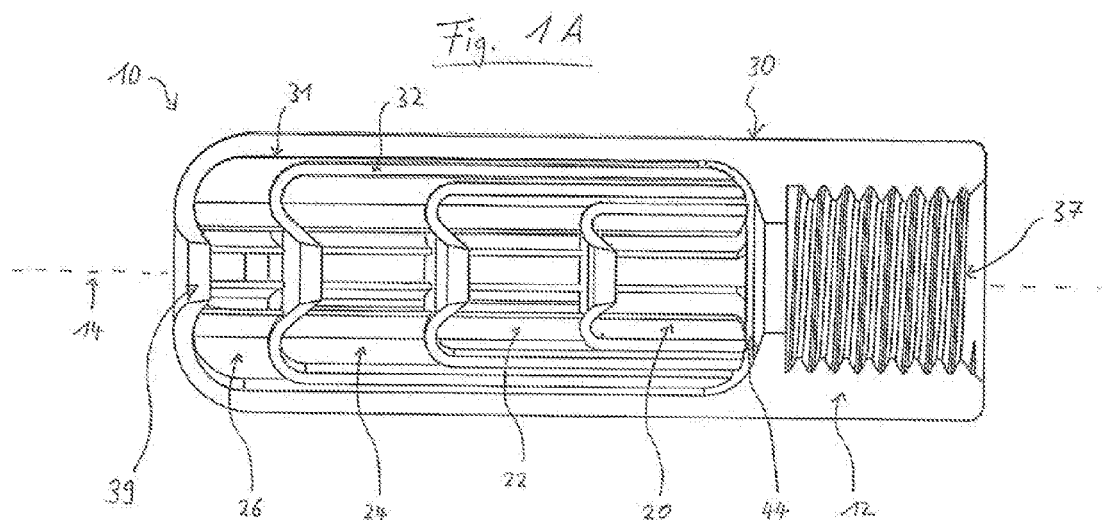


Fig. 2A

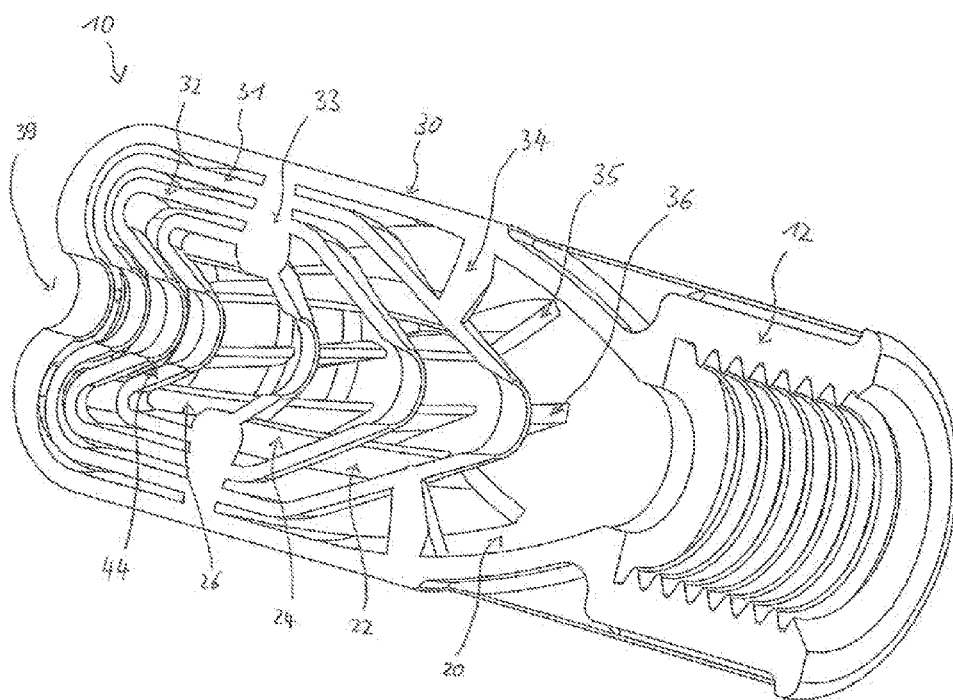
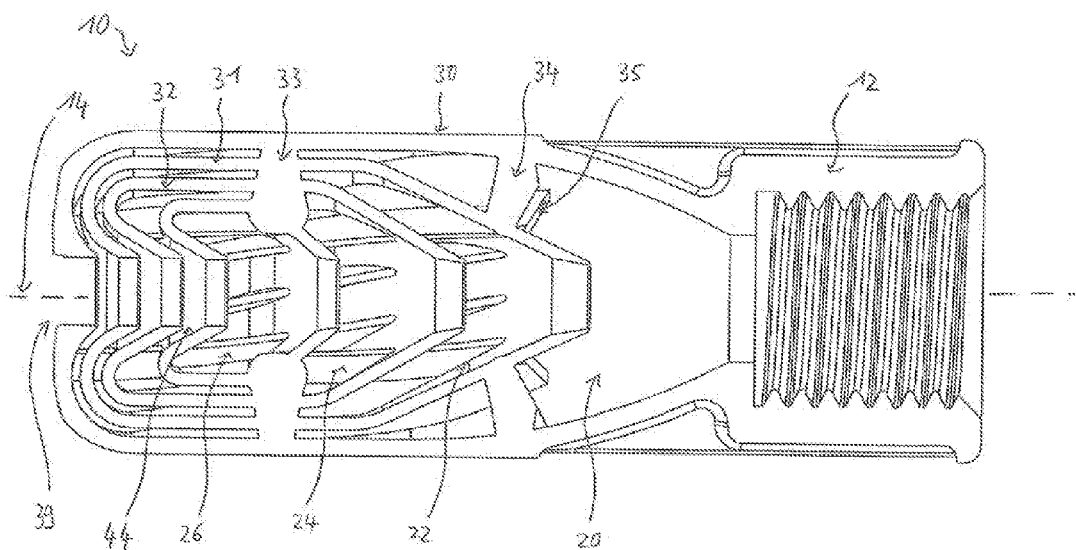


Fig. 2B

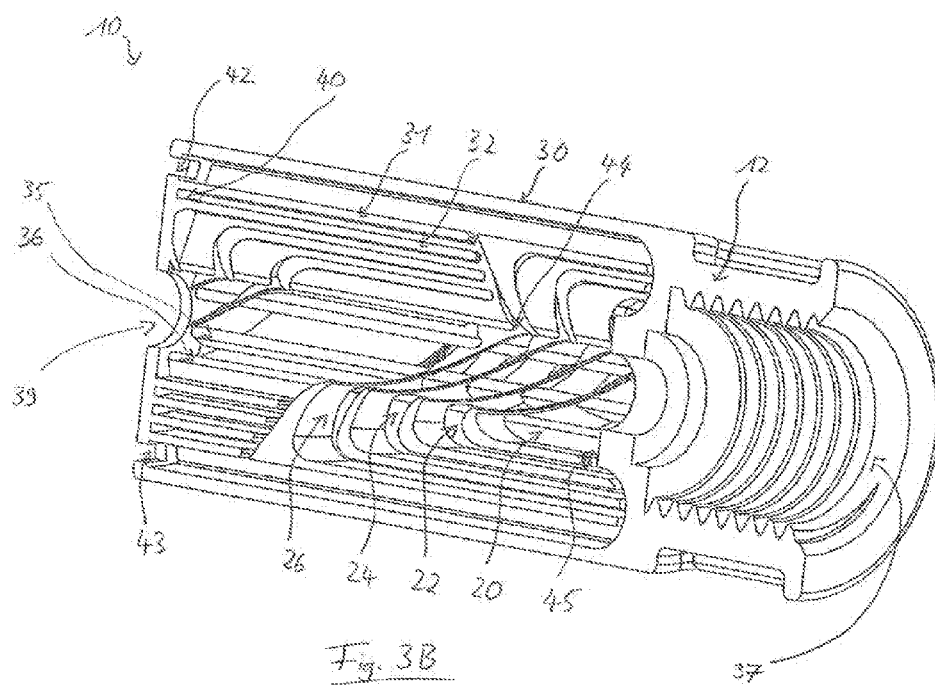
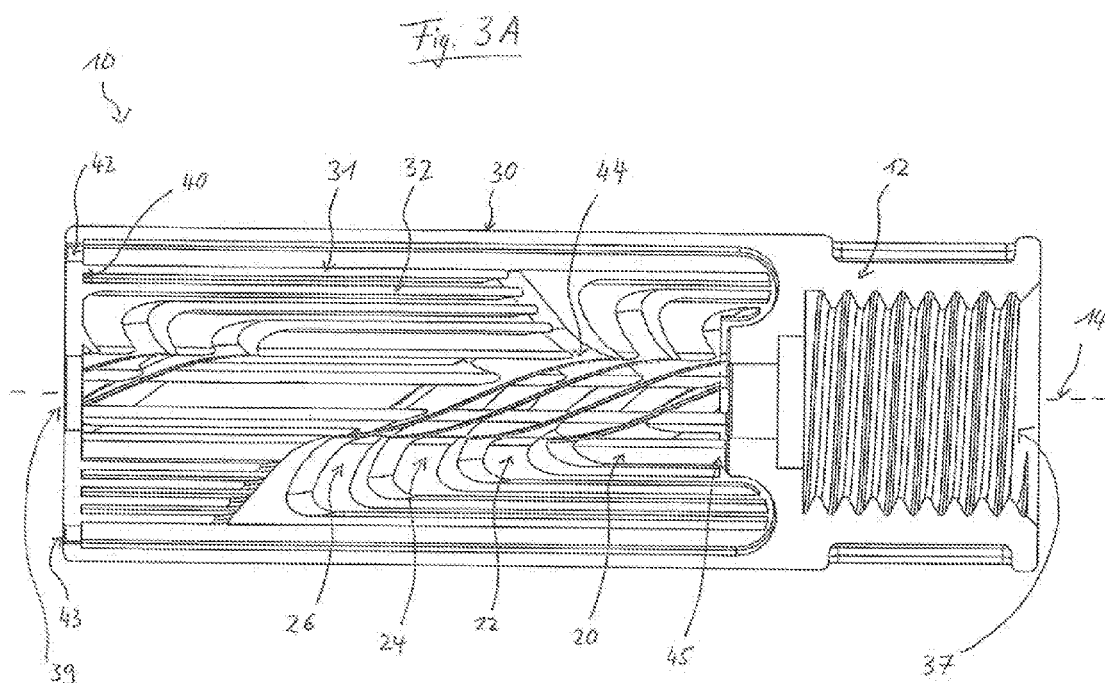


Fig. 4A

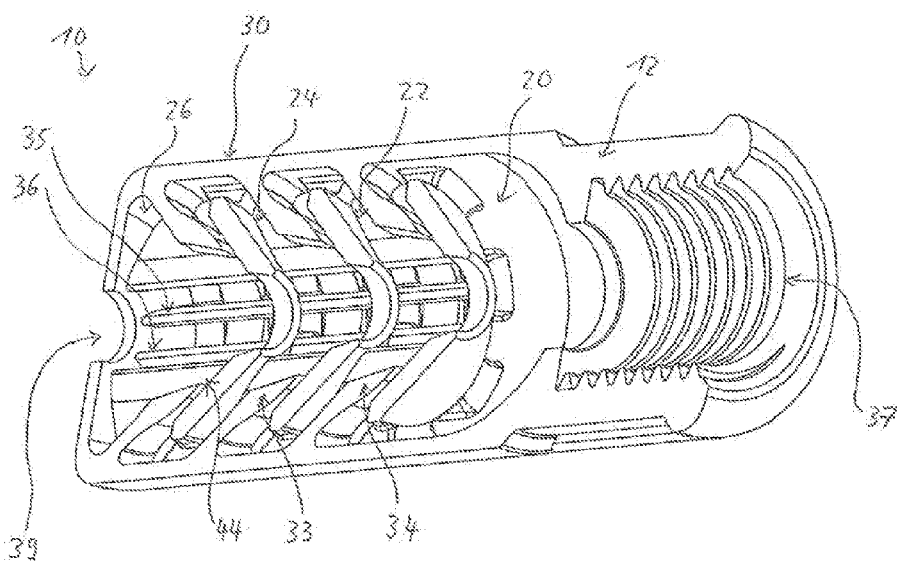
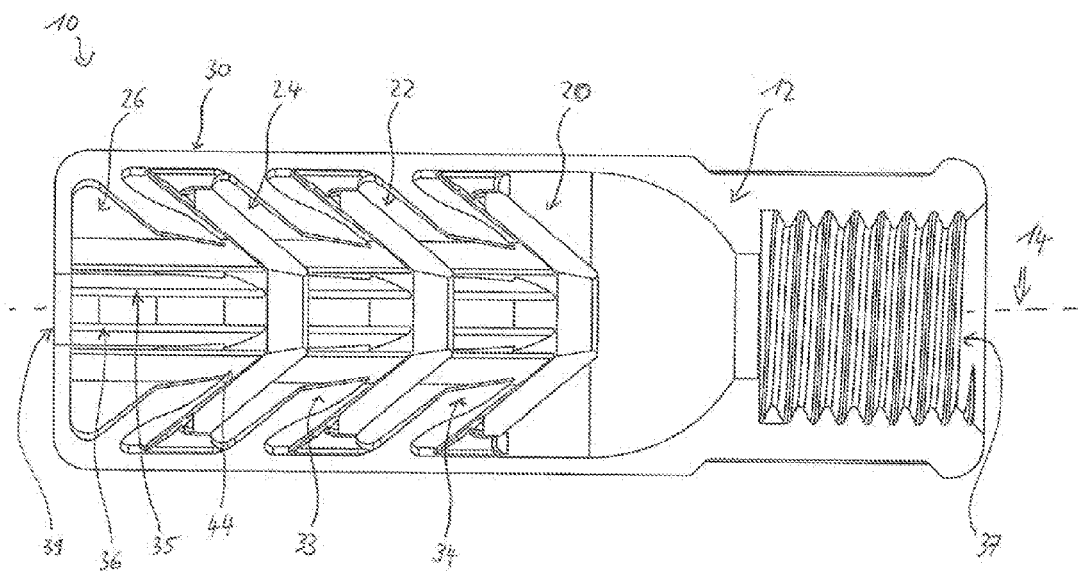


Fig. 4B

Fig. 5A

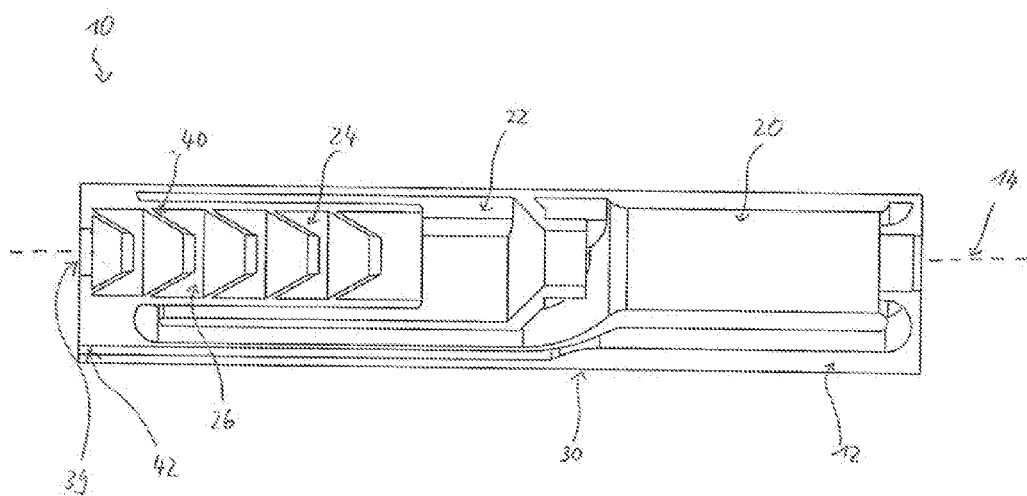
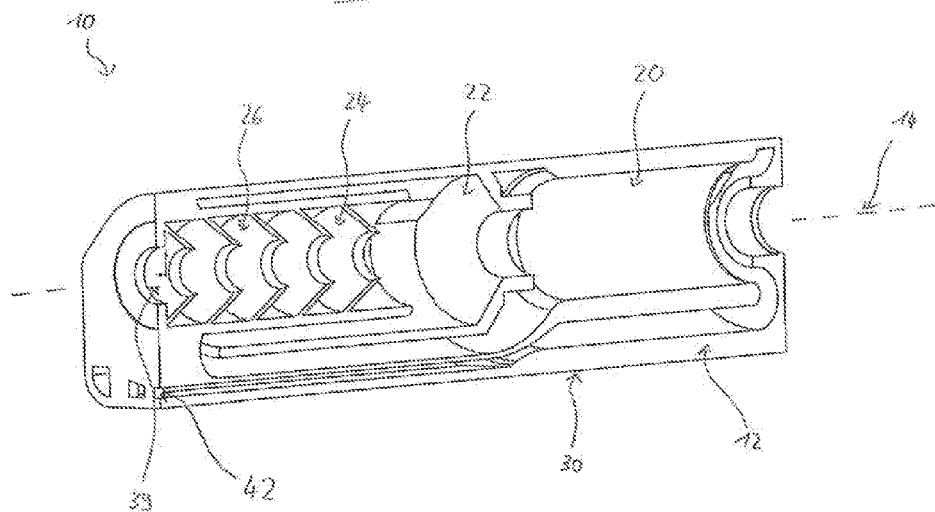


Fig. 5B



SILENCER WITH EXPANSION CHAMBERS AND MANUFACTURING METHOD THEREOF

FIELD

[0001] The invention at hand relates to the field of silencers for firearms.

BACKGROUND

[0002] Silencers for firearms serve the purpose of reducing the noise emissions resulting from the expansion of gases escaping from the barrel's muzzle, the so-called muzzle blast. Silencers are usually attached by being screwed on by a thread of the barrel or tube of the gun. Alternatively, they are connected factory-set with the weapon.

[0003] The noise reduction is desirable in some areas of use: examples of usage purposes of silencers include hunting in populated areas or avoiding alarming the wild animals. In addition, they preserve the hearing health of police and military forces.

[0004] Conventional silencers share some common characteristics. For one, they consist of several individual pieces, which are held together by a sleeve or a piece of pipe. These items are typically made of different materials. In addition, traditional silencers are turned and milled by means of conventional manufacturing processes.

[0005] A traditional silencer is, for example, known from the German patent DE 17 03 420 B2. A multi-part silencer, which has several expansion chambers divided by inserts, is disclosed there. In particular, several inserts which support each other are surrounded and held together by a piece of pipe.

[0006] The above features of conventional silencers have some disadvantages. The construction with several individual items and partially different materials, drives up both the production costs and the weight. A construction involving several individual parts is also susceptible to developing interference vibrations and assembly failures. Production by means of turning and milling limits the geometry of the silencer, in particular the geometry of the sound-absorbing elements.

SUMMARY

[0007] The invention at hand is based on the object of, at least partially, reducing the above-mentioned disadvantages of conventional silencers.

[0008] The above problem is solved by a device and a production method in accordance with independent patent claims. The dependent claims describe preferred versions. The invention consists of a firearm silencer, in short: silencer.

[0009] The device according to the invention includes a main body. This main body is formed as a single-piece body extending along and around a central longitudinal axis, and defines at least one expansion chamber, which is formed coaxially with the central longitudinal axis.

[0010] A production method for the layered, i.e. layer-wise structure is to achieve the object of the invention to provide a compact, light, material and/or cost saving construction and/or the development of new geometries and designs according to the invention.

[0011] The central longitudinal axis preferably matches a path of a projectile shot from an attached gun.

[0012] The main body, which can be produced as one single piece, is a single piece in that it is preferably made of a homogeneous material and/or requires no assembly steps involving several components, as is the case with conventional silencers.

[0013] The expansion chambers are hollow spaces formed in the main body which allow room for the expansion of gases. These gases escape from a muzzle of a firearm. Without a silencer mounted on the muzzle, the uncontrolled expansion of these gases leads to the muzzle blast. The silencers according to the invention include at least one expansion chamber which is formed to be coaxial to the central longitudinal axis. Expansion chambers can be designed as sound guide chambers. The term expansion chamber should not be understood as a description of a particular geometry. In general, co-axial bodies, chambers, etc. do not necessarily have to be rotationally symmetrical around the corresponding axis, in the sense of the present invention. Expansion chambers aligned coaxially to the central longitudinal axis result in an at least partly structural alignment.

[0014] Preferably, the main body defines at least two expansion chambers which are formed coaxially in relation to the central longitudinal axis.

[0015] The main body is preferably also made of layers in direction of the central longitudinal axis.

[0016] The main body can preferably be produced using one of the following production method of producing in the direction of a central longitudinal axis: a 3D printing method, a stereo-lithography method, a selective laser sintering method, a casting, or a forming method. A selective laser sintering method is particularly preferred during which materials, for example a metal, is selectively sintered by a laser, i.e. bound together and compacted. This procedure is preferably carried out in layers. After sintering the material of one layer, the unsintered raw material of each following layer is applied and then laser-sintered in turn. Due to symmetry and structural considerations, it is especially advantageous to form the silencer layer by layer along the direction of a central longitudinal axis, which corresponds to the firing channel.

[0017] The main body preferably defines at least one of the following elements: an outer wall, which limits at least one expansion chamber on the outside; walls aligned coaxially along the central longitude which limit at least one expansion chamber; bars, at least some of which are extending perpendicular to the central longitudinal axis; supporting structures at least some of which extend coplanar to the central longitudinal axis; a thread for connection to the barrel or an interface for connection to the barrel of the firearm; a muzzle opening; a firing channel extending along the central longitudinal axis through the main body.

[0018] An exterior wall can serve for an external presentation of the suppressor marked with a trade mark or company logo. In addition, it can provide easier handling for the user. The user grasps the external wall to attach the silencer onto a firearm.

[0019] Walls, bars and support structures respectively can each serve to provide stable statics and/or to direct the flow of the expanding gases.

[0020] A thread can provide the simple, rapid, gas leak-proof and/or secure connection with a firearm. This connection can be made either directly or indirectly. This connection can be made directly with the barrel of the firearm.

Alternatively, or in addition, this connection can be achieved indirectly using a suitable adapter or a different interface to connect the silencer with the barrel of a firearm, such as, for example, a quick-clamp. A muzzle opening serves for the projectiles to leave the silencer. A firing channel provides an unobstructed path for the projectiles and a primary direction of flow of expanding gases.

[0021] It is preferable for at least one of the expansion chambers to be curved. This allows, among others things, redirections and/or trajectories of the expansion chambers with twists, curves, etc. This has several advantages, according to the invention. For the same length of the silencer, longer effective lengths of expansion chambers become possible. Turbulence is reinforced by strong curvature, which can result in a strong reduction of the muzzle blast. Long expansion chambers also increase the limiting surface of the expansion chamber, thereby also strengthening the absorption effect.

[0022] With this invention, curvatures of the expansion chambers can be designed in various forms as desired. These curvatures may include components or portions in one or more of the following directions: azimuth direction, radial direction, or axial direction. The above-mentioned directions refer preferably to silencers being essentially cylindrical. The skilled person is well-acquainted with cylindrical geometries for use with cylindrical coordinate systems. Here, the three dimensions are described respectively using an azimuthal, radial or axial unit vector. A curvature can be expressed locally by a tangent vector. Within the cylindrical coordinate system, the tangential vector can be deconstructed into components or portions with regard to said unit vectors. Accordingly, a curvature component in azimuth direction is oriented around the central longitudinal axis.

[0023] A curvature component in radial direction is oriented away from the central axis. A curvature component in axial direction is oriented along or parallel to the central longitudinal axis. Exemplary curvatures oriented in one or more of the above directions are discussed in the version examples.

[0024] Alternatively or in addition, at least one of the expansion chambers can have a tapering and/or widening at its cross section. According to the invention, tapering and/or widening of the cross-section can be used to control the expansion of gases. They lead to increased or reduced flow velocities, and this can have impact on the damping of the muzzle blast.

[0025] Preferably, one or more expansion chambers can open into in a sound absorption area. Such a sound absorption area can have various forms. According to the invention, forms of sound absorption areas include areas made porous and areas having a foam structure. In addition or alternatively, a sound absorption area can take the shape of a bag-like end of an elongated expansion chamber. The expansion energy of the expanding gas or noise generated by the gas expansion is absorbed wholly or in part by such sound absorption areas. The ratio of absorbent surface to expansion volume can be optimized by having the expansion chambers branch out and/or or having long expansion chambers.

[0026] Preferably, one or more expansion chambers can open toward an outer wall of the main body. Such openings to an outer wall allow some of the expanding gases to escape into the environment after passing through one or more expansion chambers. By decreasing the expansion energy in

the expansion chamber(s) (through absorption, turbulence, etc.), the blast resulting from the gases flowing out is at least reduced or even completely suppressed. Openings of expansion chambers towards an outer wall of the main body can be formed at various locations along the outer wall. In particular, it is conceivable, for example, given an essentially cylindrical main body, to provide these openings at one or both faces of the cylinder and/or on the mantle surface of the cylinder.

[0027] It is preferred that one or more expansion chambers can be open towards the central longitudinal axis. This opening can be formed so that it leads to the firing channel. In particular, this opening may be situated opposite the firing direction. According to the invention, such a preferred design may allow to increasingly mitigate the expanding gases by repeatedly passing them through the—or the same—expansion chambers.

[0028] In addition or alternatively, several of the expansion chambers can combine/merge along their extensions. This can be advantageous, for example, if one or a few expansion chambers have openings to an outer wall or to the central longitudinal axis. In this or other cases, other expansion chambers can combine/merge along their extensions with the expansion chambers with openings, so that the gases expanding therein can also escape through these openings. This can lead, among other things, to a more compact design and/or weight saving compared with a design without combining/merging of expansion chambers.

[0029] In addition or alternatively, at least one of the expansion chambers can branch out along its extension. This is advantageous, for example, if the expanding gases in a single expansion chamber should be directed to two locations. These locations may include, among others, one or more of the above-cited sound absorption areas, one or more of the above-cited openings to the outer wall, and/or one or more openings to the central longitudinal axis. For example, the branching of an expansion chamber, where a branch has an opening to the outer wall, and a second branch has an opening to the central longitudinal axis, is very advantageous. Other combinations of the above locations are apparent to the skilled person and are as well according to the invention.

[0030] Further, preferably expansion chambers are arranged as helices coaxial to the central longitudinal axis. Particularly, two expansion chambers can be arranged as double helix, three expansion chambers as triple helix, etc.

[0031] Furthermore, preferred is an arrangement of expansion chambers, where several of them surround each other each other in a concentric layout. Thus, a compact and material-saving construction can be achieved also. For example, a broad range of distribution of expansion chambers of different lengths can achieve such a nested construction. As a result, the routes or volumes, along which the expanding gases pass through in the expansion chambers, have a broad range of distributions. In addition or alternatively, possible recirculation towards the central longitudinal axis can be made in reverse order. More information will be provided in the following, for example, by means of preferred versions.

[0032] A method according to the invention of producing a firearm silencer includes forming material along a central axis for one single-piece main body, so that at least one expansion chamber is coaxially formed with regard to the central longitudinal axis.

[0033] It is preferred that the formation of the material is carried out layer by layer along the central longitudinal axis. It is particularly preferred that the formation of each layer is carried out perpendicular to the central longitudinal axis in a two-dimensional grid. It is especially preferred that this two-dimensional grid extends along Cartesian or polar coordinates.

[0034] In addition or alternatively, the production is carried out using a single raw material. This raw material is particularly preferred to be a metal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] FIG. 1A shows a cross-section, which is parallel to the central axis, of a first version of the invention.

[0036] FIG. 1B shows a cross-section, which is parallel to the central axis, of the first version of the invention.

[0037] FIG. 2A shows a cross-section, which is parallel to the central axis, of a second version of the invention.

[0038] FIG. 2B shows a cross-section, which is parallel to the central axis, of the second version of the invention.

[0039] FIG. 3A shows a cross-section, which is parallel to the central axis, of a third version of the invention.

[0040] FIG. 3B shows a cross-section, which is parallel to the central axis, of the third version of the invention.

[0041] FIG. 4A shows a cross-section, which is parallel to the central axis, of a fourth version of the invention.

[0042] FIG. 4B shows a cross-section, which is parallel to the central axis, of the fourth version of the invention.

[0043] FIG. 5A shows a cross-section, which is parallel to the central axis, of a fifth version of the invention.

[0044] FIG. 5B shows a cross-section, which is parallel to the central axis, of the fifth version of the invention.

DETAILED DESCRIPTION

[0045] Hereafter, the invention will be discussed in more detail based on the versions presented in the illustrations; in all illustrations, essentially functionally identical elements will have the same reference numeral.

[0046] FIGS. 1A and 1B shows a first version of a silencer 10 according to the invention. FIG. 1A provides a top view of a longitudinal section of the silencer 10, and FIG. 1B the same longitudinal section of the silencer 10 in foreshortened view. Both partial illustrations show the same features that are consequently also marked with the same reference numerals and will likewise be described below.

[0047] The silencer 10 comprises a main body 12. The main body 12 can be manufactured along a central longitudinal axis 14.

[0048] The main body 12 is essentially cylindrical and defines, by its shape and geometry, among other things, an outer wall 30. The outer wall 30 essentially describes a cylinder barrel mantle, two faces with cut-outs for a thread 37 and a muzzle opening 39, as well as rounded edges at the transition between the cylinder mantle and face surfaces.

[0049] The thread 37 is of a screw type for being connected either indirectly or directly with a barrel of a gun. The thread 37 is connected to the muzzle opening 39 by a firing channel that extends through the main body 12 and along the central longitudinal axis 14. The inner structures, in particular the expansion chambers 20, 22, 24, 26 of the silencer 10, are defined by the main body 12; these expansion chambers serve to reduce the muzzle blast of a projectile fired by this firearm.

[0050] For this purpose, the illustrated version provides, e.g., the invention's features of walls, support structures, tapering of expansion chambers, curvatures of expansion chambers, merging of expansion chambers, expansion chambers surrounding each other, as well as openings to the firing channel.

[0051] The walls 31, 32 serve as exemplary illustration of walls extending coaxially to the central longitudinal axis, and they are defined by the main body 12 and limit the expansion chambers. For example, the wall 31 limits the expansion chamber 26 toward the outside. Wall 32 limits the expansion chamber 24 toward the outside and the expansion chamber 26 toward the inside. The other depicted expansion chambers 20, 22 have walls which are not separately named here for reasons of economy of representation.

[0052] The exemplary support structures 35, 36, each of which extends respectively in a manner that is coplanar to the central longitudinal axis, serve to stabilize statics and/or to direct the flow direction of expanding gases.

[0053] The expansion chambers 20, 22, 24, 26 also show changes in their cross sections, especially taperings.

[0054] Further, there is a curvature of the expansion chamber at the transition between the muzzle-side part of each expansion chamber and the thread-side part of each expansion chamber. The above-mentioned features of tapering and curvature of the expansion chambers are designed to improve noise reduction.

[0055] Further, the expansion chambers 20, 22, 24, 26 are open toward the firing channel. The common opening to the firing channel is marked with reference numeral 44. These expansion chambers merge in close proximity to this opening. In the case at hand, the merging of multiple expansion chambers serves to produce a single opening 44.

[0056] Further, the illustrated exemplary version shows that the expansion chambers 20, 22, 24, 26 surround each another. This construction, which resembles Matryoshka dolls or nested assemblies, leads to a compact construction and expansion chambers having different lengths with the resulting differently sized volumes. In the case at hand, expansion chamber 26 is the outermost expansion chamber, whereas expansion chamber 20 forms the innermost expansion chamber.

[0057] In operation, the silencer 10 is connected to the barrel of a firearm either indirectly or directly with the help of the thread 37 (not shown). After a projectile has been fired, it passes through the firing channel along the central longitudinal axis, through the main body and to the muzzle opening 39. In addition, gases travel this route and into the suppressor. According to the invention, some of these gases then expand in the expansion chambers, whereby their expansion can be partially controlled to largely prevent an explosive expansion, which would result in a muzzle blast. The gases thus flow through the firing channel from the thread 37 to the muzzle opening 39 and, during the course of this flow, are partially absorbed in each of the expansion chambers 20, 22, 24, 26. The respective part flowing through one of the expansion chambers is re-directed along this expansion chamber opposite the firing direction to the opening 44, where a repeated flow begins through the firing channel. This redirection can be carried out multiple times. Thus, only a fraction of the expanding gases gradually escapes in each instance through the muzzle opening 39, and, according to the invention, there is no, or at the very least a significantly reduced, muzzle blast.

[0058] FIGS. 2A and 2B shows a second exemplary version of a silencer 10 according to the invention. FIG. 2A shows the top view of a longitudinal section of the silencer 10, and FIG. 2B shows the same longitudinal section of the silencer 10 in foreshortened view. Both partial illustrations display the same features that are consequently also marked with the same reference numerals and will likewise be described below.

[0059] The silencer 10 comprises a main body component 12. The main body component 12 can be manufactured along a central longitudinal axis 14.

[0060] The main body component 12 is essentially cylindrical and defines, by its shape and geometry, among other things an outer wall 30. The outer wall 30 is essentially made up of a cylinder mantle, two faces with cut-outs for a thread 37 and a muzzle opening 39, as well as rounded edges at the transition between the cylinder mantle and face surfaces.

[0061] The screw-type thread 37 is connected either indirectly or directly with the barrel of a gun. The thread 37 is connected to the muzzle opening 39 by a firing channel that extends through the main body 12 and along the central longitudinal axis 14. The inner structures, in particular the expansion chambers 20, 22, 24, 26 of the silencer 10, are defined by the main body/component 12; these expansion chambers serve to reduce the muzzle blast of a projectile fired by this firearm.

[0062] For this purpose, the illustrated version provides, among other things, the invention's features of the walls, support structures, tapering of expansion chambers, curvatures of expansion chambers, expansion chambers surrounding each other, as well as openings to the firing channel.

[0063] The walls 31, 32 serve as exemplary illustrations of walls extending coaxially to the central longitudinal axis and they are defined by the main body 12 and limit the expansion chambers. For example, the wall 31 limits the expansion chamber 22 toward the outside, and the expansion chamber 20 toward the inside. Wall 32 limits the expansion chamber 24 toward the outside and the expansion chamber 26 toward the inside. The other illustrated expansion chambers also have walls that are not individually named for reasons of economy of representation.

[0064] The exemplary support structures 35, 36, each of which extends respectively in a manner that is coplanar to the central longitudinal axis, serve to stabilize statics and/or to direct the flow direction of expanding gases.

[0065] The expansion chambers 20, 22, 24, 26 also show changes in their cross sections, especially taperings. Each of the expansion chambers show a part extending essentially diagonally to the central longitudinal axis 14 in a relatively large cross-section, as well as one part extending essentially parallel to the central longitudinal axis 14 in a relatively small cross-section. A reduction of the cross-section, i.e. tapering, is thus located at the transition point between the two said parts.

[0066] Further, there is a curvature of the expansion chamber at the transition between the part of each expansion chamber which is essentially diagonal to the central longitudinal axis 14 and the part of each expansion chamber which is parallel to the central longitudinal axis 14. In the case at hand, the curvature has predominantly axial components, as well as, in part, radial and azimuthal components. The azimuthal, i.e. helix-like components are determined here among other things by the form and pathway of supporting structures. Two examples of support structures

have been assigned the reference numerals 35, 36. The above-mentioned features of tapering and curvature of the expansion chambers are for improving noise reduction.

[0067] Further, the expansion chambers 20, 22, 24, 26 open into the firing channel. Each expansion chamber has an individual opening to the firing channel. The one for the expansion chamber 24 is referred to by its reference numeral 44.

[0068] Further, the illustrated exemplary version shows that the expansion chambers 20, 22, 24, 26 surround each another. This method of construction, along the lines of Matryoshka or nested arrangement serves to keep construction compact and to allow the expansion chambers to be of varying lengths. In the case at hand, expansion chamber 20 is the outermost expansion chamber, whereas expansion chamber 26 forms the innermost expansion chamber.

[0069] In operation, the silencer 10 is attached to the barrel of a firearm (not shown) by means of the thread 37. After a projectile has been fired, it passes through the firing channel along the central longitudinal axis, through the main body and to the muzzle opening 39. In addition, gases travel this route and into the suppressor. According to the invention, some of these gases then expand in the expansion chambers, whereby their expansion can be partially controlled to largely prevent an explosive expansion, which would result in a muzzle blast.

[0070] The gases thus flow through the firing channel from the thread 37 to the muzzle opening 39 and, during the course of this flow, are partially absorbed in each of the expansion chambers 20, 22, 24, 26. The respective part flowing through one of the expansion chambers, is directed, along the expansion chamber and along the firing direction, to an opening, e.g. opening 44 in the case of expansion chamber 24, where a partially backward-directed flow through the firing channel begins. Thus only a fraction of the expanding gases gradually escapes in each instance through the muzzle opening 39, and conforming to the invention, there is no, or at the very least a significantly reduced, muzzle blast.

[0071] FIGS. 3A and 3B shows a third version of a silencer 10 according to the invention. FIG. 3A shows the top view of a longitudinal section of the silencer 10 and FIG. 3B the same longitudinal section of the silencer 10 in foreshortened view. Both partial illustrations show the same features that are consequently also marked with the same reference numerals and will likewise be described below.

[0072] The silencer 10 comprises a main body 12. The main body 12 can be manufactured along a central longitudinal axis 14.

[0073] The main body/component 12 is essentially cylindrical and defines, by its shape and geometry, among other things, an outer wall 30. The outer wall 30 essentially includes a cylinder mantle, two faces with cut-outs for a thread 37 and a muzzle opening 39, as well as rounded edges at the transition between the cylinder mantle and face surfaces.

[0074] The screw-type thread 37 is connected either indirectly or directly with the barrel of a gun. The thread 37 is connected to the muzzle opening 39 by a firing channel that extends through the main body 12 and along the central longitudinal axis 14. The inner structures, in particular the expansion chambers 20, 22, 24, 26 of the silencer 10, are defined by the main body/component 12 and serve to reduce the muzzle blast of a projectile fired by this firearm.

[0075] The illustrated exemplary version provides, for this purpose, among other things, the invention's features of walls, support structures, tapered expansion chambers, curved expansion chambers, branching expansion chambers, openings to the firing channel, openings to the outer wall, sound absorption areas, as well as expansion chambers surrounding each other.

[0076] The walls 31, 32 serve as an exemplary illustration of walls extending coaxially to the central longitudinal axis, which are defined by the main body 12 and limit the expansion chambers. The other illustrated expansion chambers also have walls that are not individually named for reasons of economy of representation.

[0077] The exemplary support structures 35, 36, each of which extends respectively in a manner that is coplanar to the central longitudinal axis, serve to stabilize statics and/or to direct the flow direction of expanding gases.

[0078] The expansion chambers 20, 22, 24, 26 also show changes in their cross sections, especially taperings. Each of the expansion chambers has a part which extends essentially perpendicularly to the central longitudinal axis 14 and has a relatively large cross section, as well as a part that is essentially parallel to the central longitudinal axis 14 and has a relatively small cross section. A reduction of the cross-section, i.e. a tapering is thus located at the transition point between the two said parts.

[0079] Further, a curvature of every expansion chamber is located at the transition between the part of each expansion chamber essentially perpendicular to the central longitudinal axis 14 and the part of each expansion chamber which is parallel to the central longitudinal axis 14. In the case at hand, the curvature has predominantly axial and azimuthal components, and in part some radial components. Two examples of support structures have been assigned the reference numerals 35, 36. The above-mentioned features of tapering and curvature of the expansion chambers are for improving noise reduction.

[0080] Further, the expansion chambers have branches, so that the gases expanding in them can flow to different locations. These locations include opening to the firing channel, openings to the outer wall, as well as sound absorption areas. In particular, the expansion chambers 20, 22, 24, 26 respectively open towards the firing channel. Each expansion chamber has an individual opening to the firing channel. The one for the expansion chamber 24 is referred to by its reference numeral 44. Further, the expansion chambers 20, 22, 24, 26 are open to the outer wall. Reference numerals 42, 43 refer to two exemplary openings. Also, some expansion chambers have sound absorption areas. Reference sign 40 refers to an exemplary sound absorption area.

[0081] Further, from the illustrated exemplary version it can be seen that the expansion chambers 20, 22, 24, 26 surround one another. This method of construction, along the lines of Matryoshka or nested arrangement, serves to keep construction compact and to allow the expansion chambers to be of varying lengths. In the case at hand, expansion chamber 26 is the outermost expansion chamber, whereas expansion chamber 20 forms the innermost expansion chamber.

[0082] In operation, the silencer 10 is attached to the barrel of a firearm (not shown) by means of the thread 37. After a projectile has been fired, it passes through the firing channel along the central longitudinal axis, through the main body

and to the muzzle opening 39. In addition, gases travel this route and into the suppressor. According to the invention, some of these gases then expand in the expansion chambers, whereby their expansion can be partially controlled to largely prevent an explosive expansion, which would result in a muzzle blast.

[0083] The gases thus flow through the firing channel from thread 37 to muzzle opening 39 and, during the course of this flow, are partially absorbed in each of the expansion chambers 20, 22, 24, 26.

[0084] The respective part flowing through one of the expansion chambers is directed along this expansion chamber opposite to the firing direction. These gases, which expand in the expansion chambers, encounter branchings and mergings. On the one hand, the expansion chambers 20, 22, 24, 26 merge so that the gases flow into a common area. On the other hand, this common space branches out. The expanding gases flow partly to a sound absorption area 40, partly to one of several openings 42, 43 in the outer wall 30, or to one of several openings 44, 45 to the firing channel. Thus only a fraction of the expanding gases gradually escapes in each instance through the muzzle opening 39, and, according to the invention, there is no, or at the very least a significantly reduced, muzzle blast. A part of the expanding gases passes through one of the openings 42, 43 from the silencer. Some of the expanding gases once again, or repeatedly, are directed through one of the openings 44, 45 through the firing channel. Further, some of the expansion energy is absorbed in sack-like cul-de-sacs in the expansion chambers, i.e. the sound absorption area 40. Due to the large number of curvatures, taperings/widenings and branches, turbulence also arises in the gases' flow behavior, leading to a further expansion energy dissipation.

[0085] FIGS. 4A and 4B shows a fourth version of the silencer 10. According to the invention, FIG. 4A shows the top view of a longitudinal section of the silencer 10 and FIG. 4B the same longitudinal section of the silencer 10 in foreshortened view. Both partial illustrations show the same features that are consequently also marked with the same reference numerals and will likewise be described below.

[0086] The silencer 10 comprises a main body 12. The main body 12 can be manufactured along a central longitudinal axis 14.

[0087] The main body 12 is essentially cylindrical and defines, by its shape and geometry, among other things, an outer wall 30. The outer wall 30 essentially includes a cylinder mantle, two faces with cut-outs for a thread 37 and a muzzle opening 39, as well as rounded edges at the transition between the cylinder mantle and face surfaces.

[0088] The screw-type thread 37 is connected either indirectly or directly with the barrel of a gun. The thread 37 is connected to the muzzle opening 39 by a firing channel that extends through the main body 12 and along the central longitudinal axis 14. The inner structures, in particular the expansion chambers 20, 22, 24, 26 of the silencer 10, are defined by the main body 12; and serve to reduce the muzzle blast of a projectile fired by this firearm.

[0089] For this purpose, the illustrated exemplary version provides, inter alia, the invention's features of curved expansion chambers, taperings and widenings, support structures, as well as openings to the firing channel.

[0090] The expansion chambers 20, 22, 24, 26 exhibit changes in their cross section. As seen from the top view, each of the expansion chambers has an essentially u-shaped

longitudinal section. Each of the legs of the U shows a different cross-section. Thus, on the one hand, a curvature, and, on the other hand, taperings, or widenings are provided at the transition between the respective legs. In this case, the curvature features predominantly axial and radial components.

[0091] Two exemplary support structures are assigned the reference numerals **35, 36**. The above-mentioned characteristics of taperings/widenings and curved expansion chambers serve to improve noise reduction.

[0092] Further, the expansion chambers **20, 22, 24, 26** open to the firing channel. Each expansion chamber has an individual opening to the firing channel. The one for the expansion chamber **24** is referred to by its reference numeral **44**.

[0093] Further, in the exemplary version shown, it is evident that in the present case the expansion chambers **20, 22, 24, 26** do not surround each other, but are arranged sequentially along the firing direction.

[0094] The exemplary support structures, **35, 36**, that at least partly extend in a coplanar manner to the central longitudinal axis, serve to stabilize static and/or the direction of the flow of the expanding gases.

[0095] In operation, the silencer **10** is attached to the barrel of a firearm (not shown) by means of the thread **37**. After a projectile has been fired, it passes through the firing channel along the central longitudinal axis, through the main body and to the muzzle opening **39**. In addition, gases travel this route and into the suppressor. According to the invention, some of these gases then expand in the expansion chambers; whereby their expansion can be partially controlled to largely prevent an explosive expansion, which would result in a muzzle blast.

[0096] The gases thus flow through the firing channel from the thread **37** to the muzzle opening **39** and, during the course of this flow, are partially absorbed in each of the expansion chambers **20, 22, 24, 26**. The respective part of gases flowing through one of the expansion chambers is directed along this expansion chamber. Along their path in the expansion chambers, the expanding gases encounter curvatures and cross-section changes. Thus, only a fraction of the expanding gases gradually escapes in each instance through the muzzle opening **39**, and, according to the invention, there is no, or at the very least a significantly reduced, muzzle blast. Due to the large number of curvatures, taperings/widenings and branches, turbulence also arises in the gases' flow behavior, leading to the expansion energy dissipating even further.

[0097] FIGS. **5A** and **5B** shows a fifth version of a silencer **10** according to the invention. FIG. **5A** shows the top view of a longitudinal section of the silencer **10**, and FIG. **5B** the same longitudinal section of the silencer **10** in foreshortened view. Both partial illustrations show the same features that are consequently also marked with the same reference numerals and will likewise be described below.

[0098] The silencer **10** comprises a main body **12**. The main body **12** can be manufactured along a central longitudinal axis **14**.

[0099] The main body **12** is essentially oblong and defines by its shape and geometry by, among other things, an outer wall **30**. However, the outer wall **30**, in contrast to the above exemplary version, does not describe a cylindrical shape in the case at hand. Also, central longitudinal axis **14** does not run through the geometric center, but, instead, is offset

upwards. This exemplary version illustrates the structural flexibility of the invention, something which goes hand in hand with its production according to the invention.

[0100] For this purpose, the illustrated exemplary version provides, among other things, the invention's features of tapering of expansion chambers, curvatures of expansion chambers, merging of expansion chambers, expansion chambers surrounding each other, sound absorbing areas and openings to the outer wall.

[0101] The tapering of expansion chambers is illustrated by means of expansion chambers **24, 26**. The use of multiple curved expansion chambers is represented by the expansion chamber **22**, resulting in an unusually long expansion chamber. A merging of two expansion chambers is shown as example for the expansion chambers **20** and **22**. Further, it is evident from the illustrated exemplary version that the expansion chamber **22** surrounds the expansion chambers **24** and **26**. The use of sound absorption areas is demonstrated in the example of the expansion chamber **26** with its sound absorption area **40**. Expansion chamber **22** also includes an opening **42** to the outer wall **30** of the main body **12**.

[0102] In operation, the silencer **10** is connected (not shown) to the firearm by a tube placed in the area of the expansion chamber **20**. After a projectile is fired, it passes along the central longitudinal axis through the firing channel, through the main body and then to the muzzle opening **39**. In addition, gases travel this route and into the suppressor. According to the invention, some of these gases then expand in the expansion chambers and their expansion can be partially controlled to largely prevent an explosive expansion, which would result in a muzzle blast.

[0103] The gases thus flow through the firing channel to the muzzle opening **39**, and, along this way are partially absorbed by each of the expansion chambers **20, 22, 24, 26**. Thus, only a fraction of the expanding gases gradually escapes through the muzzle opening **39** and the opening **42** to the outer wall; and in accordance with the invention, there is no, or at the very least a significantly reduced, muzzle blast.

REFERENCE NUMERALS

- [0104] Firearm silencer **10**
- [0105] Main body **12**
- [0106] Longitudinal axis **14**
- [0107] Expansion chamber **20, 22, 24, 26**
- [0108] Outer wall **30**
- [0109] Wall **31, 32**
- [0110] Bars **33, 34**
- [0111] Support structure **35, 36**
- [0112] Thread **37**
- [0113] Muzzle Opening **39**
- [0114] Sound absorption area **40**
- [0115] Opening to the outer wall **42, 43**
- [0116] Opening to the firing channel **44, 45**

What is claimed is:

1. A firearm silencer comprising a main body, which is formed and a single-piece body extending along and around a central longitudinal axis, and defines at least one expansion chamber formed coaxially in relation to the central longitudinal axis.
2. The silencer according to claim 1, wherein the main body of the silencer is formed in layers in the direction of the central longitudinal axis.

3. The silencer according to claim 1, wherein the silencer is producible by one of the following production processes:

- 3D printing process;
- a stereo-lithography method;
- a selective laser sintering process;
- a casting process; and
- a forming process.

4. The silencer according to claim 1, wherein the main body of the silencer is defined by at least one of the following features:

- an outer wall which limits, toward the outside, the at least one expansion chamber;
- a muzzle opening; and
- a firing channel that extends through the main body in the direction of the central longitudinal axis.

5. The silencer according to claim 1, wherein the main body of said silencer is defined by at least one of the following features:

- walls extending coaxially in relation to the central longitudinal axis, which walls limit at least the one expansion chamber;
- bars at least partly extending perpendicular to the central longitudinal axis;
- supporting structures at least partly extending in coplanar manner in relation to the central longitudinal axis; and
- a thread for direct or indirect connection with at least one of a barrel of a firearm and an interface for attachment to a barrel of a firearm.

6. The silencer according to claim 1, wherein at least one of the expansion chambers is curved.

7. A silencer according to claim 1, wherein the curvature includes components in at least one of the following directions:

- curvature component in azimuthal direction;
- curvature component in radial direction; and
- curvature component in axial direction.

8. A silencer according to claim 1, wherein at least one of the expansion chambers is tapered or widened in its cross section.

9. A silencer according to claim 1, wherein at least one of the expansion chambers opens into a sound absorption area.

10. A silencer according to claim 1, wherein at least one of the expansion chambers opens to an outer wall of the main body.

11. A silencer according to claim 1, wherein at least one of the expansion chambers opens into the firing channel or the central longitudinal axis.

12. A silencer according to claim 1, wherein the main body defines at least two expansion chambers, which merge along their extension.

13. A silencer according claim 1, wherein at least one of the expansion chambers branches out along its extension.

14. A silencer according to claim 1, wherein the main body defines at least two expansion chambers which are arranged as coaxial helices along the central longitudinal axis.

15. A silencer according to claim 1, wherein the main body defines at least two expansion chambers, surrounding one another in concentric manner.

16. A method of producing a firearm silencer, wherein material for a single-piece main body of the firearm silencer is formed along a central longitudinal axis, in such a manner that at least one expansion chamber is coaxially formed with regard to the central longitudinal axis.

17. The method according to claim 16, wherein the formation of the material is carried out layer-wise towards the central longitudinal axis.

18. The method of claim 17, wherein the formation of each layer is carried out perpendicular to the central longitudinal axis two-dimensional grid pattern.

19. The method of claim 16, wherein the formation of material is carried out according to one of the following manufacturing processes:

- a 3D printing process;
- the stereo-lithography method;
- a selective laser sintering process;
- a casting process; and
- a forming process.

20. The method of claim 16, wherein the producing is carried out by means of a process employs the use of a single raw material.

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