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(71) Applicant: **Sako OY**
**FIN-11100 Riihimäki (FI)**

(72) Inventors:
- **JANTUNEN, Lauri**
  **00780 Helsinki (FI)**
- **TAMMINEN, Miikka**
  **00980 Helsinki (FI)**

(74) Representative: **Berggren Oy**
**P.O. Box 16**
**Eteläinen Rautatiekatu 10A**
**00101 Helsinki (FI)**

# (54) FIREARM SUPPRESSOR, IN PARTICULAR A RIFLE SUPPRESSOR

(57) The invention relates to a firearm suppressor, in particular a rifle suppressor, which suppressor (50) has a substantially rotationally symmetrical cylindrical form and comprises a suppressor housing (55), chambers (18, 20, 30) for expansion and burning of propellant gases and arranged inside the suppressor housing (55), an aperture (12) for a projectile configured to be fired by the firearm and located around an imaginary center axis of the suppressor (50). The suppressor (50) comprises an inner flow guide structure (20) and the inner flow guide structure (20) comprises radially inclined guide openings (25).

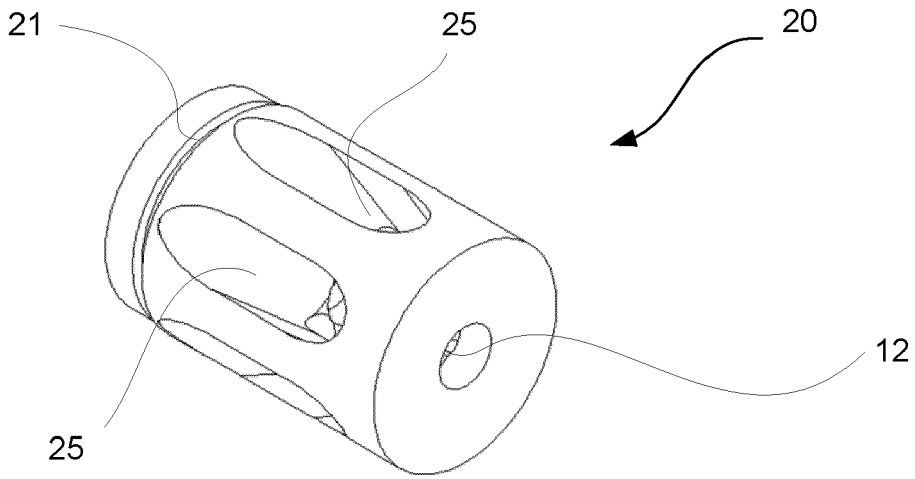


**Fig. 3**

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## Description

### Technical field

**[0001]** The present invention relates to suppressors for firearm, in particular for rifles. More precisely the present invention relates to a firearm suppressor, in particular to a rifle suppressor, according to the preamble part of claim 1. The present invention also relates to a firearm comprising a suppressor.

### Background

**[0002]** The noise generation in a firearm shot has three main components: muzzle blast, sonic boom and the mechanical action. In the field of noise and flash reduction of firearms has been presented quite many different constructions and devices for the same purpose i.e. to dampen the noise and flash caused by the rapid burning of propellants when the firearm is fired. As the benefits of this reduction are quite obvious, the noise of undamped firearm may exceed 130 dB, even 160 dB, and can be harmful for firearm users or anyone nearby and disturb large surrounding areas, for example by a hunting area or by a shooting range. It is also preferred to be avoided or at least minimized in military applications where the sound of the firing immediately attracts the attention of parties concerned. The better the suppressor is in terms of noise reduction and if combined to easy or simple manufacturability and to low weight, the better the suppressor is in terms of commercial interest.

**[0003]** A firearm bullet or in general a projectile, is rapidly accelerated at firing to an initial velocity of 300 to 1100 m/s depending the type of the firearm. The initial velocity means here the velocity of the projectile when exiting the barrel or corresponding part of a firearm. This means that the initial velocity may be within range on about 0,8 to 3,3 Mach (where 1 Mach is the speed of the sound when the medium is normal atmospheric air in about normal temperature and pressure (ntp). Thus, the flow dynamics range concerned may vary from slightly subsonic to highly supersonic flows.

**[0004]** In case of supersonic noise dampening, the suppressor is not capable of reducing the noise originating from the projectile breaking the sound barrier during the flight to a destination. Thus the aim of the suppressor is to reduce as much as possible the noise generated by the muzzle blast i.e. the phase when the projectile is no longer in front of that high pressure propellant gas and the pressure is rapidly normalizing to an atmospheric pressure, the burning propellant is exiting the barrel and when the propellant residuals are burning outside the barrel. Without any kind of muzzle suppressor device, the propellant gases will expand violently to the atmosphere and produce noise. The main operating principle of the suppressor is to provide a controlled volume to allow the gas to expand into, and preferably burn out. Thus, when the projectile exits the barrel, no more burning propellant gas should follow the projectile and thus the muzzle blast is significantly reduced as the burning propellant is contained in a closed volume. The regular suppressors are basically formed as a closed structure as long as the projectile is inside the suppressor, which causes excess back pressure. A flow-through suppressor allows the gas to pass through the suppressor so that the back-pressure increase is eliminated or at least minimized.

**[0005]** An important factor of the suppressors is also weight as attached at the end of the barrel the suppressor affects to the shooting properties of the firearm and also increases the overall weight of the firearm in use.

**[0006]** The objective of the present invention is to provide a firearm suppressor capable of reducing a significant amount of noise caused by the firing of a firearm.

**[0007]** One objective is also to provide a suppressor construction, which is capable of producing an effective flow loss i.e. consume the flow energy inside the suppressor to different losses and thus reducing the noise caused sudden eruption of propellant gases.

**[0008]** One objective is also to enable the residual burning of the propellant gas still containing some unburned propellants within the suppressor housing, thus diminishing the noise effect of suddenly burning residuals outside the barrel. One objective is further to create an improved firearm suppressor, in particular a rifle suppressor, by which the above described problems disadvantages relating to known suppressors are eliminated or at least minimized.

**[0009]** Yet, an objective is to create an improved firearm suppressor, in particular a rifle suppressor, in which the noise eliminating properties in relation to the weight of the suppressor are optimized.

### Summary

**[0010]** In order to achieve the above objects and those that will come apparent later the firearm suppressor, in particular a rifle suppressor, is mainly characterized by the features of the characterizing part of claim 1.

**[0011]** Dependent claims present advantageous features and embodiments of the invention.

**[0012]** According to the invention the firearm suppressor, in particular a rifle suppressor has a substantially rotationally symmetrical cylindrical form and comprises a suppressor housing, chambers for expansion and burning of propellant gases and arranged inside the suppressor housing, an aperture for a projectile configured to be fired by the firearm and located around an imaginary center axis of the suppressor, wherein the suppressor comprises an inner flow guide structure and the inner flow guide structure comprises radially inclined guide openings.

**[0013]** According to the invention the suppressor comprises a circumferential chamber inside the suppressor housing and the inner flow guide structure is located inside the circumferential chamber.

**[0014]** According to an advantageous feature of the invention the inner flow guide structure comprises 3 - 8 radially inclined guide openings.

**[0015]** According to the invention inclination angle of the radially inclined guide openings in relation to travel direction of the projectile is advantageously 30 - 70 degrees.

**[0016]** According to an advantageous feature of the invention the inner flow guide structure further comprises a conical space configured to provide further space for expansion and burning of the propellant gases.

**[0017]** According to an advantageous feature of the invention the conical space is followed by a cylindrical space inside a flange.

**[0018]** According to the invention the suppressor comprises a baffle chamber with baffles.

**[0019]** According to the invention a sleeve is provided around the baffles configured to form a separate burning chamber for the propellant gases. The sleeve closes the baffle chamber such, that the propellant gases cannot escape from the circumferential chamber comprising the inner flow guide structure past the projectile into the separate burning i.e. baffle chamber nor escape from the suppressor before the projectile and thus deviate trajectory of the projectile.

**[0020]** According to an advantageous feature of the invention the suppressor is a flow-through suppressor and comprises exit openings for gas is provided in the suppressor housing.

**[0021]** According to an advantageous feature of the invention a tubing is provided for gas is provided in the circumferential chamber inside the suppressor housing and inlet end/-s of the tubing is in flow connection with the radially inclined guide openings of the inner flow guide structure.

**[0022]** According to an advantageous feature of the invention outlet end/-s of the tubing is in flow connection with the exit openings.

**[0023]** According to an advantageous feature of the invention the tubing circumvents in the circumferential chamber.

**[0024]** According to an advantageous feature of the invention the suppressor comprises three main volumes, or chambers for exhausting and burning the propellant gases, that a first chamber is located at one end of the suppressor and in travel direction of the projectile before the inner flow guide structure and the middle chamber is located inside a circumferential chamber and formed by the inner flow guide structure comprising diagonal cuts with acute angles i.e. the radially inclined openings from a projectile channel i.e. the aperture and at other end a baffle chamber.

**[0025]** According to the invention a firearm, in particular a rifle, comprises the suppressor according to the invention or to any of the advantageous features of the invention.

**[0026]** According to an advantageous aspect of the invention the suppressor comprises three main volumes, or chambers for exhausting and burning the propellant gases. First chamber, not shown in the figures, is located at the right end of the suppressor i.e. in travel direction of the projectile before the inner flow guide structure. The suppressor has thus two large volumes, or chambers for the expanding gases to burn in and the third volume, or chamber is a separate enclosed space inside the second large chamber formed by the inner guide structure. Thus, by the time the projectile reaches the third part, i.e. the baffle chamber of the suppressor, most of the high-pressure gas has already expanded to the two larger volumes and the purpose of the smaller chambers divided by the baffles in the baffle chamber is to help equalize the pressure instead of allowing the gas to violently burst into the atmosphere. The middle chamber inside the circumferential chamber formed by the inner flow guide structure comprises diagonal cuts with acute angles i.e. the radially inclined openings from the projectile channel i.e. the aperture, which cuts and redirect the gas flow in addition to allowing the gas to expand outwards. After the first chamber the expanding gas has already gained some momentum and begins to move forward more than expanding outside due to the radially inclined openings. The location of the radially inclined openings provide moving the suppressor further back from the muzzle resulting in less length past the muzzle without decreasing internal volume.

**[0027]** By the suppressor according to the invention and its advantageous features many advantages are achieved: The firearm suppressor is capable of reducing a significant amount of noise caused by the firing of a firearm. The firearm suppressor construction is capable of producing an effective flow loss i.e. consume the flow energy inside the suppressor to different losses and thus reducing the noise caused sudden eruption of propellant gases. It also enables the residual burning of the propellant gas still containing some unburned propellants within the suppressor housing, thus diminishing the noise effect of suddenly burning residuals outside the barrel. The improved firearm suppressor, in particular the rifle suppressor has optimized the noise eliminating properties in relation to the weight of the suppressor.

## Brief description of the drawings

**[0028]** In the following the invention and its advantages are explained in greater detail below in the sense of example and with reference to accompanying drawing, where

In figure 1 is schematically shown an advantageous example of a firearm, in particular a rifle with a suppressor.

In figure 2 is schematically shown an advantageous example of a suppressor according to the invention.

In figure 3 is schematically shown an advantageous

example of an inner flow guide structure of the example of figure 2.

In figure 4 is schematically shown as a cross-sectional view the example of the inner flow guide structure of figure 3.

In figure 5 is schematically shown as a cross-sectional view an advantageous example of inner structure of the suppressor according to the invention.

In figure 6 is schematically shown as a perspective view the example of the inner structure of figure 5.

In figure 7 is schematically shown as a perspective view an advantageous example of inner structure of the suppressor according to the invention with the outer circumferential chamber directly inside the suppressor housing.

In the figure 8 is schematically shown an advantageous example of the suppressor according to the invention for a flow-through configuration of a suppressor.

In the figure 9 is schematically shown another advantageous example of the suppressor according to the invention for a flow-through configuration of a suppressor.

In figure 10 is schematically shown the advantageous example of figures 2-7 of the suppressor according to the invention.

Detailed description

**[0029]** During the course of the following description like numbers and signs will be used to identify like elements according to the different views which illustrate the invention and its advantageous examples. In the figures some repetitive reference signs may have been omitted for clarity reasons.

**[0030]** In the figure 1 is shown an example of a firearm 100, in particular a rifle, comprising a suppressor 50 attached to a barrel 75 of the firearm 100.

**[0031]** In figure 2 is schematically shown an example of the suppressor 50 comprising a suppressor housing 55 defining the outer surface of the suppressor 50. The travel direction of a projectile in the suppressor 50 is along the imaginary center axis of the rotationally symmetrical cylindrical form of the suppressor 50 from left to right in the figure 2. At one end of the suppressor 50, in the figure at the left end the suppressor 50 comprises an inlet opening to an aperture 12 for the projectile and the propellant gases and mounting means for fastening / detaching the suppressor 50 with a barrel 75 of the firearm 100. At another end of the suppressor 50, in the figure at the right end the suppressor 50 comprises an outlet opening from the aperture 12 for the projectile. Inside the suppressor 50 is arranged a number of compartments configured to allow the gas to expand into and to burn out. The aperture 12 for projectile to pass through the suppressor 50 extends through the suppressor 50 along the imaginary center line of the suppressor 50. The suppressor 50 comprises three main chambers inside the suppressor housing 55 for exhausting and burning the propellant gases. First chamber 60, shown in the figure 10, is located at one end, the left end in the figure 2, of the suppressor 50, i.e. in travel direction of the projectile before an inner flow guide structure 20 (figs. 3-7 and 10). The suppressor 50 has thus two large volumes, or chambers for the expanding gases to burn in and the third volume, or chamber is a separate enclosed space inside a circumferential chamber, a second large chamber 30 and is formed by the inner guide structure 20 and is configured to form a middle chamber. A baffle chamber 18 is also located inside the circumferential chamber 30.

**[0032]** In figure 3 is schematically shown an example of an inner flow guide structure 20 of the suppressor 50 of figure 2. The travel direction of the projectile in the inner flow guide structure 20 is along the imaginary center axis of the rotationally symmetrical cylindrical form of the inner flow guide structure 20 from right to left in the figure 2. The inner flow guide structure 20 comprises radially inclined guide openings 25, advantageously 3 - 8 radially inclined guide openings 25, which provide for expansion of the propellant gases and guide the propellant gases into a larger volume in a circumferential chamber 30 (fig. 7) inside the suppressor housing 55 (fig. 2) to extend time of the burning of the propellant gases. The inclination angle of the radially inclined guide openings 25 in relation to travel direction of the projectile is advantageously 30 - 70 degrees.

**[0033]** In figure 4 is schematically shown as a cross-sectional view the example of the inner flow guide structure of figure 3. The travel direction of the projectile in the inner flow guide structure 20 is along the imaginary center axis of the rotationally symmetrical cylindrical form of the inner flow guide structure 20 from right to left in the figure 2. The inner flow guide structure 20 comprises radially inclined guide openings 25, advantageously 3 - 8 radially inclined guide openings 25, which provide for expansion of the propellant gases and guide the propellant gases into a larger volume to extend time of the burning of the propellant gases. The inclination angle of the radially inclined guide openings 25 in relation to travel direction of the projectile is advantageously 30 - 70 degrees. The inner flow guide structure 20 also comprises a conical space 24, which also provides space for expansion and burning of the propellant gases. The conical space 24 is advantageously followed by a cylindrical space 23 inside a flange 21, which is sealed to a next chamber 18 (figs 5-7, 10).

**[0034]** In figure 5 is schematically shown as a cross-sectional view an advantageous example of inner structure of the suppressor according to the invention without

the outer circumferential chamber 30 (fig. 7) directly inside the suppressor housing 55 (figs. 2 & 7, 10). In figure 6 is schematically shown as a perspective view the example of the inner structure of figure 5. The travel direction of projectile in the suppressor 50 is along the imaginary center axis of the rotationally symmetrical cylindrical form of the suppressor 50 from right to left. As can be seen from figures 5-6, 10 the radially inclined guide openings 25 in the inner flow guide structure 20 provide guidance for the propellant gases inside the suppressor 50 such, that in addition to expanding the propellant gases are guided forward to larger volume in the circumferential chamber 30 inside the suppressor housing 55 for the propellant gases to burn and for pressure of the propellant gases to balance. The inner flow guide structure 20 also comprises a conical space 24, which also provides space for expansion and burning of the propellant gases before the propellant gases meet first of baffles 15 in a baffle chamber 18. Additionally, conical form of the conical space 24 provides significant decrease in weight of the suppressor 50 and a well suppressing and light suppressor 50 is achieved. A sleeve 16 is provided around the baffles 15 and a separate burning chamber i.e. a baffle chamber 18 provided for the propellant gases. The sleeve 16 closes this baffle chamber 18 such, that the propellant gases cannot escape from the circumferential chamber 30 comprising the inner flow guide structure 20 past the projectile into the baffle chamber 18 nor escape from the suppressor 50 before the projectile and thus deviate trajectory of the projectile.

**[0035]** In figure 7 is schematically shown as a perspective view an advantageous example of inner structure of the suppressor according to the invention with the outer circumferential chamber 30 (fig. 7) directly inside the suppressor housing 55. The travel direction of projectile in the suppressor 50 is along the imaginary center axis of the rotationally symmetrical cylindrical form of the suppressor 50 from right to left. The circumferential chamber 30 is configured to provide larger volume for expanding of the propellant gases.

**[0036]** In the figure 8 is schematically shown an advantageous example of the suppressor 50 according to the invention for a flow-through configuration of a suppressor. In this example construction of the suppressor 50 corresponds to that of the previous figures but additionally exit openings 41 for gas is provided in the suppressor housing 55.

**[0037]** In figure 9 is schematically shown an advantageous example of the suppressor according to the invention. This example is advantageously combined with the example of figure 8. In this example construction of the suppressor 50 corresponds to that of the previous figures but additionally a tubing 42 is provided for gas is provided in the circumferential chamber 30 (fig. 7) inside the suppressor housing 55. Inlet end of the tubing 42 is in flow connection with the radially inclined guide openings 25 of the inner flow guide structure 20 and the outlet end is in flow connection with the exit openings 41. Advantageously, the tubing 42 circumvents in the circumferential chamber 30 in a spiral form. Thus, the increase in the travelling distance of the propellant gases is provided and the burning of the propellant gases, as well as balancing of the pressure, is maximized, even completed. This also provides for eliminating the back pressure.

**[0038]** In figure 10 is schematically shown as a cross-sectional view the example of the inner flow guide structure of figures 3-7. The firearm suppressor 50 has the substantially rotationally symmetrical cylindrical form and comprises the suppressor housing 55, the chambers 18, 20, 30, 60 for expansion and burning of propellant gases and is arranged inside the suppressor housing 55. The suppressor also comprises the aperture 12 located around the imaginary center axis of the suppressor 50 for a projectile configured to be fired by the firearm and to pass through the suppressor 50 as indicated by arrow P. The suppressor 50 comprises the inner flow guide structure 20 and the circumferential chamber 30 inside the suppressor housing 55 and he baffle chamber 18 with baffles 15. The inner flow guide structure 20 is located inside the circumferential chamber 30 and comprises the radially inclined guide openings 25 having the inclination angle of 30 - 70 degrees in relation to travel direction of the projectile. The sleeve 16 is provided around the baffles 15 and is configured to form the separate burning chamber for the propellant gases. the inner flow guide structure 20 further comprises the conical space 24, which is configured to provide further space for expansion and burning of the propellant gases. The conical space 24 is followed by the cylindrical space 23 inside the flange 21. The suppressor 50 comprises three main volumes, or chambers for exhausting and burning the propellant gases, flows F of which propellant gases are indicated by arrows F. The first chamber 60 is located at one end of the suppressor 50 and in travel direction of the projectile before the inner flow guide structure 20 and that the middle chamber is located inside the circumferential chamber 30 and formed by the inner flow guide structure 20 comprising the diagonal cuts with acute angles i.e. the radially inclined openings 25 from the projectile channel i.e. the aperture 12 and at other end the baffle chamber 18. The first chamber 60 comprises a first expansion space 64 and a back expansion space 65, to which part of the propellant gases are guided by reflectors 64.

**[0039]** The suppressor 50 thus comprises three main volumes, or chambers for exhausting and burning the propellant gases. First chamber 60, shown in figure 10, is located at one end, the right end in figures 3-7, 10, of the suppressor 50 i.e. in travel direction of the projectile before the inner flow guide structure 20. The suppressor 50 has thus two large volumes, or chambers for the expanding gases to burn in and the third volume, or chamber is a separate enclosed space inside the second large chamber 30 formed by the inner guide structure 20. Thus, by the time the projectile reaches the third part 18, i.e. the baffle chamber 18 of the suppressor 50, most of the

high-pressure gas has already expanded to the two larger volumes and the purpose of the smaller chambers divided by the baffles 15 in the baffle chamber 18 is to help equalize the pressure instead of allowing the gas to violently burst into the atmosphere. The middle chamber inside the circumferential chamber 30 formed by the inner flow guide structure 20 comprises diagonal cuts with acute angles i.e. the radially inclined openings 25 from the projectile channel i.e. the aperture 12, which cuts and redirect the gas flow in addition to allowing the gas to expand outwards. After the first chamber the expanding gas has already gained some momentum and begins to move forward more than expanding outside due to the radially inclined openings 25. The location of the radially inclined openings 25 provide moving the suppressor further back from the muzzle resulting in less length past the muzzle without decreasing internal volume.

**[0040]** The radially inclined openings 25 are advantageously borings but the inner flow guide structure 20 can be produced in various ways, for example by 3D printing.

**[0041]** In the description in the foregoing, although some functions and elements have been described with reference to certain features and examples, those functions and elements may be performable by other features and examples whether described or not. Although features have been described with reference to certain embodiments or examples, those features may also be present in other embodiments or examples whether described or not.

**[0042]** Above only some advantageous examples of the inventions have been described to which examples the invention is not to be narrowly limited and many modifications and alterations are possible within the invention.

## Claims

1. Firearm suppressor, in particular a rifle suppressor, which suppressor (50) has a substantially rotationally symmetrical cylindrical form and comprises a suppressor housing (55), chambers (18, 20, 30) for expansion and burning of propellant gases and arranged inside the suppressor housing (55), an aperture (12) for a projectile configured to be fired by the firearm and located around an imaginary center axis of the suppressor (50), which suppressor (50) comprises an inner flow guide structure (20), **characterized in that** the suppressor (50) comprises a circumferential chamber (30) inside the suppressor housing and a baffle chamber (18) with baffles (15), **that** the inner flow guide structure (20) is located inside the circumferential chamber (30) and comprises radially inclined guide openings (25) having inclination angle of 30 - 70 degrees in relation to travel direction of the projectile and **that** a sleeve (16) is provided around the baffles (15) configured to form a separate burning chamber for the propellant gases.

2. Firearm suppressor according to claim 1, **characterized in that** the inner flow guide structure (20) comprises 3 - 8 radially inclined guide openings (25).

3. Firearm suppressor according to any of previous claims, **characterized in that** the inner flow guide structure (20) further comprises a conical space (24) configured to provide further space for expansion and burning of the propellant gases.

4. Firearm suppressor according to claim 3, **characterized in that** the conical space (24) is followed by a cylindrical space (23) inside a flange (21).

5. Firearm suppressor according to any of previous claims, **characterized in that** the suppressor (50) is a flow-through suppressor and comprises exit openings (41) for gas is provided in the suppressor housing (55).

6. Firearm suppressor according to any of previous claims, **characterized in that** a tubing (42) is provided for gas is provided in the circumferential chamber (30) inside the suppressor housing (55) and **that** inlet end/-s of the tubing (42) is in flow connection with the radially inclined guide openings (25) of the inner flow guide structure (20).

7. Firearm suppressor according to claim 6, **characterized in that** outlet end/-s of the tubing (42) is in flow connection with the exit openings (41).

8. Firearm suppressor according to claim 6 or 7, **characterized in that** the tubing (42) circumvents in the circumferential chamber (30)

9. Firearm suppressor according to any of previous claims, **characterized in that** the suppressor (50) comprises three main volumes, or chambers for exhausting and burning the propellant gases, that a first chamber (60) is located at one end of the suppressor (50) and in travel direction of the projectile before the inner flow guide structure (20) and **that** the middle chamber is located inside a circumferential chamber (30) and formed by the inner flow guide structure (20) comprising diagonal cuts with acute angles i.e. the radially inclined openings (25) from the projectile channel i.e. the aperture (12) and at other end a baffle chamber (18).

10. A firearm (100), in particular a rifle, comprising the suppressor (50) of any of the claims 1-9.

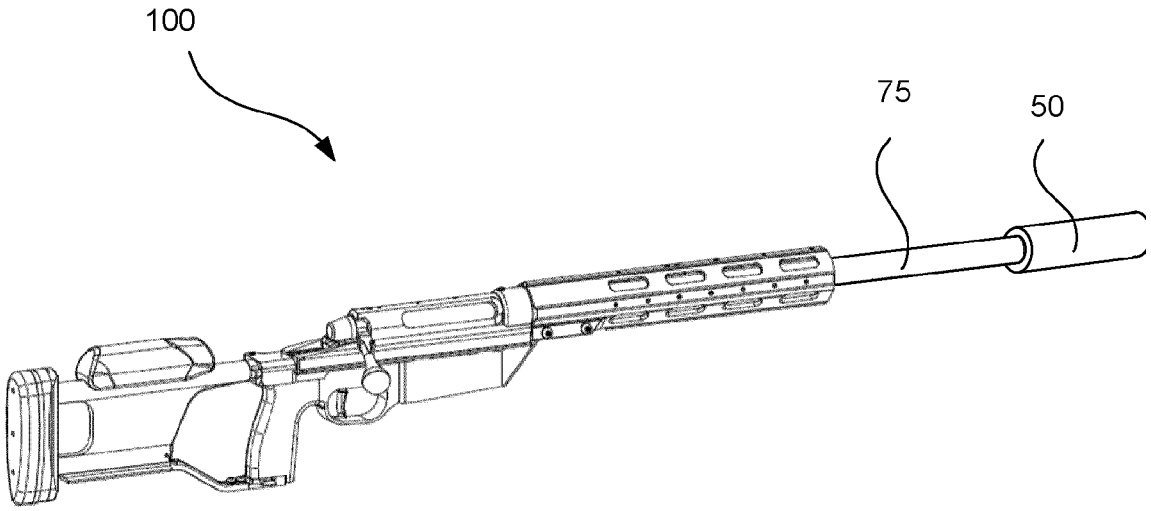


Fig. 1

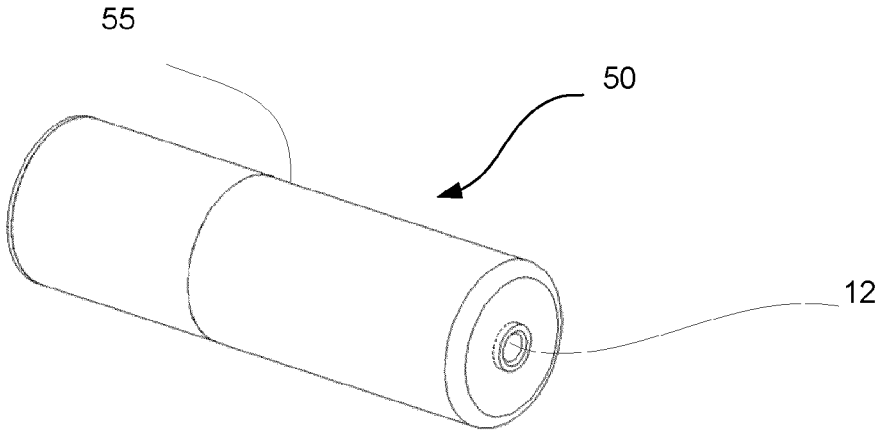


Fig. 2

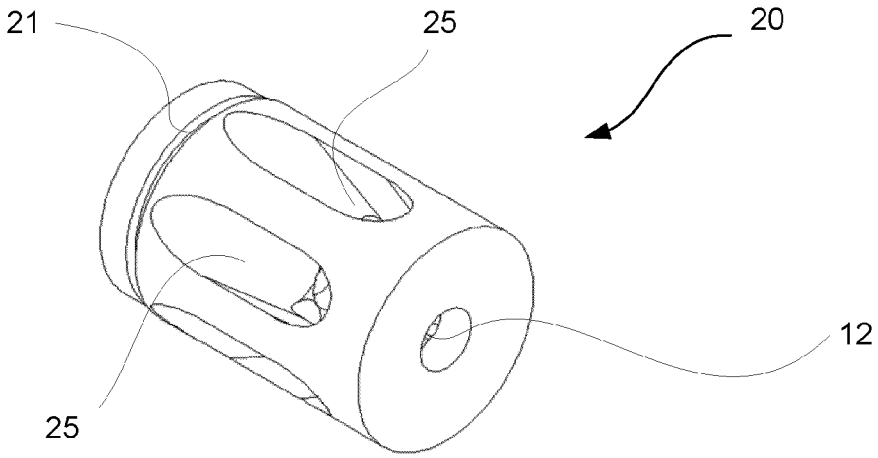


Fig. 3

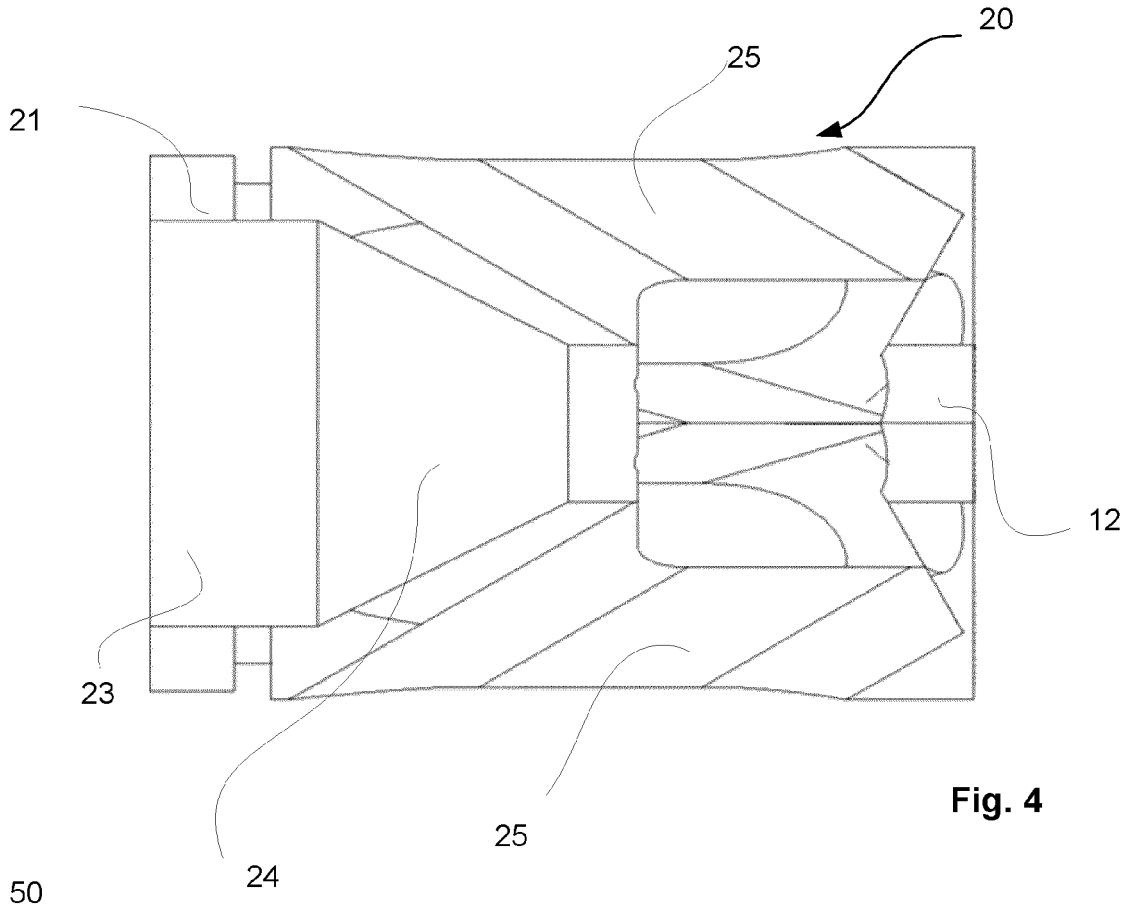


Fig. 4

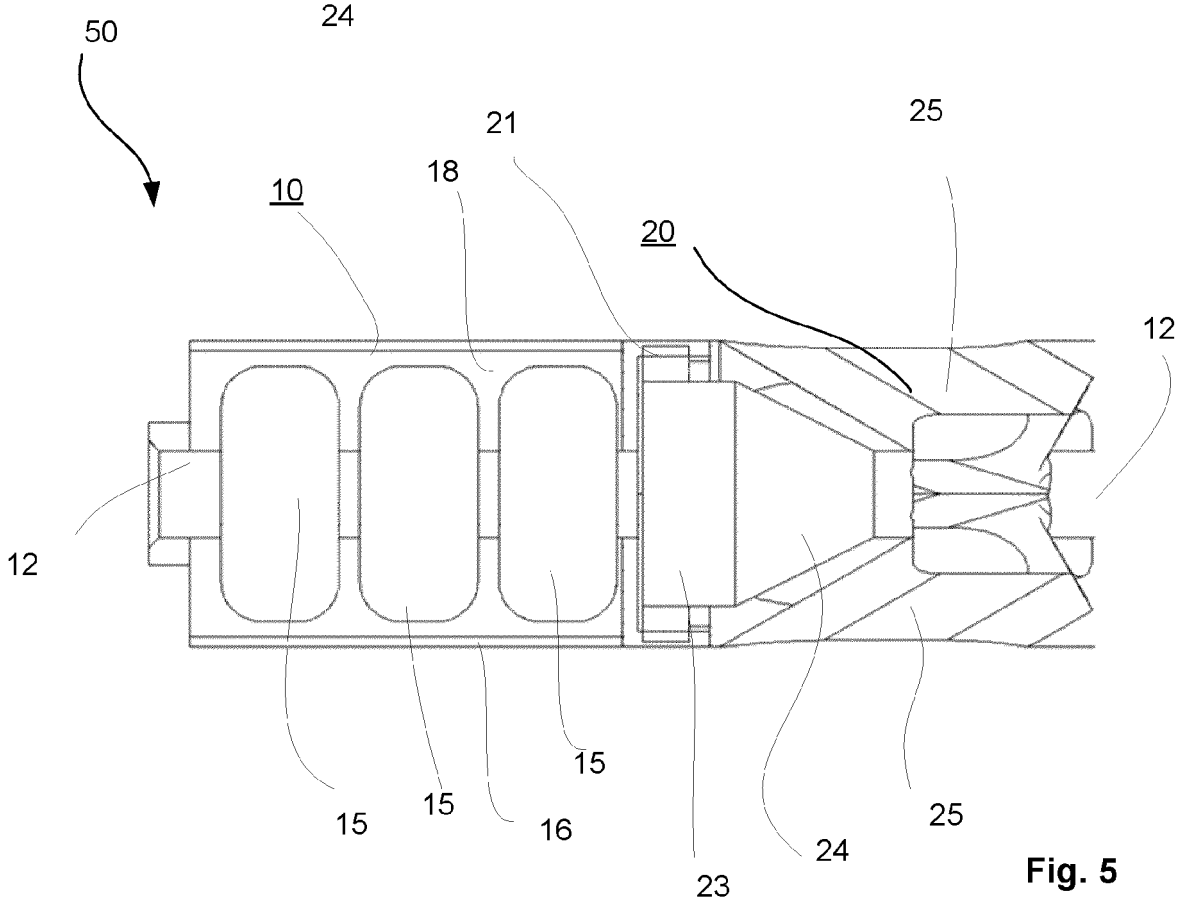


Fig. 5

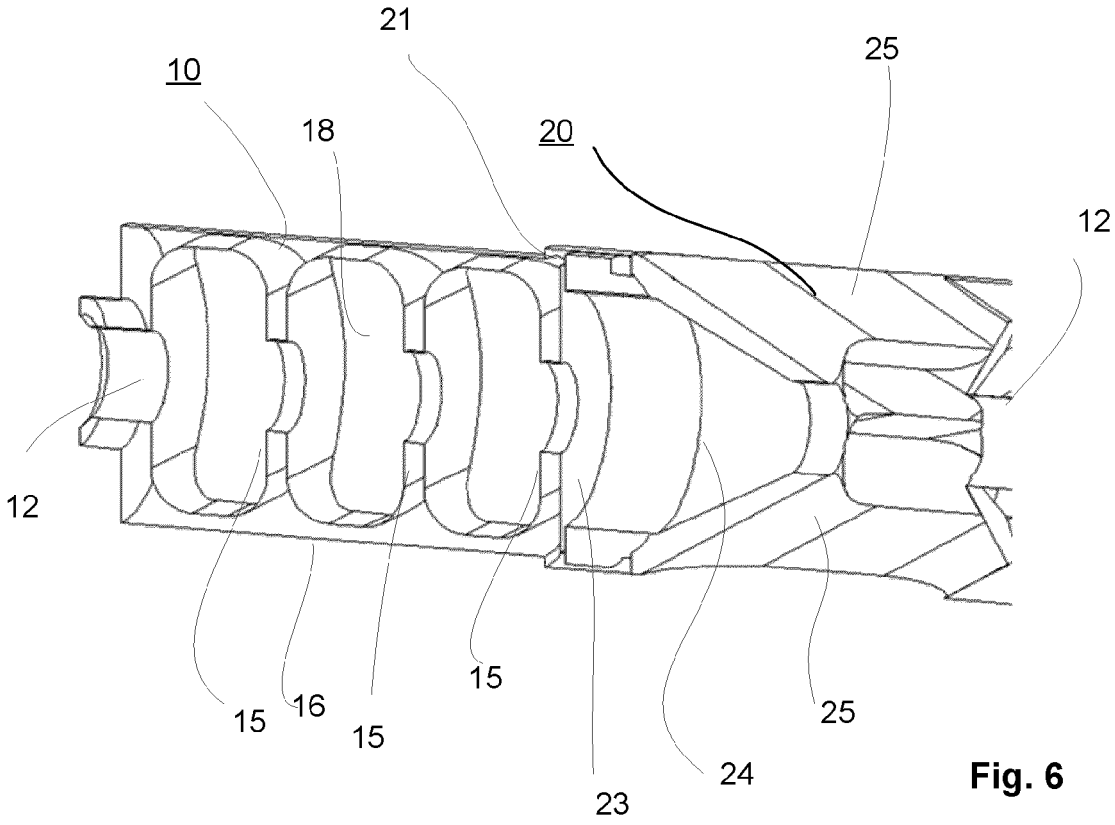
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Fig. 6

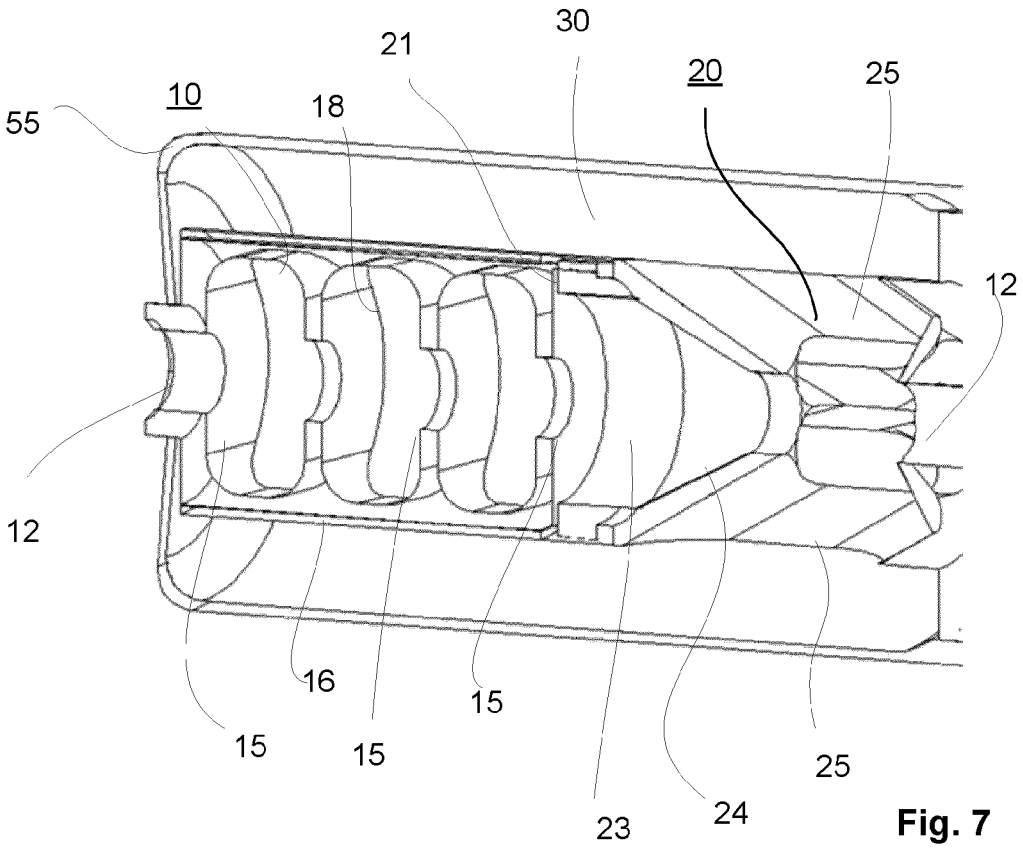
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Fig. 7

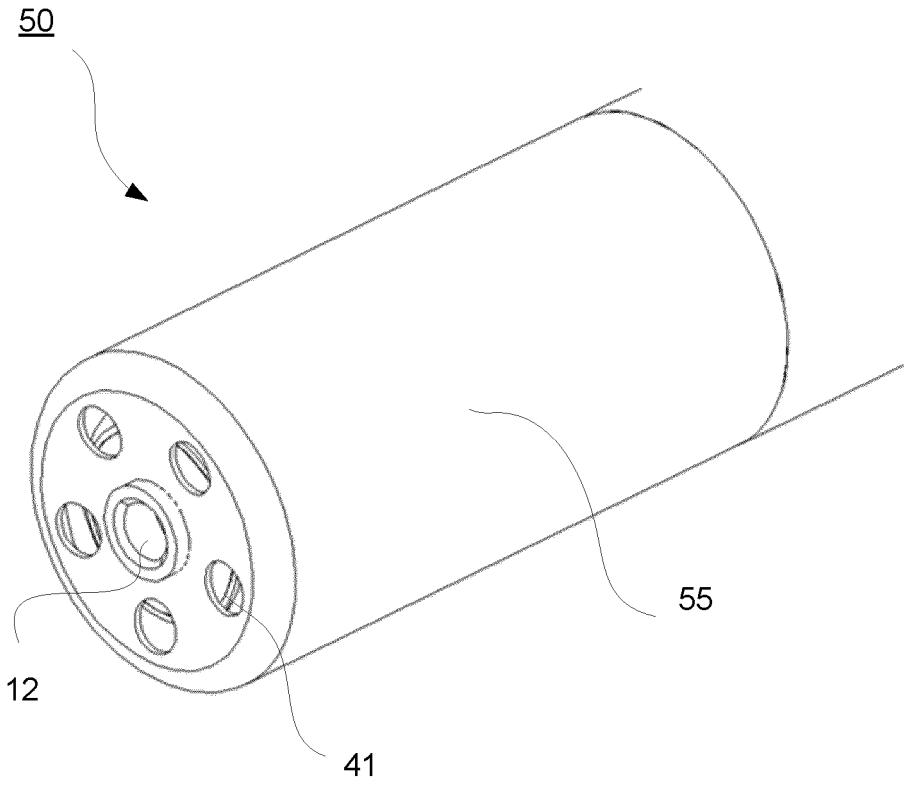


Fig. 8

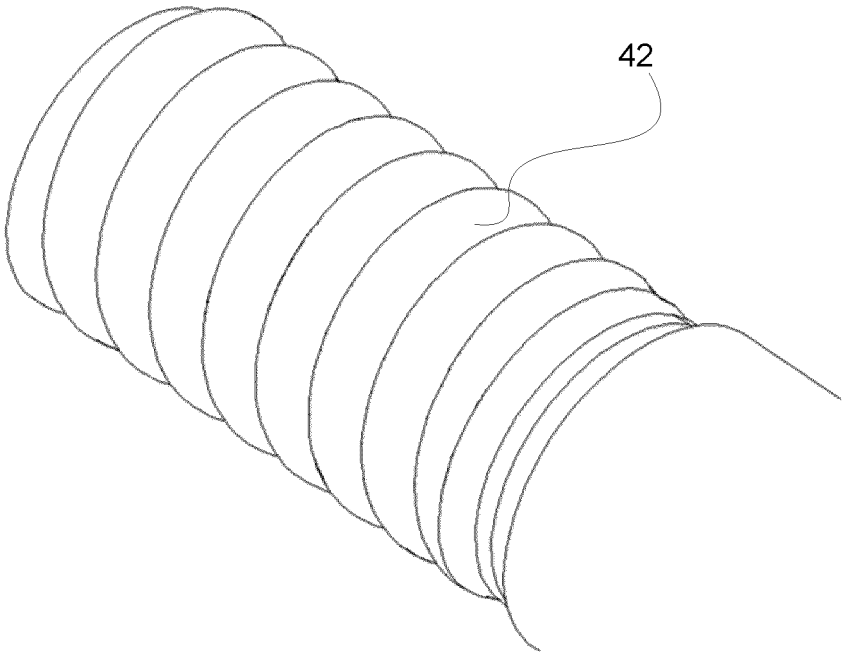


Fig. 9

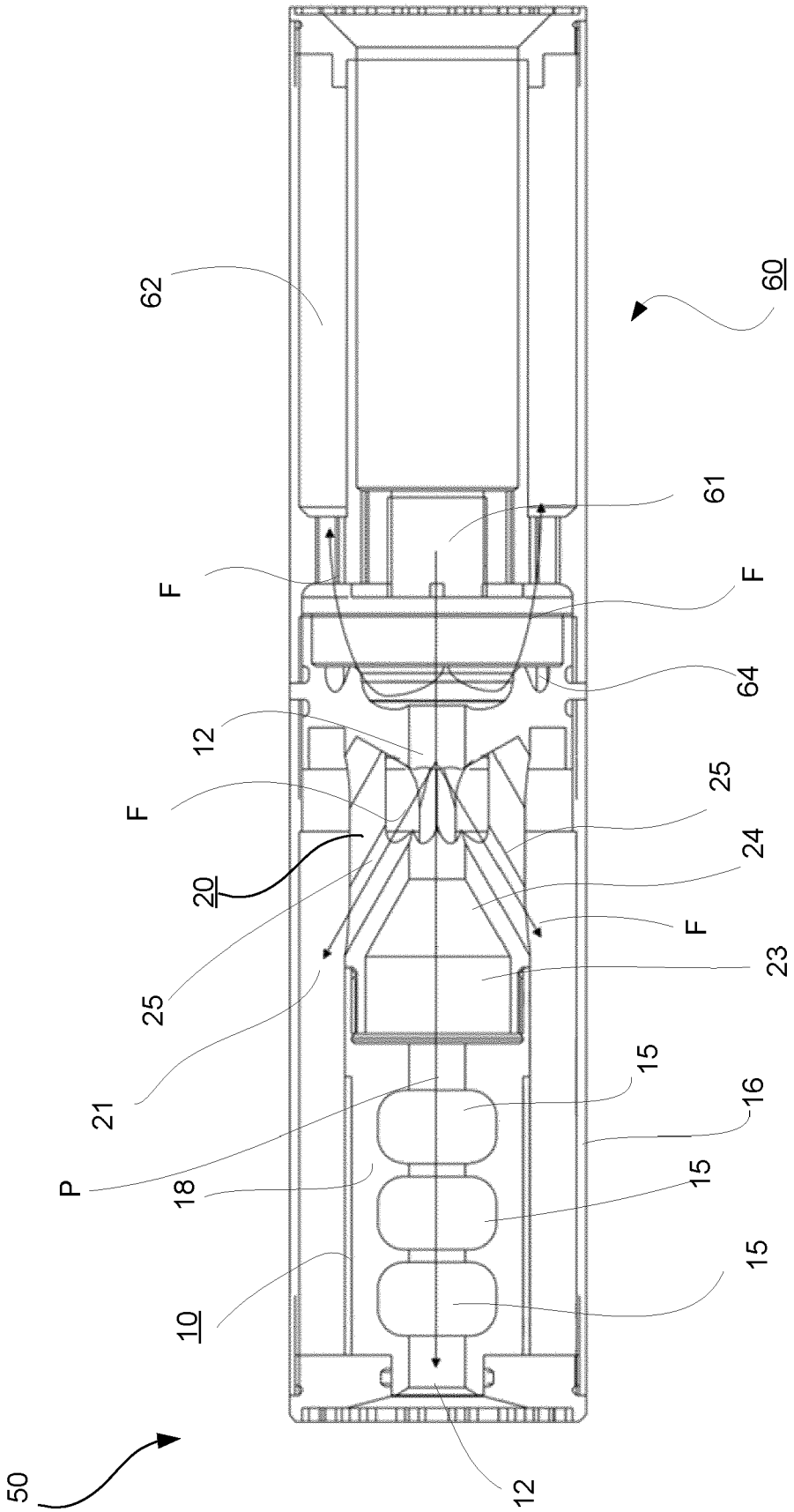


Fig. 10

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# EUROPEAN SEARCH REPORT

Application Number
EP 21 18 5487

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X<br>A | WO 2019/134011 A1 (MDG MUZZLE DEVICES GMBH [AT]) 11 July 2019 (2019-07-11)<br>* abstract *<br>* page 12, line 4 - line 18 *<br>* page 16, line 7 - line 24 *<br>* figures * | 1-5,9,10<br>6-8 | INV.<br>F41A21/30 |
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# EUROPEAN SEARCH REPORT

Application Number
EP 21 18 5487

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