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(72) Inventor; and
(71) Applicant: **BALABANOV, Heorhiy** [UA/UA]; st. Liotna 25/30, Chernihiv, 14033 (UA).

(72) Inventor: **SKOPENKO, Arthur;** Krasvts'koho St. 58, Kyiv, 02000 (UA).

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Declarations under Rule 4.17:
— *of inventorship (Rule 4.17(iv))*

(54) **Title:** SILENCER

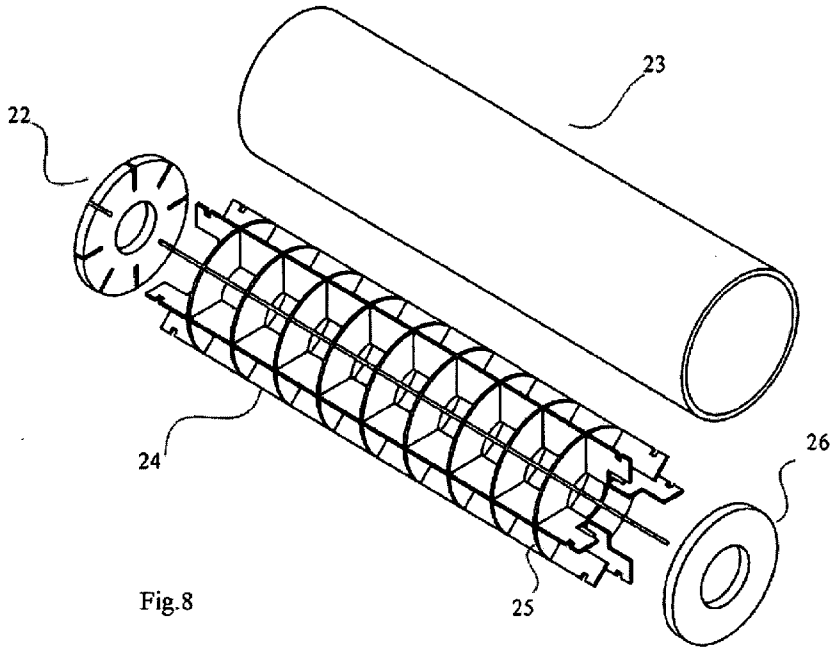

Fig.8

(57) Abstract: The present invention discloses a silencer, comprising a tubular case, connected to a first sleeve and a second sleeve. The first sleeve is connectable to a firearm muzzle or other source of sound. The silencer also comprises multi-cellular modular frame structure, having guides and membranes. The guides are arranged along the axis of tubular case. The inner diameter of the structure is made close to the diameter of the central hole in the second sleeve. The structure is made of sheet material.

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[Continued on next page]

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— *with international search report (Art. 21(3))*

Silencer system Balabanov-Skopenko.

Description of invention

1. Design of invention.

Silencer of Balabanov-Skopenko design, modular-frame and multi-cellular type, hereinafter referred to as "SBSD", is universal self-supporting structure of increased strength and relatively low weight, which can withstand high loads without practical increase in overall weight of systems, where it is used. Specific features include two main factors - maximum internal volume for expansion of generated gases (in numerous individual cells) and high technological efficiency in manufacturing of main elements. "SBSD" has prefabricated design, with quick and easy replacement of any structural elements by means of standard tools. This versatile design can be used to produce light-weight sound dampers for internal combustion engines or firearm silencers.

Basic model consists of multi-cellular frame inside the case, which can be made on the basis of tube (any section). Multi-cellular frame is assembled of transverse bearing membranes (repeating the internal tube profile), longitudinal guides (setting the direction for projectile), and two flanges (input and output, fixing the entire structure and keeping it inside the tube, thus forming a durable closed system). Input flange is provided with thread or other means of "SBSD" fixing to gas output and/or projectile channel.

To improve the system strength as a whole, transverse membranes may have additional through-holes (to increase the volume of expansion chambers due to their array). It reduces the peak loads in high-pressure chambers (due to gas expansion), without increasing the weight of the whole system - due to quick modifying of silencer, without major changes in design.

2. Concept of "SBSD" action - hot (pushing) gases, which expand to low-pressure zone, go through the input flange and into channel formed by transverse

guides. They move in closed system, to output flange, but expand into numerous silencer cells. It results in losing the most of pressure and temperature. Cooled and diluted gases get outside "SBSD".

Same way, part of unburnt fuel/gunpowder is destroyed or mixed with carbon dioxide/nitrogen (left on combustion of oxygen from atmospheric air) and returned to atmosphere after cooldown. This mix is no longer ignited, but dispersed into environment (without extra detonation or sound). Then, gas (expanded in cells) further expands in opposite direction – to channel and output flange, while leaving closed "SBSD" system and dissipating in atmosphere. It leads to major noise reduction (during operation of system utilizing "SBSD").

Well-known silencer (patent US2780962A) has metal tubular case coaxially connected to the first sleeve (made with ability to connect to firearm muzzle). On the opposite end of the case, there is a membrane (second sleeve with central hole for passage of bullet and exit of powder gases). The case has the guides arranged along the axis of tubular case – with ability for reciprocal motion and metal / non-metal washers set in turn.

Tubular case coaxially connected to the first sleeve (made with ability to connect to firearm muzzle) and second sleeve (located on the opposite end of the case) match the essential features of well-known firearm silencer. Second sleeve contains a central hole for passage of bullet/exit of powder gases. The case contains the guides arranged along the axis of tubular case.

Drawback of well-known silencer is insufficient sound suppression – due to poor dissipation of powder gases by its structural elements.

Well-known firearm silencer ((patent US2375617A), selected as the closest analog, has tubular case coaxially connected to the first sleeve ((made with ability to connect to firearm muzzle) and second sleeve ((located on the opposite end of the case). Tubular case contains two or more membranes, which have central hole

for passage of bullet and exit of powder gases (like second sleeve). Second sleeve also has additional holes for exit of powder gases. Volumetric dynamic chambers (formed by membranes and tubular case) contain guiding elements arranged along the axis of tubular case. Membranes and guides are made with ability for axial displacement in tubular case – under the action of powder gases.

Tubular case coaxially connected to the first sleeve (made with ability to connect to firearm muzzle) and second sleeve (located on the opposite end of the case) match the essential features of well-known firearm silencer. Second sleeve has central hole (for passage of bullet/exit of powder gases) and additional holes (for exit of powder gases); the case has at least one guide plate located along the axis of tubular case.

Drawback of well-known silencer is similar to previous analog.

Invention is based on task of improving the well-known silencer – via change of design, which improves the efficiency of powder gas dispersion on original structural elements. Combination of features in new silencer ensures better sound suppression for firearms/intemal combustion engines – due to more advanced (compared to prototype) channels for powder gases, which improve the dispersion. Second component of the task is simultaneous reduction of exhaust gas temperature (compared to prototype), its energy and sound intensity.

3. Expertise. Unique "SBSD" design is self-supporting, multi-cellular frame, without use of complex (assembly and manufacturing) technology. This design also has a lot of supporting elements and qualitatively improved distribution of high-pressure gases (to individual zones). In production, "SBSD" design applies technology of conventional stamping or automatic cutting of sheet material (any composition). On use of thermostable stainless steel alloys/low-heat titanium alloys, unique "SBSD" design has undeniable advantage over all known silencer designs. It has low cost, low weight, high strength, resistance to heating, and rapid cooling (due to low mass). System serviceability has no analogs among

effective silencing systems.. Replacing of defective element or complete cleaning in the field takes several minutes and does not need any special tools.. All this confirms that "SBSD"' is unique in design and versatile in use – without known analogs in design and simple production technology..

The drawing shows schematic image of the silencer..

The silencer has tubular case 23..

Basic model consists of multi-cellular frame 21 inside the case 23, which can be made on the basis of tube (any section).. Multi-cellular frame, assembled of transverse bearing membranes 25 (repeating the internal tube profile), longitudinal guides 24 (setting the direction of projectile), and two flanges (input 22 and output 26, fixing the entire structure and keeping it inside the tube, thus forming a durable closed system). Input flange is provided with thread or other means of "SBSD" fixing to gas output and/or projectile channel.

Proposed silencer works as follows.

The silencer is fixed by first sleeve 22 to firearm muzzle (or other source of sound in mechanic engineering). In the course of shooting, the bullet passes through holes of the first sleeve 22 and central hole of the second sleeve 26. Powder gases (with high pressure/temperature) push the bullet through multi-cellular frame 21 and case 23, while partially dissipating in transverse bearing membranes 25 (repeating the internal tube profile). Energy of the gases is effectively reduced, thus suppressing the sound of shot or running engine.

Proposed silencer successfully passed the experimental tests – including the high fire rate and engine speed.

Brief description of figures.

Fig. 1 – side view (exploded).

Fig. 2 and Fig. 3 illustrate several projections of longitudinal guides.

Fig. 4 and Fig. 5 illustrate several projections of transverse bearing items.

Fig. 6 shows connection of longitudinal and transverse items in modular- frame type (outside).

Fig. 7 shows connection of longitudinal and transverse items in modular-frame type (inside).

Fig. 8 – side view (partially assembled).

Detailed description.

Pic. 1 shows an option of isometric view for longitudinal guide plate.

Pic. 2 – longitudinal guide plate (bottom view).

Pic. 3 – longitudinal guide plate (front view).

Pic. 4 – longitudinal guide plate (top view).

Pic. 5 – two types of longitudinal guide plate.

Pic. 6 – longitudinal guide plate (left-side view).

Longitudinal guide plate is a strip made of sheet material (quite durable to withstand chemical and physical loads). The plate can be made by any known method of material processing. The plate has transverse slots (width and depth vary depending on item size). Distance between the slots, as well as their number, varies depending on requirements to item.

Pic. 7 – bottom view of longitudinal guide plate (with slots for inside connection).

Pic. 8 – bottom view of longitudinal guide plate (with slots for outside connection).

Both ends of longitudinal guide plate are provided with slots (for fixing by lock ring).

Pic. 9 – front view of transverse bearing membrane.

Pic. 10 – rear view of transverse bearing membrane.

Pic. 11 – bottom view of transverse bearing membrane.

Pic. 12 – isometry of transverse bearing membrane.

Pic. 13 – option of isometric view for transverse bearing membrane.

Transverse bearing membrane is washer made of sheet material (quite durable to withstand chemical and physical loads). The washer can be made by any known method of material processing. The washer has through-hole. Slots are arranged from the center of hole axis. Width and depth of the slots vary depending on item

size.. Distance between the slots,, as well as their number,, varies depending on requirements to item.. The washer may be of different shape (for example: round,, square,, rectangular,, etc.)

Pic.. 14 – bottom view of transverse bearing membrane (with slots for inside connection).

Pic.. 15 – bottom view of transverse bearing membrane (with slots for outside connection).

Fig.. 6 shows connection of longitudinal and transverse items in modular- frame type (outside).

Pic.. 16 illustrates the mechanism of outside connection between transverse bearing membrane and longitudinal guide plate shown in Fig.. 17.

Fig.. 7 shows connection of longitudinal and transverse items in modular- frame type (inside).

Pic. 18 shows one connecting element of bearing membrane with one longitudinal guide plate.

Pic. 19 shows several connecting elements of bearing membrane with one longitudinal guide plate.

Pic. 20 shows several connecting elements of bearing membrane with several longitudinal guide plates.

Pic. 21 shows full assembly of connections (transverse bearing membranes with longitudinal guide plates).

Fig. 8 is optional view of the system (partially assembled).

Pic. 22 – top ring.

Pic. 23 – outer case.

Pic. 24 – longitudinal guide plates.

Pic. 25 – transverse bearing membranes.

Pic. 26 – sleeve.

Formula of invention

1. Silencer of Balabanov-Skopenko design, modular-frame and multi-cellular type, hereinafter referred to as "SBSD", with tubular case coaxially connected to the first sleeve (made with ability to connect to firearm muzzle or other source of sound) and second sleeve (on the opposite end of the case, with central hole for passage of bullet, projectile, missile, etc. and/or exit of powder gases or fuel combustion gases); inside of the case has modular-frame, multi-cellular structure located along the axis of tubular case (characterized by the fact that inner diameter of the structure is made close to diameter of central hole in the second sleeve; the structure is made of sheet material).

2. Silencer according to Item 1: the case has the guides arranged along the axis of tubular case – with ability for reciprocal motion and metal/non-metal washers set in turn.

3. Silencer according to Item 1 or 2 (characterized by the fact that volumetric dynamic chambers, formed by membranes and tubular case, contain guiding elements arranged along the axis of tubular case). Membranes and guides are made with ability for axial displacement in tubular case – under the action of powder gases.

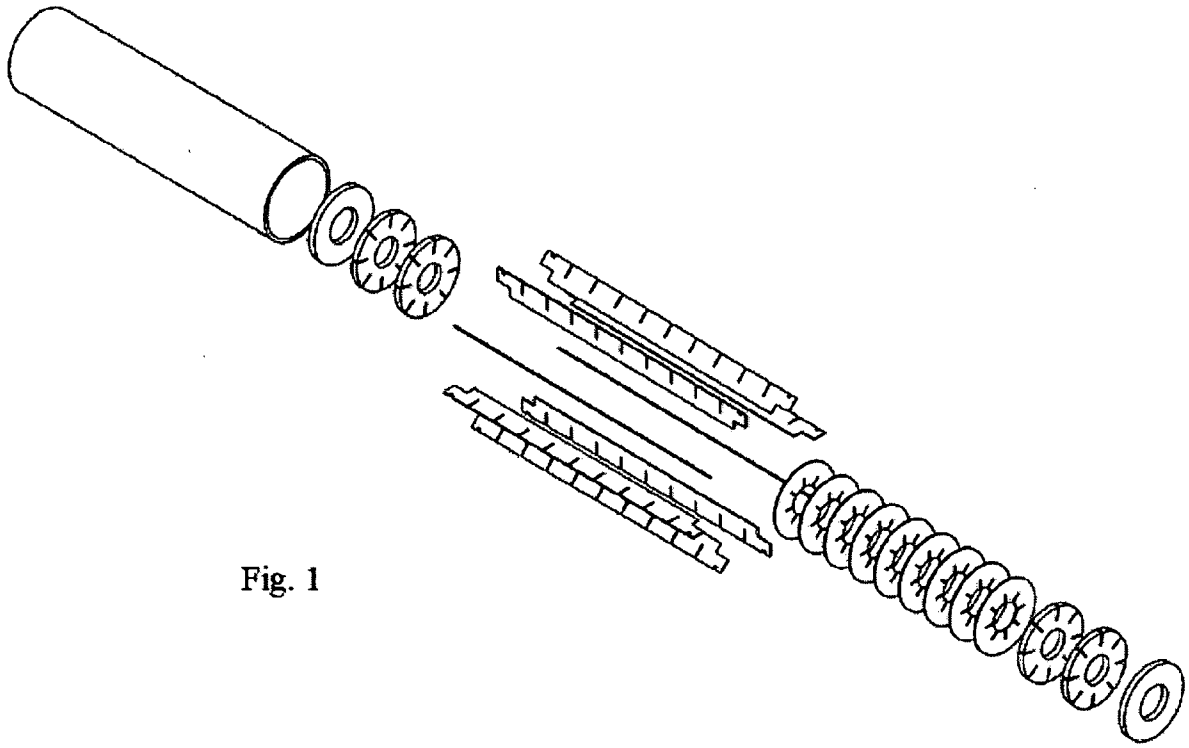
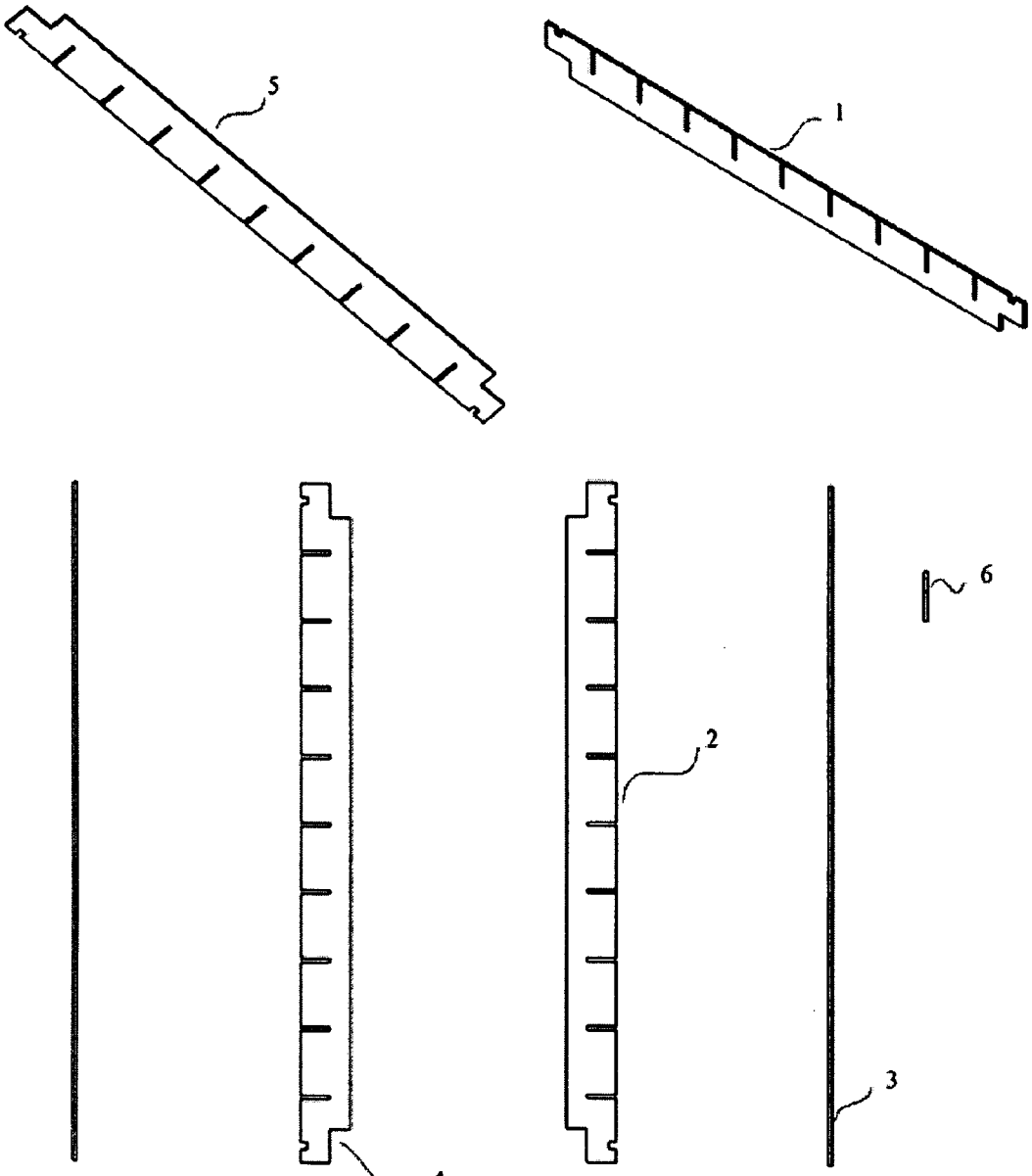


Fig. 1



Fig, 2

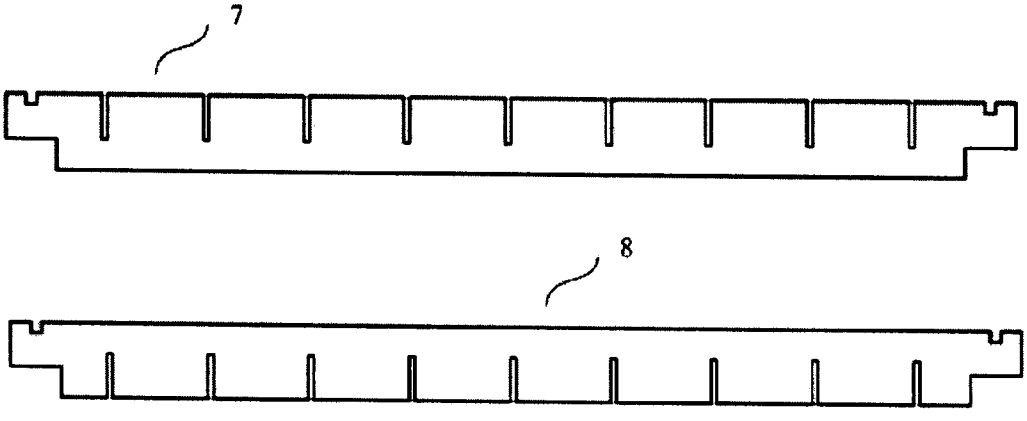


Fig.3

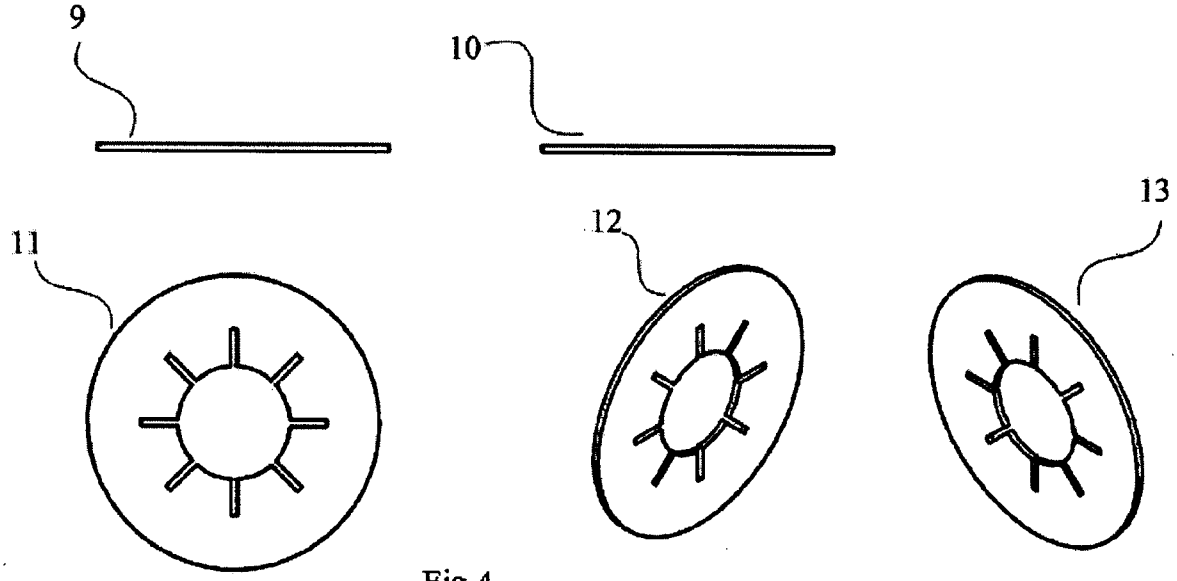


Fig.4

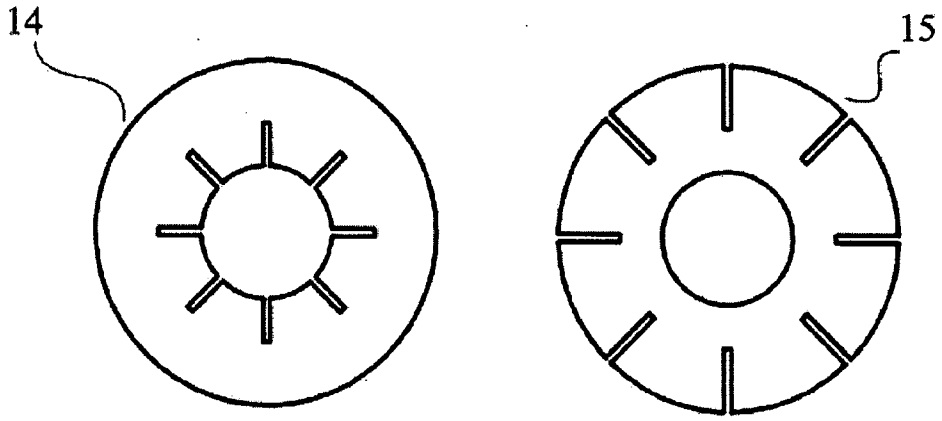


Fig. 5

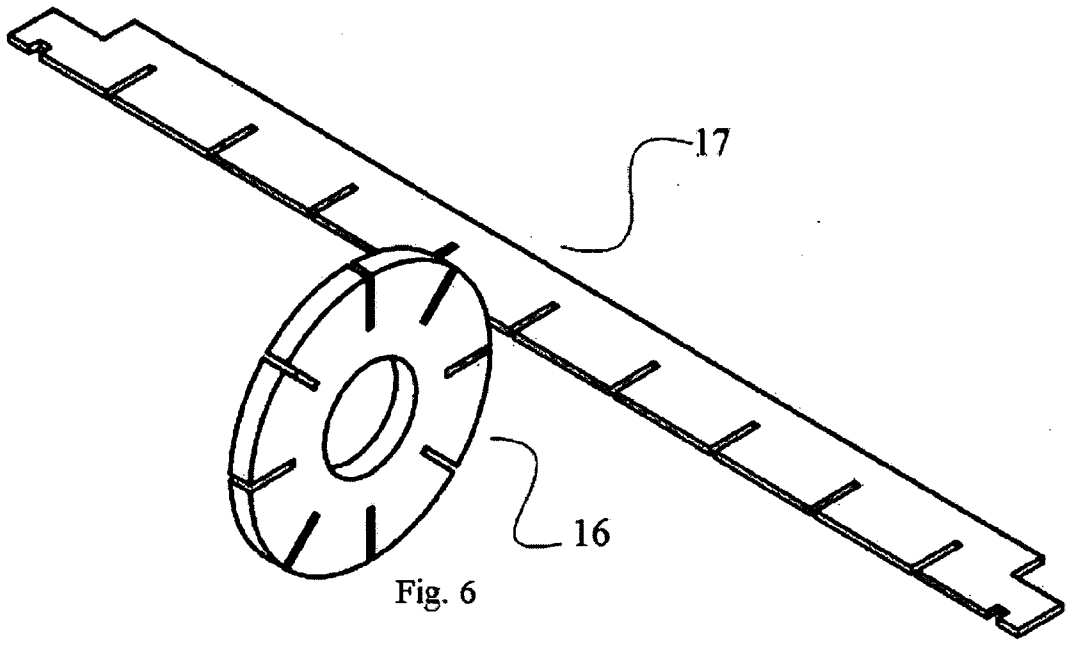


Fig. 6

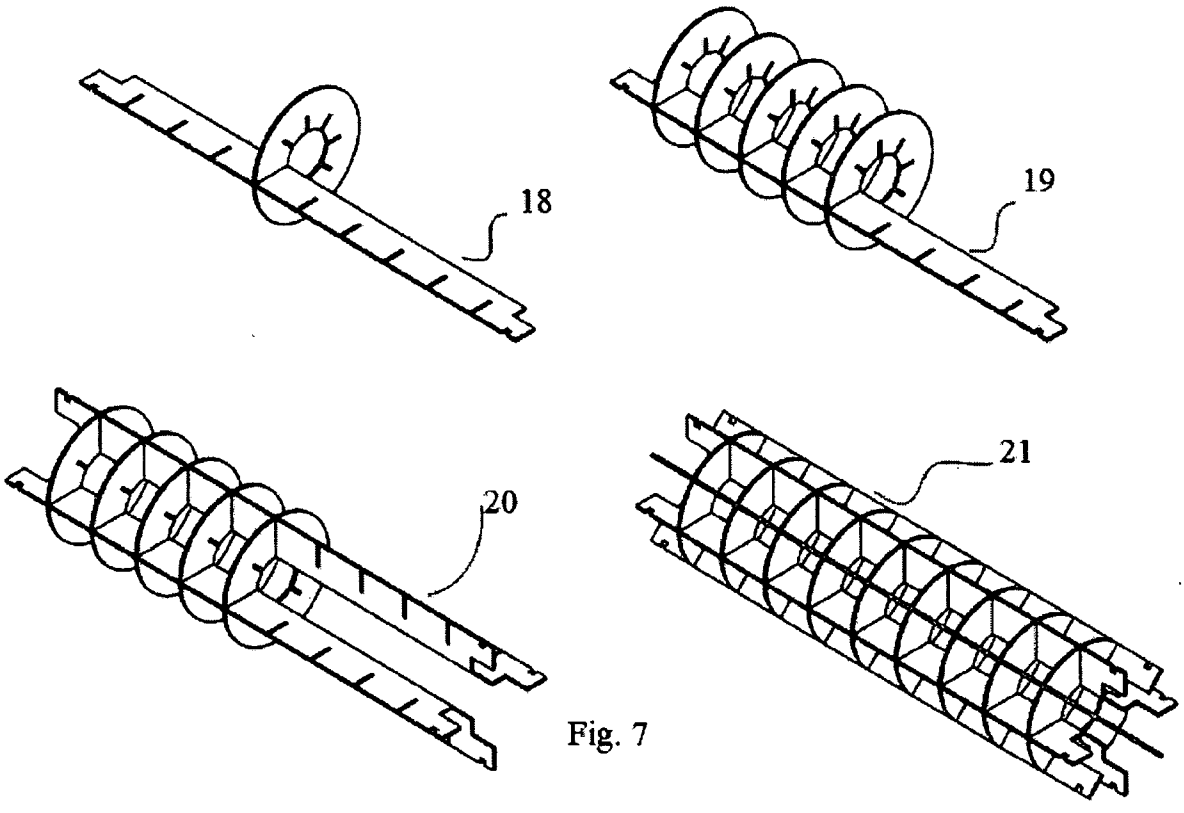


Fig. 7

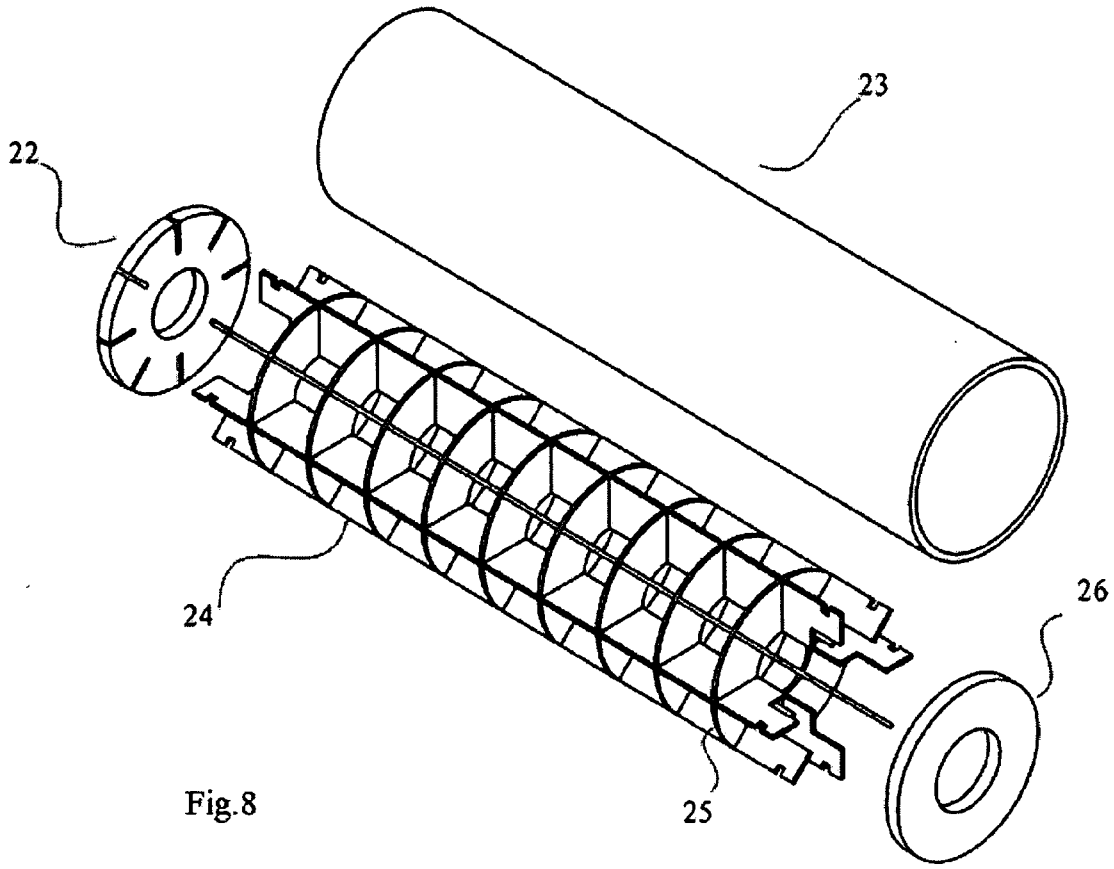


Fig.8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/UA2019/000012

A. CLASSIFICATION OF SUBJECT MATTER
F41A21/30, F01N1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: F41A21/30, F01N1/00
CPC: F01N1/003

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Espacenet, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	CN 1821704 A (XU YONGSHENG [CN]) 23 August 2006 (2006-08-23) (figures, abstract)	1 2, 3
Y	GB 299449 A (ZYGMUNT WILMAN [PL]) 09 January 1930 (1930-01-09) (figures)	2, 3
Y	US 3677132 A (US NAVY [US]) 18 July 1972 (1972-07-18) (figures)	2, 3
Y	US 1111202 A (WESTFALL WALTER E [US]) 22 September 1914 (1914-09-22) (figures)	2, 3
Y	US 6374718 B1 (TACTICAL OPERATIONS INC [US]) 23 April 2002 (2002-04-23) (col. 4, ln. 46-56)	2, 3
A	US 5164535 A (SILENT OPTIONS INC [US]) 17 November 1992 (1992-11-17) (figures)	1-3

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 April 2019 (15.04.2019)	**22 April 2019 (22.04.2019)**
Name and mailing address of the ISA/UA The State Enterprise "Ukrainian Intellectual Property Institute" 1 Hlazunova Str., Kyiv-42, 01601, Ukraine Facsimile No. +380 (44) 494-05-06	Authorized officer **A. VEREMENKO** Telephone No. +380 (44) 494-05-74

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/UA2019/000012

Patent document, cited in the search report	Publication date	Patent family member(s)	Publication date
CN 1821704 A	2006-08-23	None	
GB 299449 A	1930-01-09	BE 354173 A	
		CH 137778 A	1930-01-31
		FR 643038 A	1928-09-08
US 3677132 A	1972-07-18	None	
US 1111202 A	1914-09-22	None	
US 6374718 B1	2002-04-23	None	
US 5164535 A	1992-11-17	None	