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(54) **Device for cleaning a particulate filter**

(57) The invention pertains to a device (1) designed to be used when cleaning a particulate filter (2) inside a silencer (3) for a combustion engine. The device (1) comprises a disc unit (4) adapted to be arranged in connection with a mounting opening (5) for the particulate filter (2) inside the silencer (3) in order to partly shield off one

outlet end (6) of the particulate filter (2). The disc unit (4) is designed like an apertured plate which has an opening (7) designed to let through air when cleaned through a suction device (20) connected to the silencer (3) sucking air through the opening (7) and backwards through the particulate filter (2).

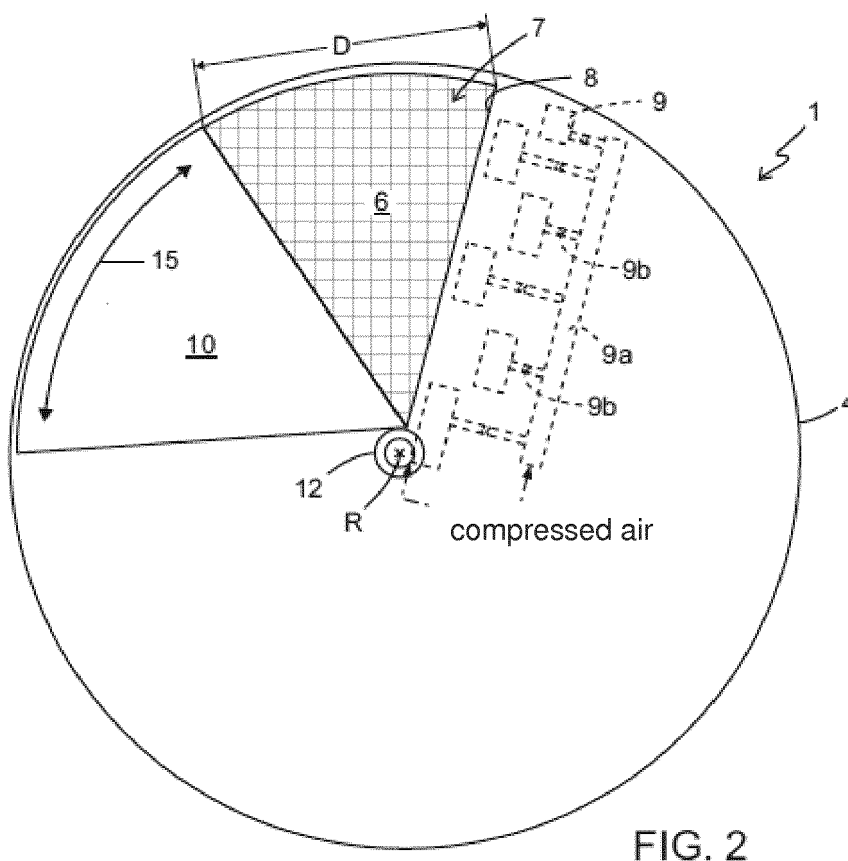


FIG. 2

Description

Field of the invention

[0001] The invention pertains to a device at cleaning a particulate filter according to further details set out in the preamble of the enclosed patent claim 1, and a cleaning system for a particulate filter, where the system comprises such a device.

Background of the invention

[0002] In a combustion engine the exhaust pipe from the engine usually comprises a silencer. A silencer, e.g. in a cargo vehicle with a diesel engine, today often comprises a particulate filter for exhaust aftertreatment. The particulate filter is intended to catch soot particles which are later oxidised into ash. Usually, such a silencer is mounted primarily with regard to available space in the vehicle and without taking into account that the silencer should be dismantled easily, or be easily accessible when serviced. This entails difficulties in connection with dismantling, or accessing the particulate filter when the particulate filter is serviced and cleaned. Similar problems also occur in cases where the engine is arranged in other applications than in a vehicle, e.g. if the engine is used for industrial or marine purposes.

[0003] The particulate filter in the silencer may need to be dismantled in order to be replaced or cleaned of deposited ash, and, in connection therewith, the silencer also usually needs to be dismantled at least partly. This dismantling may become considerably difficult since the silencer may weigh between 100 to 150 kg and is not always easily accessible. The particulate filter itself may also be difficult to dismantle since it may be tightly attached to the silencer, and in particular since it may be difficult to dismantle the particulate filter if accessibility to the particulate filter is limited. Typically, the particulate filter needs to be replaced or cleaned at certain intervals since accumulated ash increases the back pressure in the exhaust system, which entails increased fuel consumption, for instance. Usually, the replacement or cleaning of the particulate filter takes place in connection with service, which typically entails dismantling of the silencer and the particulate filter with approximately one year's interval. In cases with high mileages, typically above 360,000 km, for a cargo vehicle with a diesel engine driven with alternative fuels, replacement or cleaning of the particulate filter may need to be carried out at even shorter intervals. It is thus significant that the particulate filter may be replaced or cleaned easily.

[0004] Due to relatively high costs of particulate filters there are replacement systems today where a particulate filter is submitted for cleaning and replaced with a cleaned replacement filter. The problem still remains that the silencer, or at least the particulate filter, needs to be dismantled to replace the existing particulate filter with a replacement filter. The solution with a replacement sys-

tem is also often expensive and time consuming since, usually, several different parties are involved in handling the replacement filter.

[0005] A significant problem identified with today's replacement of particulate filters is thus the difficulty in dismantling the silencer in order to dismantle the particulate filter, and/or to dismantle the particulate filter itself. An additional problem identified in connection with this is to be able to clean the particulate filter carefully and simply, and without the need to dismantle the particulate filter from the silencer.

[0006] The document WO 2008/054262 A1 describes an example of how cleaning a particulate filter in a silencer may occur without the filter having to be dismantled from the silencer. As an example of prior art, reference is made to US 7716922, which describes how purging of a particulate filter may take place on site in a vehicle.

Summary of the invention

[0007] One objective of the present invention is to provide a solution for cleaning of a particulate filter arranged inside a silencer without the silencer, and thus without the particulate filter, having to be dismantled from its position.

[0008] An additional objective of the present invention is to provide a solution for cleaning of a particulate filter which ensures that it may occur in a simple and careful manner.

[0009] The above-mentioned objectives are achieved with the invention as defined by the independent patent claims.

[0010] According to a first aspect, the invention pertains to a device for cleaning of a particulate filter in a silencer for a combustion engine. This may apply to a combustion engine arranged in a vehicle, an engine for industrial use or an engine for marine use. The device comprises a disc device adapted to be arranged in connection with a mounting opening for the particulate filter inside the silencer in order to shield off one outlet end of the particulate filter. The disc unit has an opening intended to let in air in order to clean the filter through flowing in one direction, backwards, opposite to a normal flow direction when used.

[0011] The device is intended to be used in combination with a suction device, which is arranged to suck air backwards through the opening, i.e. through a limited part of the particulate filter, so that cleaning is only carried out for a limited part of the filter at a time. In this manner, the risk of all ash that has accumulated in the particulate filter coming off at the same time and thus risking damage of other equipment inside the silencer, such as a catalyst or other item, is reduced.

[0012] The objective of the device is for neither the silencer nor the particulate filter having to be dismantled for cleaning of the particulate filter, but that the particulate filter may remain installed in the silencer in connection with cleaning. Time and work with unnecessary disman-

ting of the particulate filter for cleaning or replacement is thus saved. This entails reduced costs of service where unnecessary dismantling of the particulate filter is saved; lower costs since no filter is replaced, not even for a replacement filter, and simpler logistics compared to a replacement system.

[0013] The device is also easy to install and dismantle, even in the event of limited accessibility to the particulate filter, since it is compact, and easy to use.

[0014] According to one embodiment of the invention, the disc unit has an edge side at the opening which comprises at least one pressure means element, such as a compressed air nozzle adapted to lead out the detergent, such as compressed air, along the edge, where the pressure means element is adapted to be connected to a pipe for the detergent, such as compressed air.

[0015] In this manner the particulate filter is cleaned, by compressed air being pressed backwards through the particulate filter and transporting away loose particles, such as ash that has accumulated in the particulate filter. Likewise, the compressed air loosens particles caught in the filter.

[0016] According to a second aspect, the invention pertains to a cleaning system for a particulate filter inside a silencer in a vehicle. The cleaning system comprises a device for cleaning of the particulate filter according to the invention, and a suction device.

[0017] The cleaning system has, in addition to the advantages specified above for the device, also the advantage that the existing system for exhaust extraction may be used.

[0018] Additional features and advantages characteristic of the invention are set out in the description below, with reference to the enclosed drawings exemplifying an advantageous embodiment of the invention.

Brief description of drawings

[0019]

- Fig. 1 shows schematically a perspective view of a silencer with an exposed particulate filter before the assembly of a device according to the invention,
- Fig. 2 shows a view from the front of an embodiment of a device in connection with cleaning of a particulate filter in a silencer,
- Fig. 3 shows a cross-sectional view from the side of the device in Figure 2 and
- Fig. 4 shows schematically a cleaning system comprising a device according to the invention installed inside a silencer, installed in a vehicle, the system of which also comprises a suction device connected to an inlet of the silencer.

Detailed description of embodiments of the invention

[0020] Figure 1 shows schematically a perspective

view of a silencer 3 for a combustion engine. The silencer 3 is arranged in a chassis of a heavy goods vehicle and is intended to be comprised in an exhaust pipe from the combustion engine. The silencer may, alternatively, be comprised in many other contexts where a silencer for a combustion engine is used, e.g. for industrial purposes and for marine use. In the figure, however, a silencer designed typically for a vehicle is displayed, such as a heavy goods vehicle, e.g. a cargo vehicle or a bus. The silencer is substantially square where each side is around 700 mm.

[0021] A particulate filter 2, such as a diesel particulate filter (DPF), is arranged inside the silencer 3. The silencer 3 is shown schematically with an exposed particulate filter 2 with an outlet end 6 and a mounting opening 5 for connection of a device for cleaning of the particulate filter 2. When the silencer 3 is in operation, the particulate filter's 2 outlet end is entirely covered by a hatch cover (not shown in the figure). This hatch cover may be assembled with fixture elements such as screws, or a quick fixture for quick assembly/dismantling. The particulate filter 2 is only shown schematically assembled in the mounting opening 5 and certain parts are only shown principally.

[0022] In particular inside an exhaust pipe from a diesel engine, additional equipment for exhaust aftertreatment may be arranged inside the silencer 2, e.g. a diesel oxidation catalyst (DOC) arranged upstream of the particulate filter 2, and/or a catalyst for selective catalytic reduction (SCR-catalyst) of nitrogen oxides, arranged downstream of the particulate filter 2. Here, a direction of flow is defined as the direction that exhausts normally take through the silencer 2 when the combustion engine is operating.

[0023] The silencer is shown as exposed but is suitably assembled, or only partly dismantled, e.g. pulled out in a service position, from its normal position for use, in the vehicle's chassis. The silencer is, however, dismantled from the exhaust pipe on an upstream side of the silencer, i.e. on an inlet side (hidden in this figure). The fixture elements on the silencer to fasten the silencer on the vehicle's chassis are only showed schematically.

[0024] Figure 2 shows a view from the front, and Figure 3 a view from the side in cross-section, of an embodiment of a device 1 for cleaning of a particulate filter arranged in its normal place for use at a silencer, e.g. the silencer 2 displayed in Figure 1. Figure 2 shows schematically a visible part of the particulate filter's outlet end 6 on which the device 1 is arranged for cleaning of the particulate filter 2. The particulate filter 2 is here exposed for cleaning, in accordance with the description above in connection with Figure 1.

[0025] The device 1 comprises a disc 4, in this embodiment substantially circular, which is adapted to be arranged in connection with the mounting opening 5 in order to screen off the particulate filter's outlet end 6. Schematically visible channels in the particulate filter 2 are shown as a grid with solid lines. The disc 4 has an opening

7 intended to let in air through the channels which open toward the opening 7, while other parts of the disc 4 cover the other channels of the particulate filter and substantially prevent air flowing through.

[0026] The opening 7 is thus intended to let in air through only a limited part of the particulate filter 2. The disc 4 is adapted, suitably designed, so that it fits inside the mounting opening 5 in terms of size, with a suitable clearance for the mounting opening 5 for easy mounting/dismantling and fastening, with the disc 4 rotatable in the mounting opening 5, but still with a surface covering the outlet end 6 of the filter in a suitable manner over the entire exposed filter surface (corresponding to the outlet end 6) and sealing against this in a suitable manner.

[0027] The device 1 is designed as a substantially circular, in the mounting opening 5 rotatable, apertured plate, where the opening 7 is sector-shaped with a bow-shaped outside along the line named D in the figure. Potentially additional sealing means, such as a gasket, may be arranged on the disc 4, suitably on the surface turned toward and covering the outlet end 6. The gasket is then suitably arranged inside an outer edge area of the disc 4 so that the gasket does not block any filter channel but still seals. The disc is manufactured of suitable material, such as steel or aluminium, and with suitable dimensions, e.g. a diameter of around 200 mm and with a thickness of 2-10 mm.

[0028] As shown in the embodiment in figures 2 and 3, the opening 7 has a radially pointed edge side 8 comprising at least one pressure means element 9, adapted to lead detergent with an overpressure, suitably compressed air or other compressed gas, along the edge side 8 and adapted to connect to a pipe 9a for pressure means, suitably compressed air or another compressed gas. In order to be able to use a compressed air source with limited pressure, valves 9b may be arranged between the pipe 9a and the pressure means elements 9. The pressure means elements 9 are adapted to purge the particulate filter 4 with compressed air, so that particles that are caught in the filter channels are released by the compressed air and then may be sucked through the particulate filter 2 backwards by a suction device arranged at the opposite end of the particulate filter 2.

[0029] In the embodiment shown in Figure 2, the pressure means elements 9 are designed as several compressed air nozzles, arranged along and debouching on the bottom of the disc 4, in the vicinity of the edge side 8. This edge side is here a straight radially pointed side of the sector-shaped opening 7. The compressed air nozzles on the other hand are arranged somewhat displaced in relation to each other in order to overlap each others' working areas when the disc 4 turns in the mounting opening 5, in order to thus ensure that the outlet end's 6 entire end surface is subjected to compressed air as the disc 4 rotates. It is suitable that one of the compressed air nozzles 9 is arranged with a mouth around a central area R of the disc 4 in order to ensure that the entire filter's outlet end 6 may be subjected to compressed air.

The nozzle 9, which is arranged around a rotation centre R for the disc 4, is somewhat larger than the others which have substantially the same size. The compressed air nozzles 9 may have the shape of narrow columns which extend along the edge side 8.

[0030] The device 1 for cleaning the particulate filter 2 also comprises the said suction device which is arranged to suck air through the channels of the particulate filter in a direction which is opposed to the direction of the exhausts when the combustion engine is operating. The suction device is arranged at the opposite side of the particulate filter 2 to the side at which the above disc 4 is arranged. The suction device is connected so that the entire particulate filter's end surface is subject to the suction device's underpressure. In practice, it is usually possible to achieve this by connecting the silencer's inlet to the suction device, suitably by loosening a joint of the exhaust pipe and connecting the silencer's inlet to the suction device.

[0031] Even though the entire particulate filter is subject to the underpressure of the suction device, cleaning is carried out by air being sucked backwards only through a limited part of the filter. This is because only the channels which debouch at the opening 7 allow passage through the channels, while the inlets to the other channels are covered by the disc 4.

[0032] In order to regulate the flow of purifying air through the particulate filter 2, the disc 4 is equipped with a sector-shaped pulling hatch 10, which is arranged in a rotatable manner (shown with a double-headed arrow 15), so that it covers the opening 7 fully or partly or not at all. The size of the cleaning surface (which substantially corresponds to the surface of the opening 7) may thus be controlled. The risk that all ash comes off at the same time is thus reduced, and a higher speed in the gas flow which transports the ash away is also achieved. The surface of the draft regulator 10 is suitably somewhat larger than the surface of the opening 7 in order to facilitate shutting the opening 7 completely. The draft regulator 10 may be manufactured with the same material and thickness as the disc 4 otherwise, but is suitably manufactured with thinner material, e.g. thinner plate, for better manageability. It may be pivoted parallel to the disc 4 with a suitable fixture, e.g. pivotally fastened in a narrower part of the sector-shaped draft regulator 10.

[0033] The disc 4 comprises fastening elements 11 designed to fasten the disc 4 rotatably at the mounting opening. By designing the disc with a key grip at its centre the disc 4 may with the help of a suitable hand tool be rotated easily by a mechanic, so that the opening 7 is brought to assume different rotational positions, following which different parts of the channels of the particulate filters may be exposed for cleaning.

[0034] The fastening elements 11 may be fastened to bearing elements 12a, such as rolling bearings, to the centre 12. These fastening elements 11 are suitably adapted to existing fastening elements, e.g. recesses, in order to fasten the cover (which is not shown) which is

mounted over the filter 2 in a ready position of use, i.e. where the filter 2 is not exposed for service such as cleaning. The fastening elements 11 may alternatively comprise fastening elements including screws or similar.

[0035] The device also comprises, according to an alternative embodiment, a central shaft 12, around which the disc 4 is rotatably arranged with a bearing element 13. The central shaft 12 comprises one or several pipes to the elements for detergent, typically, compressed air nozzles. The central shaft 12 is then suitably equipped with a suitable connection element to connect to a compressed air source to the disc 4, which in turn contains channels to the different nozzles. These channels may suitably be designed as drilled channels or closed tracks in the disc 4.

[0036] With the above described embodiment, certain filter channels are cleaned in the sector which corresponds to the opening 7 of the particulate filter only by underpressure from the suction device, and also by other, significantly fewer filter channels, both by way of underpressure and by the overpressure which is achieved by the overpressure of the pressure means elements 9. This provides a particularly efficient and careful cleaning of the particulate filter 2 on site in the silencing device 3 without the need to dismantle the particulate filter 2.

[0037] The device allows, through compact design and a low handling weight, typically between 0.5-2 kg, a good ergonomic position for the person or persons who carry out the cleaning of the particulate filter on site in the silencer or who mount/dismantle it.

[0038] By arranging the device 1 during use in different positions, so that the opening 7 is moved when the mounting opening 5 is rotated, over the entire filter's outlet end 6, i.e. over its entire end surface, the entire particulate filter is cleaned carefully without e.g. large soot flakes or other particles coming off in an uncontrollable way during cleaning. This solves, or at least limits, the problem with the risk that other sensitive equipment for exhaust aftertreatment may be damaged, even though it remains mounted while adjacent particulate filters are cleaned. Problems with soot or dust being spread in an undesirable manner in the service premises when cleaning is carried out are also solved, which improves comfort for the service staff.

[0039] In alternative embodiments, instead of nozzles for clean compressed air or nozzles for a suitable detergent mixed in the compressed air, different combinations of compressed air nozzles and nozzles for a detergent or different detergents are used. If different nozzles for different detergents are arranged, the number of pipes 9a is adjusted according to these. A joint pipe 9a with one or several valves for feeding of different detergents may also be arranged according to other alternative embodiments. Suitably, the pipe 9 runs through a central part, e.g. a hollow central shaft 12, of the disc 4 and is, when used, connected to e.g. a compressed air source (not shown in this figure).

[0040] Figure 4 shows schematically the more detailed

embodiment of a cleaning system 20 comprising a device 1 for cleaning of a particulate filter, according to the above description, and the suction device 21 which is comprised in the device.

[0041] The cleaning system's 20 suction device 21 is connected to an inlet 3a to the silencer 3. The suction device may be of any suitable type, e.g. an existing exhaust suction 24 with a dust or particulate trap 25, such as a cyclone, a fan 23 and, potentially, a filter 22. The dust trap 25 is suitably connected between the inlet 3a and the suction device 21 and functions like a collecting device for the particles which are cleaned from the particulate filter. Where an inlet 3a of a silencer in a cargo vehicle typically has a diameter of around 110 mm, other suction devices may easily be connected to the inlet 3a with standardised pipes and connections. The suction device 21, which is connected to the silencer's inlet 3a, sucks backwards through the particulate filter and transports away loose particles and particles that are released by the pressure means which are fed out through the pressure means nozzles 9. The fan 23 is suitable to regulate the air flow through the particulate filter.

[0042] In figure 4, the silencer 3 is shown only schematically and in an inserted position in the vehicle's chassis, but depending on e.g. the vehicle type and placement of ancillary equipment, the silencer may also be partly pulled out, e.g. in a service position, from the vehicle's chassis. The inlet 3a is shown in this embodiment dismantled from the exhaust pipe. When the silencer is pulled out, the fastening device arranged in slide rails and support rails is unscrewed. Subsequently, the silencer 3 may be pulled out. The silencer is then not entirely outside the vehicle's chassis, since it is not necessary to carry out service measures. Since the silencer's weight is between 100 and 150 kg it is desirable not to have to handle it unnecessarily.

[0043] Through the compact design of the device, the problem with limited access to the particulate filter is solved without having to remove the filter from the silencer. This means that other peripheral equipment, such as other exhaust aftertreatment equipment, e.g. a urea tank for SCR, may be mounted while the particulate filter is cleaned. The device is particularly suitable for a silencer in a cargo vehicle, but also in a bus, where it might be attached on the side of the rear end of the bus, and thus often difficult to access.

[0044] Since the device is so simple to use and has easy access, the particulate filter may be cleaned at a significantly lower cost than what has hitherto been possible. Alternatively, the cleaning may be carried out much more often, which leads to reduced emissions, since the particulate filter is significantly cleaner during a longer operating time than what has hitherto been possible. The ash contribution in the back pressure may thus be reduced already before an alarm is sounded that the filter needs to be cleaned. Even if the filter may only be cleaned up to e.g. a 95% cleaning degree, this means that the back pressure may be kept low during a much longer

period since the filter is cleaned more often than what is currently possible with conventional methods. The fuel consumption for the combustion engine is thus reduced.

Claims

1. Device (1) at cleaning a particulate filter (2) arranged inside a silencer (3) for a combustion engine, where the device (1) comprises a disc unit (4) adapted to be arranged in connection with a mounting opening (5) for a particulate filter (2) inside the silencer (3) to screen off an outlet end (6) of the particulate filter (2), **characterised in that** the disc unit (4) has an opening (7) designed to let in air through only a limited part of the particulate filter (2). 5 10 15
2. Device according to claim 1, **characterised in that** the disc unit (4) at the opening (7) has an edge side (8), the edge side (8) at which at least one pressure means element (9), adapted to lead the pressure means out towards the outlet end (6) of the particulate filter (2), is arranged, where the element (9) is adapted to be connected to a pipe (9a) for pressure means. 20 25
3. Device according to either of claim 1 or 2, **characterised in that** the disc unit (4) is substantially circular and the opening (7) is sector-shaped. 30
4. Device according to any of the previous claims, **characterised in that** the disc unit (4) comprises an adjustable damper (10) adapted to cover the opening (7). 35
5. Device according to any of the previous claims, **characterised in that** the disc unit (4) comprises fastening elements (11) designed to fasten the disc unit (4) rotatably in the mounting opening (5). 40
6. Device according to claim 1 or 2, **characterised in that** the disc unit (4) comprises a central shaft (12) around which a bearing element (13) is arranged, and in turn is arranged at the fastening element (11) in order to arrange the disc (4) rotatably in the mounting opening (5). 45
7. Cleaning system (20) for a particulate filter (2) arranged inside a silencer (3) for a combustion engine, which comprises a device (1) when cleaning of a particulate filter (2), according to any of the previous patent claims, and a suction device (21) connected to an inlet (3a) of the silencer 3 in order to achieve an air flow achieved through underpressure through the particulate filter (2). 50 55
8. Cleaning system according to claim 7, **characterised in that** the suction device (21) comprises a fan

(23) adapted to regulate the air flow through the particulate filter (2).

9. Cleaning system according to claim 7 or 8, **characterised in that** the suction device (21) comprises a collection device (25) for the particles cleaned from the particulate filter (2).

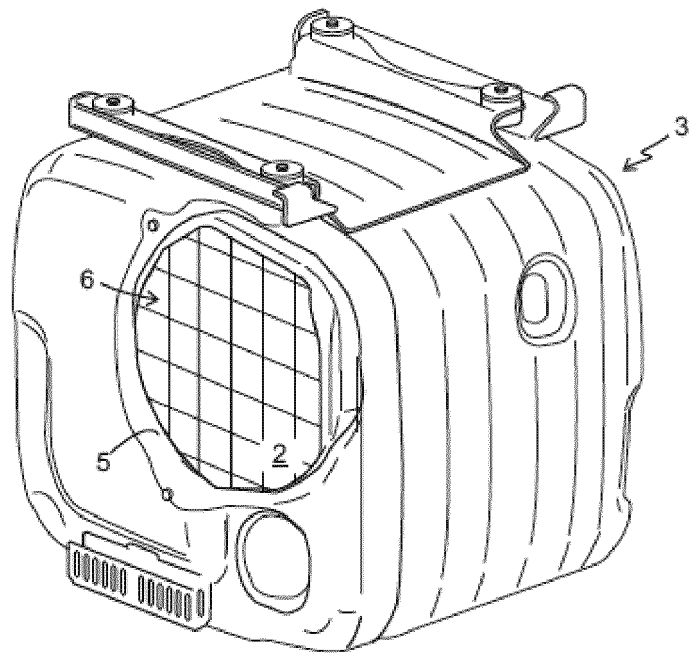


FIG. 1

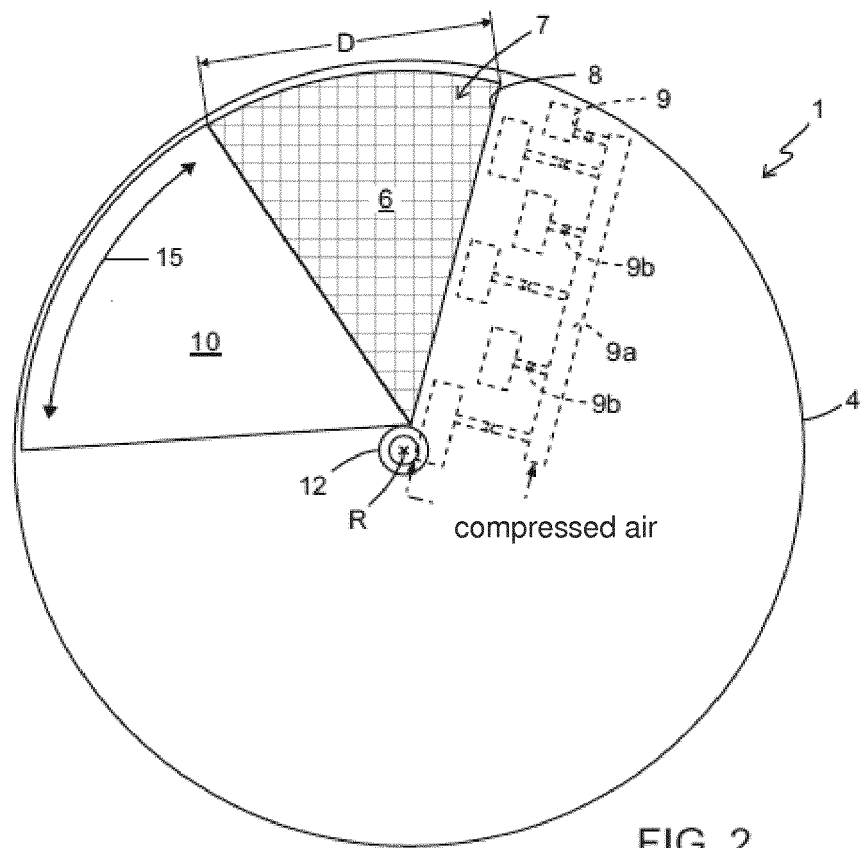


FIG. 2

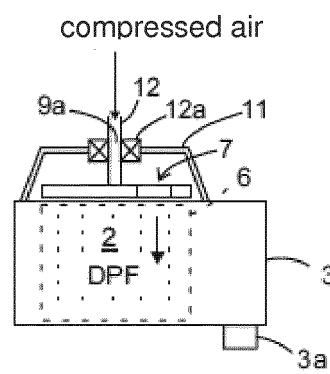


FIG. 3

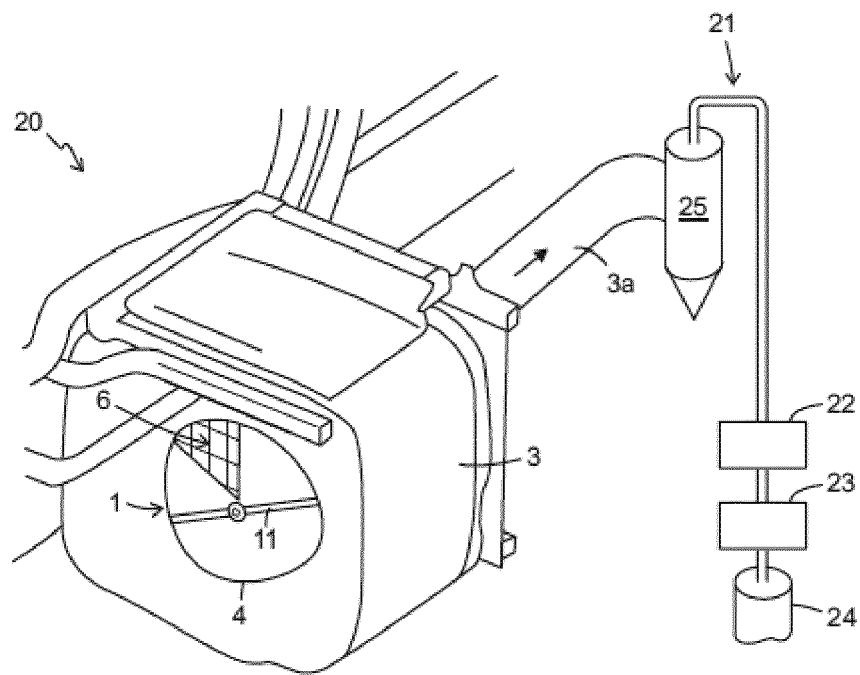


FIG. 4



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Application Number
EP 14 15 3747

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Place of search Munich		Date of completion of the search 11 June 2014	Examiner Álvarez Goiburu, G
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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