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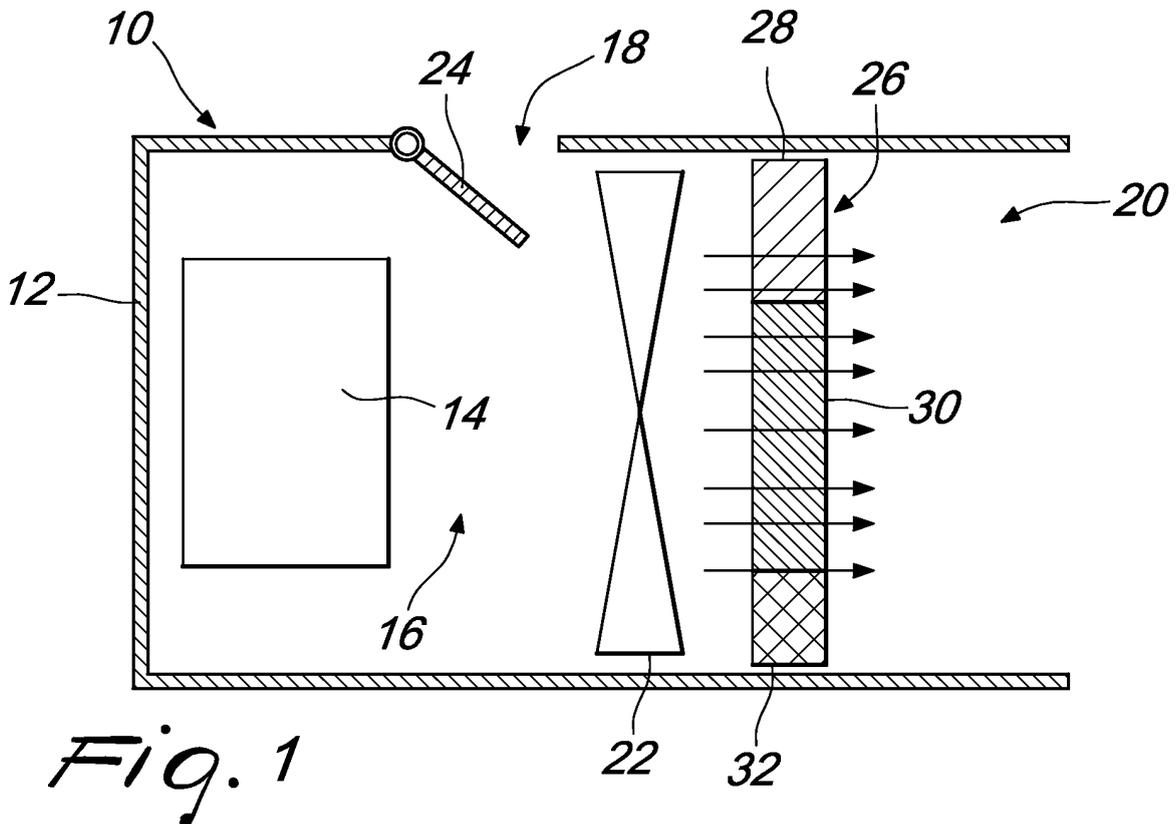
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(54) **Engine ventilation system**

(57) A ventilation system for an engine compartment comprising at least one air passage having at least one inlet and at least one outlet, for air flow over a heat core positioned in the air passage; a fluid circulator to circulate air flow through the air passage; and at least one barrier having an actuator to regulate the air flow through the air passage and to control noise emission from the engine.

A method of regulating air flow and noise emission in an engine compartment comprising circulating air flow through an air passage of the engine compartment; and actuating at least one barrier disposed about the air passage, wherein the actuation of the barrier controls air flow over a heat core in the air passage and controls noise emission from the engine.



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**Description**Technical Field

5 **[0001]** This disclosure generally relates to the field of ventilation systems for engine compartments and, particularly, to ventilation systems for combined cooling and sound reduction for an engine compartment and methods therefor. This disclosure also relates to engineering vehicles comprising said ventilation systems and methods.

Background

10 **[0002]** Generally, engine compartments of machines may generate large amounts of heat during the course of operation of the machines. Heat may be dissipated from the engine block by a liquid coolant system which may include a radiator spaced from the engine block.

15 **[0003]** To increase efficiency of the engine, other devices, for instance a turbo compressor, may be added to the engine. Hence the heat core of an engine compartment may further include powertrain components such as torque converters, hydraulic pumps, and so on.

**[0004]** Heat from the heat core may be dissipated by natural convection. Heat exchanges of the various sub-cores of the heat core may be cooled by air flowing through the engine compartment. The air flow may be produced by motion of the vehicle or by an axial fan.

20 **[0005]** Air may be blown over the sub-cores uniformly and may thereby cool the sub-cores to the same extent. However, depending on the operating conditions, all sub-cores may not require the same level of cooling.

**[0006]** Besides heat, noise or sound may be also generated by the engine and the fan itself. Local authorities may set noise regulations, which may include limits on maximum noise emissions for motor vehicles or industrial vehicles. Hence, the noise emission from the engine compartment may need to be below the maximum noise limits in order to operate legally.

25 **[0007]** Noise or sound may be reduced by lowering the fan speed or lowering engine output. However, such actions may decrease the overall efficiency of the machine.

**[0008]** Vehicles may be modified in an attempt to reduce the noise produced during their operation. Sound dampers may be used to reduce or avoid the transmission of noise or sound. The engine compartment may be lined with sound dampers, which may either absorb or reflect the noise. A known sound damper for reducing the intensity of sound waves may be for example a silencer in a motor vehicle which reduces the exhaust gas or combustion noise of the engine within the exhaust system.

30 **[0009]** Due to the cooling requirement of the heat core, it may be necessary to provide openings which may allow air to enter and exit the engine compartment for heat dissipation from the heat core by convection. Hence, noise may still exit from the engine compartments through the air inlet and outlet.

**[0010]** To further reduce sound emission, the number or size of openings in the compartment may be decreased. However, the air flow through the engine compartment may decrease to a level where the cooling effect may be also reduced, resulting in an increase in temperature within the compartment. This may adversely affect temperature sensitive components, such as alternator, fuel injection system and various electronic components such as microprocessors.

40 **[0011]** A solution may be to increase the air flow by providing a fan which has a high rotational speed. However, the increase in fan speed may result in more noise being produced from the engine compartment.

**[0012]** Hence there is a need for a system for reducing sound emissions from the engine compartment while cooling sub-cores of an engine varyingly.

45 **[0013]** The present disclosure is directed, at least in part, to improving or overcoming one or more aspects of the prior art system.

Brief Summary of the Invention

50 **[0014]** In a first aspect, the present disclosure describes a ventilation system for an engine compartment comprising at least one air passage having at least one inlet and at least one outlet for air flow over a heat core positioned in the air passage; a fluid circulator to circulate air flow through the air passage; and at least one barrier having an actuator to adjust position of the barrier so as regulate the air flow through the air passage and to control noise emission from the engine.

55 **[0015]** In a second aspect, the present disclosure describes a method of regulating air flow and noise emission in an engine compartment comprising circulating air flow through an air passage of the engine compartment and actuating at least one barrier disposed about the air passage, wherein the actuation of the barrier controls air flow over a heat core in the air passage and controls noise emission from the engine.

**[0016]** Other features and advantages of the present disclosure will be apparent from the following description of

various embodiments, when read together with the accompanying drawings.

#### Brief Description of the Drawings

5 **[0017]** The foregoing and other features and advantages of the present disclosure will be more fully understood from the following description of various embodiments, when read together with the accompanying drawings, in which:

Fig. 1 is a schematic representation of a vertical cross section of a first embodiment of an engine compartment comprising a ventilation system according to the present disclosure;

10 Fig. 2 is a schematic representation of a vertical cross section of a second embodiment of an engine compartment comprising a ventilation system according to the present disclosure;

Fig. 3 is a schematic representation of a vertical cross section of a third embodiment of an engine compartment comprising a ventilation system according to the present disclosure;

15 Fig. 4 is a schematic representation of a vertical cross section of a fourth embodiment of an engine compartment comprising a ventilation system according to the present disclosure;

Fig. 5 is a schematic representation of a vertical cross section of a fifth embodiment of an engine compartment comprising a ventilation system according to the present disclosure;

Fig. 6 is a schematic representation of a vertical cross section of a sixth embodiment of an engine compartment comprising a ventilation system according to the present disclosure;

20 Fig. 7 is a block diagram exemplifying a control system for the ventilation system of Fig. 4; and

Fig. 8 is a flowchart exemplifying a method of regulating air flow and sound emission in an engine compartment according to the present disclosure.

#### Detailed Description

25 **[0018]** This disclosure generally relates to systems and methods for regulating air flow and sound emission in an engine compartment of a machine.

30 **[0019]** Fig. 1 illustrates an engine compartment **10** comprising a first embodiment of a ventilation system according to the present disclosure. The ventilation system of an engine compartment may comprise an air passage **16**, a fluid circulator **22** and a barrier **24** as will be described hereinafter.

**[0020]** The engine compartment **10** may be bound by walls **12**. The walls **12** of the engine compartment **10** may be of any suitable material and shape as required to fit into a machine for instance an engineering vehicle or an industrial machine. In an embodiment, walls **12** may be lined with a sound absorbent material. An engine **14** may be positioned in any suitable position within engine compartment **10**.

35 **[0021]** Walls **12** may have at least one opening, formed on at least one wall **12**. In an embodiment, two or more openings may be provided. A first opening may be an inlet **18** and a second opening may be an outlet **20**. Inlet **18** and outlet **20** may allow the interior of the engine compartment **10** to communicate with air space external to the engine compartment **10** by allowing passage of air into and out of the engine compartment **10**.

40 **[0022]** The skilled person would realise that the air inlet **18** and outlet **20** may be formed on any wall **12** or may be in any suitable position on the walls **12** of engine compartment **10**. For instance, the air inlet **18** and outlet **20** may be formed on the same wall **12**. The air inlet **18** and outlet **20** may be formed on distinct walls **12**. The outlet **20** may be formed in place of a wall **12**. In this instance, the periphery of outlet **20** may be formed by ends of distinct walls **12**.

45 **[0023]** The air passage **16** may be formed within the interior of the engine compartment **10**. Air passage **16** may be enclosed by walls distinct from the walls **12**. The air passage **16** may be encompassed by walls **12** and ambient air external to the engine compartment **10** may enter into air passage **16** through inlet **18** and may then exit the air passage **16** through outlet **20**.

**[0024]** The engine compartment may further comprise a heat core **26**. The heat core **26** may generally comprise cooling mechanisms, for instance a heat exchanger, which in turn may comprise a fluid which circulates through engine components and absorbs heat therefrom. The heat exchanger may enable transfer of heat from the heated fluid to the surrounding air. The cooling mechanisms may also include a charge air cooler for a turbo compressor or similar devices.

**[0025]** The heat core **26** may generally comprise sub-cores. In one embodiment, the sub-core may include a heat exchanger for hydraulic oil **28**, an engine radiator **30** and a charge air cooler for a turbo compressor **32**.

50 **[0026]** The engine compartment **10** may further comprise the fluid circulator **22**. Ambient air may be directed into the air passage **16** through inlet **18** by fluid circulator **22**. Fluid circulator **22** may also circulate the air in the air passage **16** before the air exits through the outlet **20**. It may be appreciated by the skilled person that the fluid circulator **22** may be suitably provided as required. For instance, the fluid circulator **22** may be an air intake formed over the inlet **18** wherein the movement of the machine, such as a vehicle, forces air through inlet **18** thereby driving circulation of air through the air passage **16**.

[0027] The fluid circulator **22** may be a fan wherein rotation of the fan draws air in through the inlet **18** and forces air out of through the outlet **20** thereby driving circulation of the air through the air passage **16**. The fan may be directly connected to the engine such that the fan may be driven at the engine speed or a mechanical clutch may be provided between the fan and the engine to vary the speed of the fan. The fluid circulator **22** may be a hydraulic demand fan wherein the fan is connected to a hydraulic motor **38**.

[0028] The heat core **26** may be located in the air passage **16**. The airflow through the air passage **16** may be directed to flow over the heat core **26** such that heat may be transferred from the sub-cores **28, 30, 32** to the flowing air. In the embodiment wherein the fluid circulator **22** is a fan, the fan **22** may be positioned either between the inlet **18** and the heat core **26** or the heat core **26** and the outlet **20**. In a further embodiment, the inlet **18** may be positioned between the fluid circulator **22** and the heat core **26**.

[0029] The barrier **24** may be positioned in the air passage **16** to regulate the flow of air through the air passage **16** and to regulate the level of sound emitted from the engine compartment **10** during operation of a machine. The position of the barrier relative to the inlet **18** or outlet **20** may determine the rate of air flow and the level of sound emission. The barrier **24** may be positioned in proximity to the inlet **18** or the outlet **20**. In an embodiment, the barrier may be positioned at the inlet **18** or the outlet **20**. In another embodiment, barriers **24** may be lined with sound absorbent material.

[0030] The barrier **24** may be connected, by any suitable means, to the inlet **18** or the outlet **20** such that the rotation of the barrier about the point of connection to the inlet **18** or the outlet **20** may determine the rate of air flow and the level of sound emission. The barrier may be pivotably connected to the inlet **18** or the outlet **20** by a pivoting connection.

[0031] Barriers **24** may rotate about the connection from a closed position to a fully open position. In the closed position, barrier **24** may be in alignment with a wall **12** to cover or fit into the inlet **18** or outlet **20**. The barrier **24** may be, in the closed position, at substantially 0° relative to the inlet **18** or outlet **20**.

[0032] In the fully open position, barrier **24** may be substantially perpendicular to the inlet **18** or outlet **20** and may be located within air passage **16**. The barrier **24** may be, in the fully open position, at substantially 90° relative to the inlet **18** or outlet **20**.

[0033] The barrier **24** may also be rotated to a specific partially open position which may be one of a range of positions between the closed and fully open position. The barrier **24** may have a specific partially open position which may be at an angle comprised between 0° and 90° relative to the inlet **18** or outlet **20**.

[0034] The rate of air circulating through air passage **16** may be related to the rate of air flowing through inlet **18** and outlet **20**. Rate of air flowing over sub-cores **28, 32, 30** may be regulated by varying the angle of barrier **24** in response to the cooling requirements for said sub-cores. Fan speed may generally determine rate of air flow. However, external conditions may also effect the rate of air flow.

[0035] Generally, with fan speed and external conditions being constant and the barrier **24** being located in proximity to the inlet **18**, there may be substantially no air flow or a minimal rate of air flow through inlet **18** with the barrier **24** at substantially 0° and the maximum rate of air flow through inlet **18** with the barrier **24** at substantially 90°.

[0036] Generally, with fan speed and external conditions being constant and the barrier **24** being located in proximity to the outlet **20**, there may be substantially no air flow or a minimal rate of air flow through outlet **20** with the barrier at 0° and the maximum rate of air flow through outlet **20** with the barrier **24** at 90°.

[0037] With the barrier **24** in a partially open position, the rate of air entering and exiting through inlet **18** and outlet **20** respectively may be related to the specific partially open position of the barrier **24** which may be at an angle between 0° and 90° relative to the inlet **18** or outlet **20**.

[0038] Cooling of heat core **26** may be varied by varying the rate of air entering through inlet **18** or exiting outlet **20** and consequently circulating through air passage **16**. Differential cooling of sub-cores **28, 30, 32** may be effected by controlling the rate of air flow over each sub-core relative to the other sub-cores. A sub-core may be cooled to a greater extent by increasing the air flow over said sub-core relative to the other sub-cores and a sub-core may be cooled to a lesser extent by decreasing the rate of air flow over said sub-core relative to the other sub-cores. The rate of air flowing over a sub-core may be regulated by adjusting the position of the barrier **24**. The rate of air flowing over a sub-core may be regulated by rotating the barrier relative to the inlet **18** or outlet **20**.

[0039] Sound produced by the engine components may be substantially emitted through inlet **18** or the outlet **20**. The sound may be reflected by the barrier **24** and thereby may substantially prevent the sound from being emitted outside of the engine compartment **10**. The level of sound emitted is related to the position of the barrier **24**.

[0040] With the barrier **24** barrier at substantially 0° relative to inlet **18** or outlet **20**, substantially no sound or a lowest level of sound is emitted.

[0041] With the barrier **24** at substantially 90° relative to inlet **18** or outlet **20**, a highest level of sound may be emitted.

[0042] Between the two positions, a range of sound levels may be emitted depending on the angle of barrier **24** which may be an angle between 0° and 90° relative to the inlet **18** or outlet **20**. Hence, the specific partially open position determines the level of sound emitted from the engine compartment **10**.

[0043] The engine compartment may further comprise an actuator **36** configured to actuate the barrier in the air passage in order to regulate air flow and sound emission. The actuator **36** may be any suitable actuator capable of

rotating the barrier **24** relative to the inlet **18** or the outlet **20**. The actuator (36) may be hydraulically or electronically controlled.

**[0044]** The barrier **24** may have any suitable shape to direct a flow of air through the air passage **16**. In an embodiment, the barrier **24** may be a panel. In the embodiment wherein the barrier is positioned at the inlet **18** or the outlet **20**, the barrier **24** may be of a suitable shape to cover or fit into inlet **18** or the outlet **20**. Edges of barrier **24** may be bevelled in order to reduce turbulence in the air. Barrier **24** may be constructed from any suitable material.

**[0045]** The ventilation system of the present disclosure may co-ordinate the selection of a suitable fan speed **22** and a suitable angle of the barrier **24** in order to simultaneously cool the heat core **26** and minimise sound emission.

**[0046]** With reference to Fig. 1, in a first embodiment the barrier **24** may be positioned at inlet **18** and the heat core **26** may be positioned between the fluid circulator **22** and outlet **20**. Fluid circulator **22** may blow air over heat core **26** thereby drawing ambient air through inlet **18**. Air flowing over heat core **26** may exit through outlet **20**.

**[0047]** At 0° of barrier **24** there may be substantially no air flow or a minimal rate of air flowing through air passage **16**. As the barrier **24** may be rotated away from inlet **18**, the angle may increase and there may be an air flow. Rate of air flow over sub-core **28** may be initially greater than the rate of air flow over sub-cores **30** and **32**. Further rotation of barrier **24** may further increase the rate of air flow which may be also directed to sub-cores **30** and **32**. Initially, sub-core **28** is cooled to greater extent relative to sub-cores **32** and **30**. As barrier **24** rotates and the angle increases, sub-cores **32** and **30** are cooled consecutively to substantially the same extent as sub-core **28**.

**[0048]** With reference to Fig. 2, in a second embodiment a first barrier **24** may be positioned at a first inlet **18** and a second barrier **24** may be positioned at a second inlet **18**. The heat core **26** may be positioned between the fluid circulator **22** and outlet **20**. Ambient air flows through first and second inlets **18** over heat core **26** and exits through outlet **20**.

**[0049]** At 0° of barriers **24** there may be substantially no air flow or a minimal rate of air flow through air passage **16**. As the barriers **24** are rotated away from the first and second inlets **18**, there may be an air flow. The air flow may be initially directed to sub-cores **28** and **32**. Further rotation of the barriers **24** may further increase the rate of air flow which may also be directed to sub-core **30**. Initially sub-cores **28** and **32** are cooled to greater extent relative to sub-core **30**. As the barriers **24** rotate and the angles increase, sub-core **30** is cooled consecutively to substantially the same extent as sub-cores **28** and **32**.

**[0050]** The first and second barriers **24** may be independently rotated in response to the cooling requirements of the sub-cores and to regulate sound emission. For instance, the first barrier **24** may be maintained at 0° while the angle of second barrier **24** may be varied. Alternatively, the angles of the first and second barriers **24** may be independently increased or decreased.

**[0051]** With reference to Fig. 3, in a third embodiment a first barrier **34** may be positioned at an end of outlet **20** and a second barrier **34** may be positioned at the opposite end of outlet **20**. The heat core **26** may be positioned between the fluid circulator **22** and outlet **20**. Ambient air may flow through inlet **18** over heat core **26** and exit through outlet **20**. With first and second barriers **34** at about 0°, outlet **20** may be substantially covered or sealed.

**[0052]** At 0° of the barriers **34**, there may be substantially no air flow or a minimal rate of air flow through air passage **16**. As the first and second barriers **34** are rotated away from the outlet **20**, there may be an air flow through inlet **18** and air passage **16**. Rate of air flow over sub-core **30** may be initially greater than the rate of air flow over sub-cores **28** and **32** as barriers **34** resist air exiting through outlet **20**. Further rotation of the barriers **34** increase the angles and may further increase the rate of air flow over sub-cores **28** and **32**. Initially sub-core **30** is cooled to a greater extent relative to sub-cores **28** and **32**. As the barriers **24** rotate and the angles increase, sub-cores **28** and **32** are cooled consecutively to the same extent as sub-core **30**.

**[0053]** The first and second barriers **34** may be independently rotated in response to the cooling requirements of the sub-cores and to regulate sound emission. For instance, the first barrier **34** may be maintained at 0° while the angle of second barrier **34** may be varied. Alternatively, the angles of the first and second barriers **34** may be independently increased or decreased.

**[0054]** With reference to Fig. 4, in a fourth embodiment a first barrier **24** may be positioned at a first inlet **18** and a second barrier **24** may be positioned at a second inlet **18**. Additionally, a first barrier **34** may be positioned at an end of outlet **20** and a second barrier **34** may be positioned at the opposite end of outlet **20**. The heat core **26** may be positioned between the fluid circulator **22** and outlet **20**. Ambient air may flow through inlet **18** over heat core **26** and exit through outlet **20**. With first and second barriers **34** at 0° outlet **20** may be substantially covered or sealed.

**[0055]** The operating mechanism of the fourth embodiment is a combination of the operation mechanisms of second and third embodiments described above. Each of the barriers **24** and **34** may be independently rotated in response to the cooling requirements of the sub-cores and to regulate sound emission.

**[0056]** With reference to Fig. 5, in a fifth embodiment a barrier **44** may be positioned at an end of outlet **20**. The barrier **44** may further comprise a series of louvers **45**. In an embodiment, the louvers **45** may be connected to the barrier **44** by pivoting connections. The heat core **26** may be positioned between the fluid circulator **22** and outlet **20**. Ambient air flows through inlet **18** over heat core **26** and exits through outlet **20**.

**[0057]** At 0° the louvers **45** may be aligned to the barrier **44** and there may be substantially no air flow or a minimal

rate of air flow through air passage 16. As louvers 45 are rotated away from the barrier 44, there may be an air flow through inlet 18 and air passage 16. Rate of air flow over the sub-cores 28, 30, 32 may be uniform. Further rotation of the louvers 45 may increase the angles and may further increase the rate of air flow over sub-cores 28, 30, 32 thereby further cooling the sub-cores 28, 30, 32.

5 [0058] With reference to Fig. 6, in a sixth embodiment a barrier 24 may be positioned at inlet 18 and a barrier 44 may be positioned at an end of outlet 20. The barrier 44 may further comprise a series of louvers 45. The heat core 26 may be positioned between the fluid circulator 22 and outlet 20. Ambient air flows through inlet 18 over heat core 26 and exits through outlet 20.

10 [0059] The operating mechanism of the sixth embodiment is a combination of the operation mechanisms of the first and the fifth embodiments described above. Barriers 24 and louvers 45 may be independently rotated in response to the cooling requirements of the sub-cores and to regulate sound emission.

15 [0060] Sound emission through inlet 18 and outlet 20 may increase or decrease as the angles of barrier 24, 34 and louvers 45 increase or decrease respectively relative to said openings. Levels of sound emission may be regulated by increasing or decreasing the angles of the barrier 24, 34 and louvers 45 to the extent that cooling requirements of the sub-cores are attained. The conditions at which the ventilation system of the present disclosure may operate may be exemplified in the following Table 1 with reference to the second embodiment according to the present disclosure.

Table 1

Sub-core 28 (Temperature)	Sub-core 30 (Temperature)	Sub-core 32 (Temperature)	1 <sup>st</sup> Inlet Barrier position	2 <sup>nd</sup> Inlet Barrier position	Fan Speed
Low	Low	Low	Closed	Closed	Off
Low	Low	High	Closed	Partially open	Slow/ Medium
Low	High	Low	Partially open	Partially open	Slow/ Medium
Low	High	High	Closed	Fully open	High
			Partially open	Partially open	Medium
High	Low	Low	Partially open	Closed	Slow/ Medium
High	Low	High	Fully open	Fully open	Medium/ High
High	High	Low	Fully open	Closed	High
			Partially open	Partially open	Medium
High	High	High	Fully open	Fully open	High

[0061] Conditions set forth in Table 1 are for illustrative purposes only. The skilled in the art easily appreciates that ventilation system of the present disclosure should not be restricted to the above conditions.

40 [0062] In one instance, as the temperature of one of the sub-cores increases, for example, sub-core 30, the fan may be activated to circulate air in the air passage 16 in order to dissipate heat from such sub-core. Accordingly, the first inlet barrier 24 may be partially opened to the extent that sufficient ambient air, for cooling sub-core 30, flows into air passage 16. As the temperature of sub-core 30 increases, the second inlet barrier 24 may be partially opened and/or first inlet barrier may be fully opened to enable more ambient air to enter. Alternatively, the fan speed may be increased. Sound emission for each foregoing option may be factored in order to select an option or a combination of options suitable for cooling sub-core 30 and minimizing sound emissions from the engine compartment,

45 [0063] As temperature of sub-core 30 decreases, the fan speed may be reduced or the angles of barriers 24 relative to the inlet 18 may be decreased. Decreasing the angle of the barrier may reduce sound emissions from the engine compartment 10. The option or a combination of options in respect to adjusting the barrier angles and varying the fan speed, suitable for cooling sub-core 30 and minimizing sound emissions from the engine compartment, may be selected.

50 [0064] Fig. 7 illustrates the fourth embodiment of the ventilation system of the present disclosure connected to a control system therefor. A control system 35 may control the ventilation system of the present disclosure. The control system 35 may comprise the actuator 36, the hydraulic motor 38, a fan speed sensor 40, a bypass valve 42 and a control unit 46. The hydraulic motor 38 may control the fan speed which may be monitored by the control unit 46 via the fan speed sensor 40. The actuator 36 as described above may control rotation of barriers 24, 34 and, accordingly, the inclination angle of barriers 24, 34. The control unit 46 may control the actuator 36 and the hydraulic motor 38 simultaneously via the bypass valve 42. The control unit 46 may control the barrier angle and the fan speed through a cooling programme.

55 [0065] The general operation of the ventilation system will now be described with reference to the flow chart of Fig. 8.

[0066] At step 61, the temperature of the heat core 26 is checked.

[0067] At step 62, the control unit 46 determines if the temperature of the heat core 26 is equal to or greater than a critical temperature (CrT).

5 [0068] If the temperature of the heat core is less than the CrT, the control unit 46 may, at step 63, deactivate the fan 22 or maintain the already deactivated fan 22 in that state and may, at step 64, close the barrier 34, retain the closed barrier 34 in that state or partially open the barrier 34.

[0069] If the temperature of the heat core is equal to or greater than the CrT, the control unit 46 may, in step 65, activate the fan.

10 [0070] At step 66, the control unit 46 may set the fan 22 speed to a low level or a high level and simultaneously, at step 67, the control unit 46 may partially open barrier 34 or fully open barrier 34. The control unit 46 may co-ordinate the selection of a suitable fan speed 22 and of a suitable angle of the barrier 24 in order to simultaneously cool the heat core 26 and minimise sound emission.

15 [0071] Particularly, if the heat core 26 comprises a plurality of sub-cores 28, 30, 32, each sub-core may have a different critical temperature CrT(i). When a sub-core reaches its critical temperature, the control unit 46 may select, based on information relative to the position of the sub-cores, position of the barriers and critical temperatures of each sub-core, whether it is necessary to increase the fan speed to cool down the sub-core that has exceeded its critical temperature. The control unit 46 may then adjust positions of the sound barriers to optimise noise emission, in case the other sub-cores are still running below their critical temperature and would therefore not require additional cooling.

20 [0072] In one embodiment, the sub-core 30 that is prone to reach more frequently its critical temperature is located in a central position with regard to other sub-cores.

[0073] The skilled person would also realise that the steps of the above flow chart may be modified or changed to obtain the desired outcome and that the combinations of the above forgoing embodiments may be modified to obtain the ventilation system of the present disclosure.

25 Industrial Applicability

[0074] This disclosure describes a ventilation system for an engine compartment wherein the ventilation systems may regulate the cooling requirement of the engine and the sound emitted from the engine compartment.

30 [0075] In the operation of an engine 14, high levels of heat and noise are typically generated within the engine compartment 10. However, present mechanisms may not adequately allow for engine cooling while maintaining an adequate level of noise reduction. A sufficient cooling requirement with minimal noise emission may be achieved by using the ventilation system of the present disclosure.

[0076] The industrial applicability of the ventilating system and method for regulating air flow and sound emission as described herein will have been readily appreciated from the foregoing discussion.

35 [0077] Accordingly, this disclosure includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the disclosure unless otherwise indicated herein.

40 [0078] Where technical features mentioned in any claim are followed by reference signs, the reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, neither the reference signs nor their absence have any limiting effect on the technical features as described above or on the scope of any claim elements.

45 [0079] One skilled in the art will realise the disclosure may be embodied in other specific forms without departing from the disclosure or essential characteristics thereof. The foregoing embodiments are therefore to be considered in all respects illustrative rather than limiting of the disclosure described herein. Scope of the invention is thus indicated by the appended claims, rather than the foregoing description, and all changes that come within the meaning and range of equivalence of the claims are therefore intended to be embraced therein.

50 **Claims**

1. A ventilation system (16, 22, 24) for an engine compartment (10) comprising:

at least one air passage (16) having at least one inlet (18) and at least one outlet (20), for air flow over a heat core (26) positioned in the air passage;

55 fluid circulator (22) to circulate air flow through the air passage; and

at least one adjustable barrier (24) having an actuator (36) to adjust position of the barrier so as to regulate the air flow through the air passage (16) and to control noise emission from the engine (14).

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2. The ventilation system according to claim 1 wherein the barrier (24) is connected to a wall (12) of the engine compartment (10) by a pivoting connection.
- 5 3. The ventilation system according to claim 1 or 2 wherein the heat core (26) comprises sub-cores (28, 30, 32), and the actuator (36) rotates the adjustable barrier (24) to differentially cool the sub-cores (28, 30, 32).
4. The ventilation system according to claims 1, 2 or 3 wherein the adjustable barrier (24) is positioned in the air passage (16) in proximity to the inlet (18) or the outlet (20).
- 10 5. The ventilation system according to any of one of the preceding claims further comprising a control unit (46) to control the actuator (36), wherein the actuator (36) is triggered by the control unit (46) in response to the temperature of the heat core.
- 15 6. The ventilation system according claim 5 wherein the fluid circulator (22) comprises a hydraulic demand fan controlled by the control unit (46).
7. The ventilation system according to claim 6 wherein the control unit (46) simultaneously modulates the speed of the fan and the angle of the adjustable barrier (24) to simultaneously regulate air flow through air passage (16) and to control noise emission.
- 20 8. The ventilation system according to claim 7 wherein a cooling programme of the control unit (46) controls the simultaneous modulation of the fan speed and adjustable barrier (24) angle.
- 25 9. The ventilation system according to any of the preceding claims wherein the air passage (16) further comprises a first inlet (18) and a second inlet (18) and wherein a first adjustable barrier (24) is positioned in proximity to the first inlet a second adjustable barrier (24) is positioned in proximity to the second inlet.
- 30 10. The ventilation system according to claim 9 wherein a third adjustable barrier (34) is positioned in proximity to the outlet (20).
- 35 11. The ventilation system according to claims 9 or 10 wherein the inlet (18) and the outlet (20) of the air passage (16) are located on the engine compartment (10) and the adjustable barriers (24, 34) are connected to a wall (12) of the engine compartment (10).
- 40 12. The ventilation system according to any of the preceding claims wherein the actuator (36) is hydraulically or electronically controlled.
13. The ventilation system according to any of one of the preceding claims wherein the adjustable barrier (44) comprises a series of louvers (45).
- 45 14. An engineering vehicle comprising a ventilation system according to any one of claims 1 - 13.
15. A method of regulating air flow and sound emission in an engine compartment (10) comprising:  
45 circulating air flow through an air passage (16) of the engine compartment (10); and  
actuating at least one barrier (24) disposed about the air passage (16), wherein the actuation of the barrier (24) controls air flow over a heat core (26) in the air passage (16) and controls noise emission from the engine (14).
- 50 16. The method according to claim 15 wherein the step of actuating the barrier comprises rotating the barrier (24).
17. The method according to claims 15 or 16 wherein the step of actuating the barrier (24) comprises modulating the angle of the barrier (24) relative to an inlet or an outlet of the air passage (16) in response to the temperature of the heat core.
- 55 18. The method according to claim 17 further comprising simultaneously modulating the rate of air flow over the heat core (26) to simultaneously regulate air flow through air passage (16) and to control noise emission.
19. The method according to claim 18 wherein the simultaneous modulation of the fan speed and adjustable barrier

(24) angle is controlled by a cooling programme.

20. The method claim according to claim 16 wherein the angle of the barrier is increased.

5 21. The method claim according to claim 16 wherein the angle of the barrier is decreased.

22. A method of regulating air flow and sound emission in an engine compartment (10) comprising:

10 varying air flow gradually through an air passage (16) of the engine compartment (10) in response to gradual change in a heat core (26) temperature; and rotating at least one barrier (24) disposed about the air passage (16), wherein varying the angle of rotation of the barrier gradually (24) varies air flow gradually over the heat core (26) in the air passage (16) and controls noise emission from the engine (14).

15 23. A method of regulating air flow and sound emission in an engine compartment (10) comprising:

20 circulating air flow through an air passage (16) of the engine compartment (10); and actuating at least one barrier (24) disposed about the air passage (16), wherein gradual actuation of the barrier (24) directs air flow sub-cores (28, 30, 32) in the air passage (16) sequentially and controls noise emission from the engine (14).

24. A method of regulating air flow and sound emission in an engine compartment (10) comprising:

25 varying rate of air flow gradually through an air passage (16) of the engine compartment (10) in response to a gradual change in a heat core (26), wherein varying speed of a fluid circulator (22) varies the rate of air flow; and actuating at least one barrier (24) disposed about the air passage (16), wherein the actuation of the barrier (24) controls air flow over a heat core (26) in the air passage (16) and controls noise emission from the engine (14).

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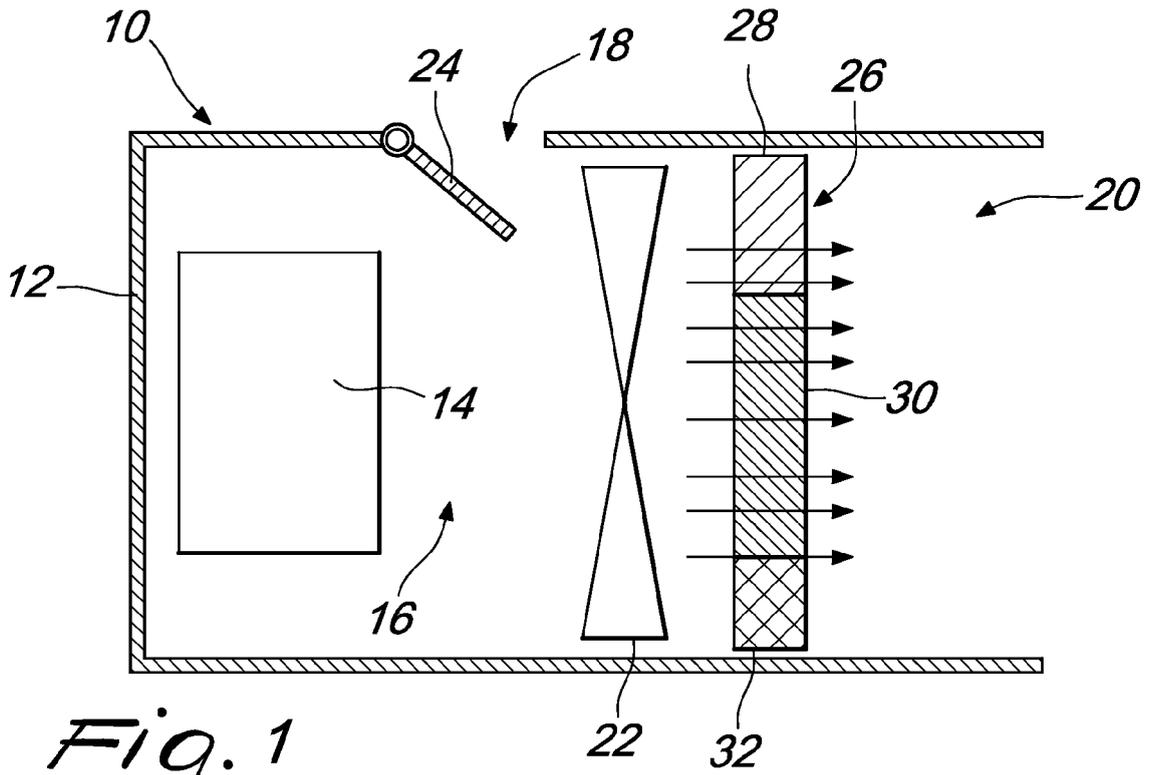


Fig. 1

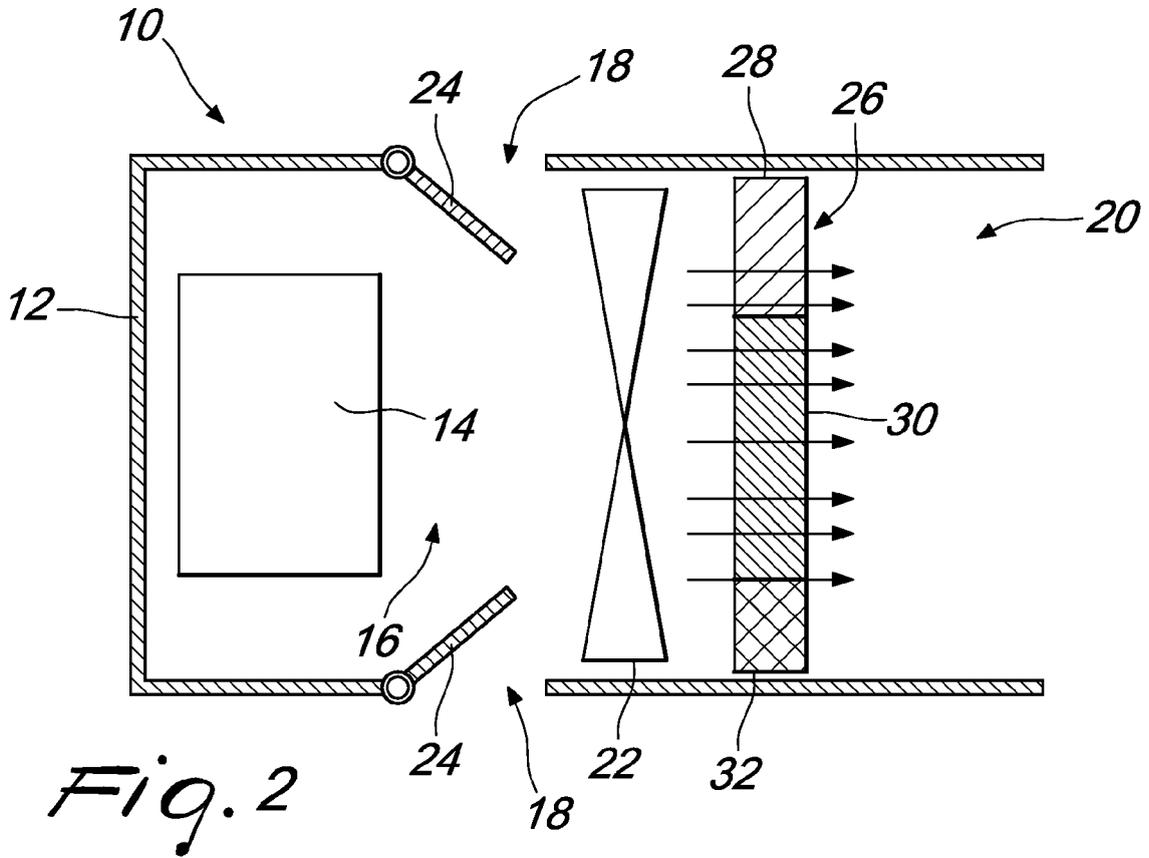
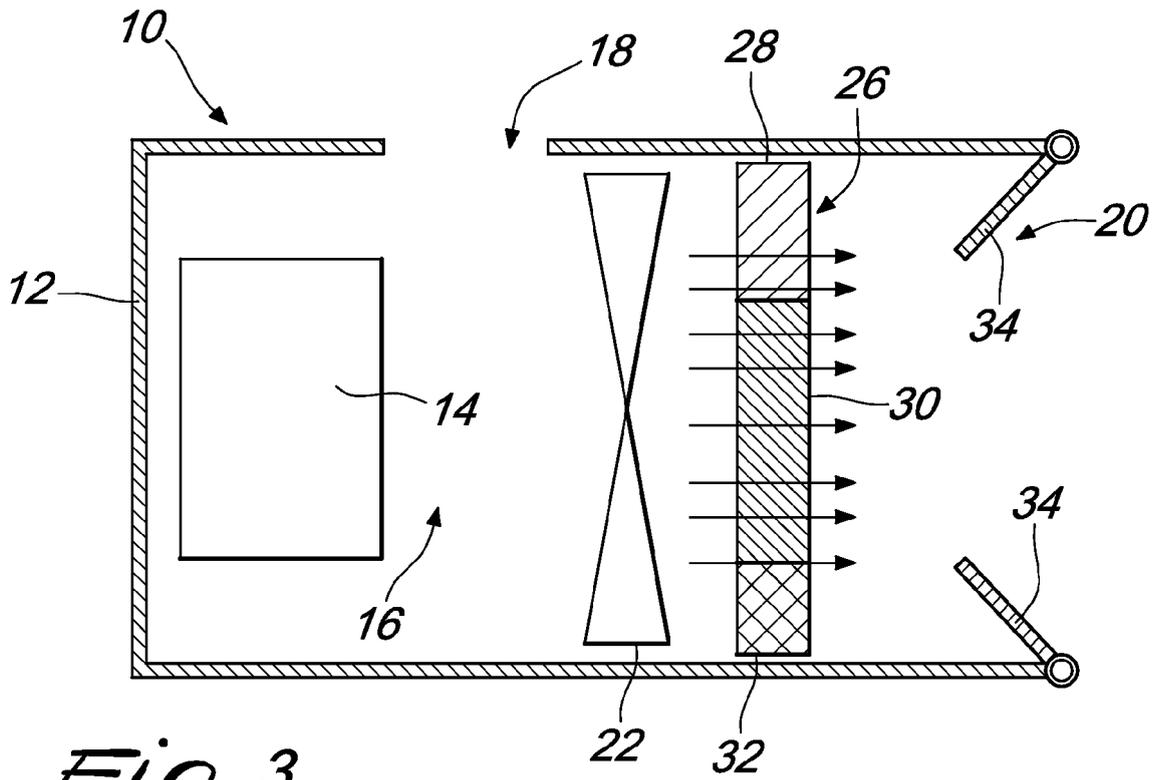
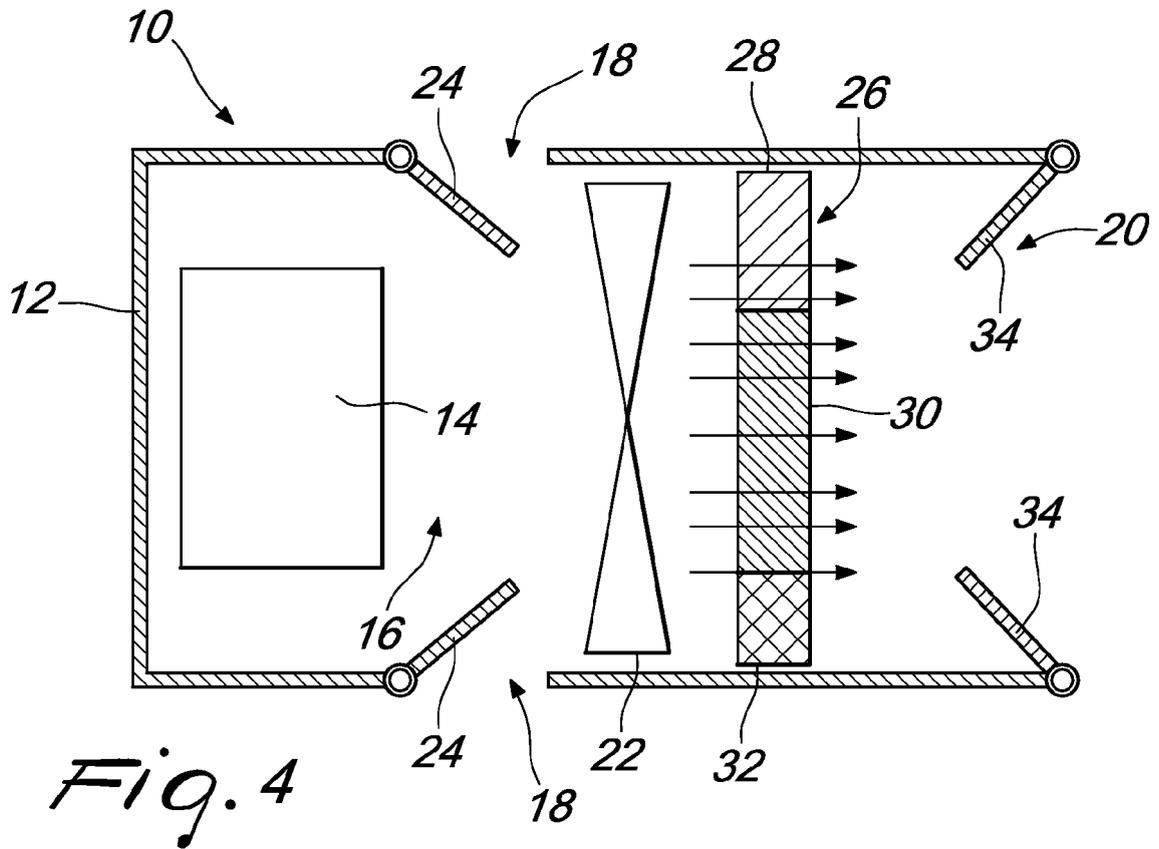


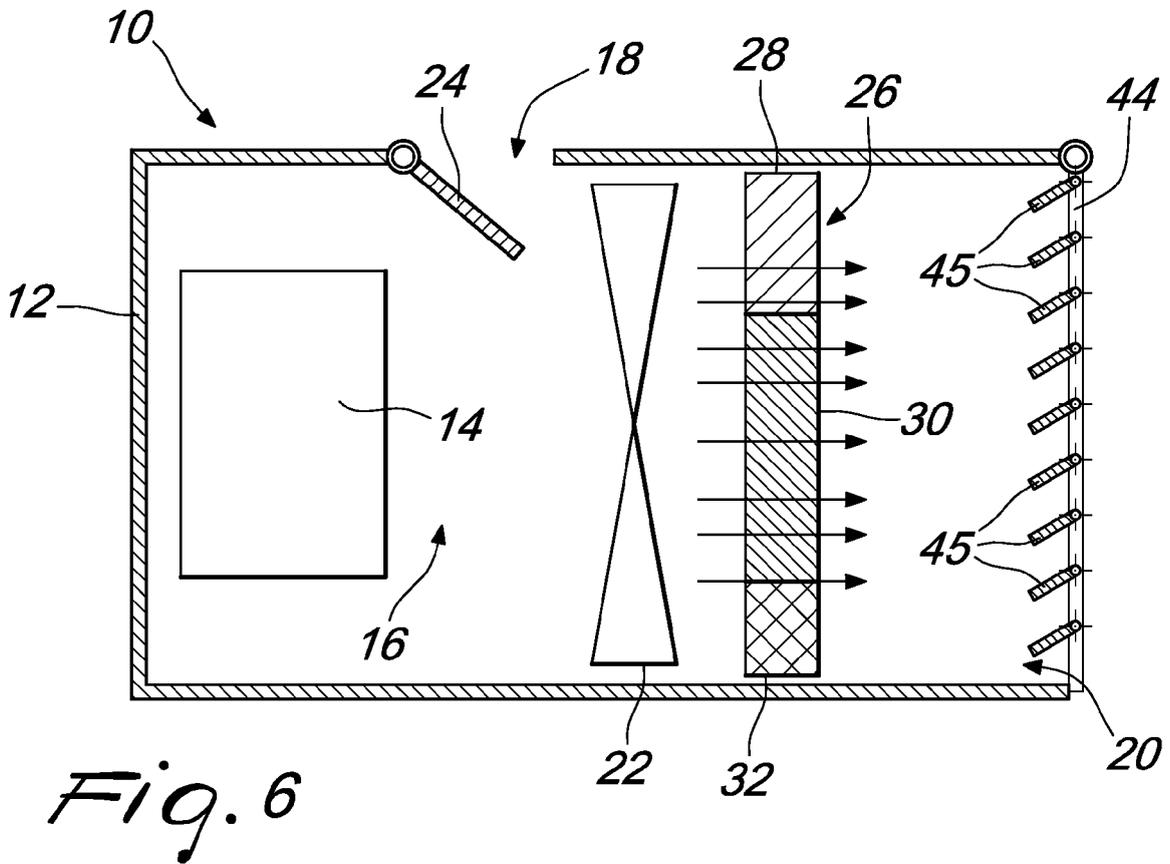
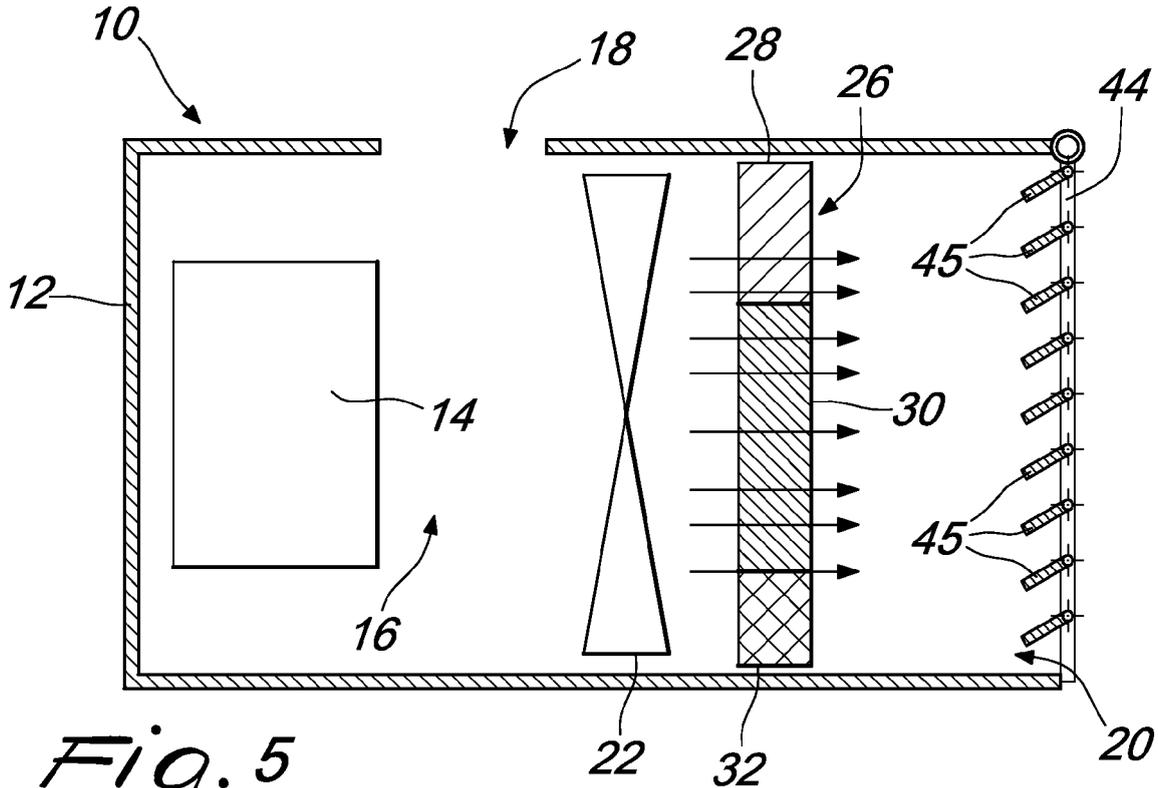
Fig. 2



*Fig. 3*



*Fig. 4*



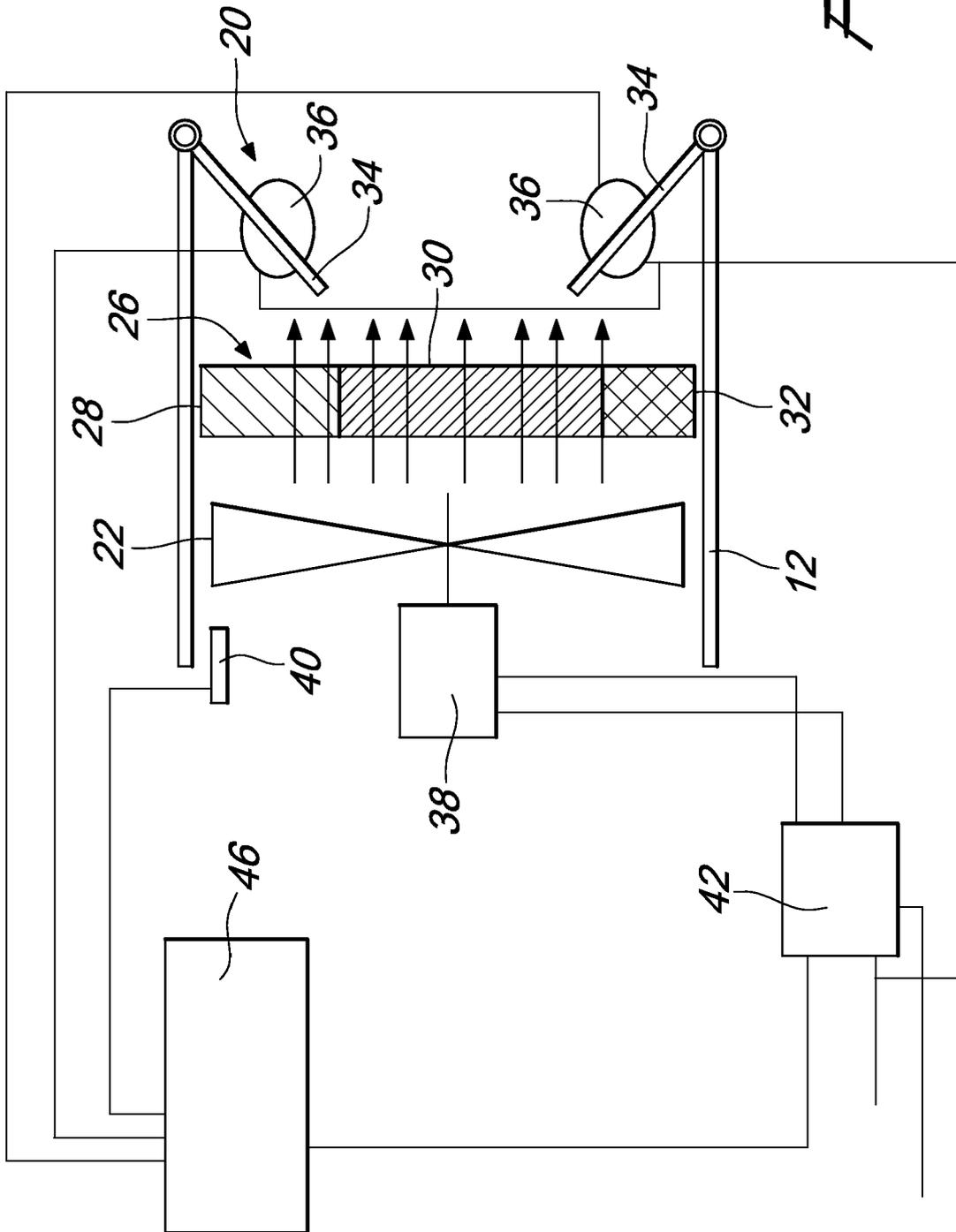


Fig. 7

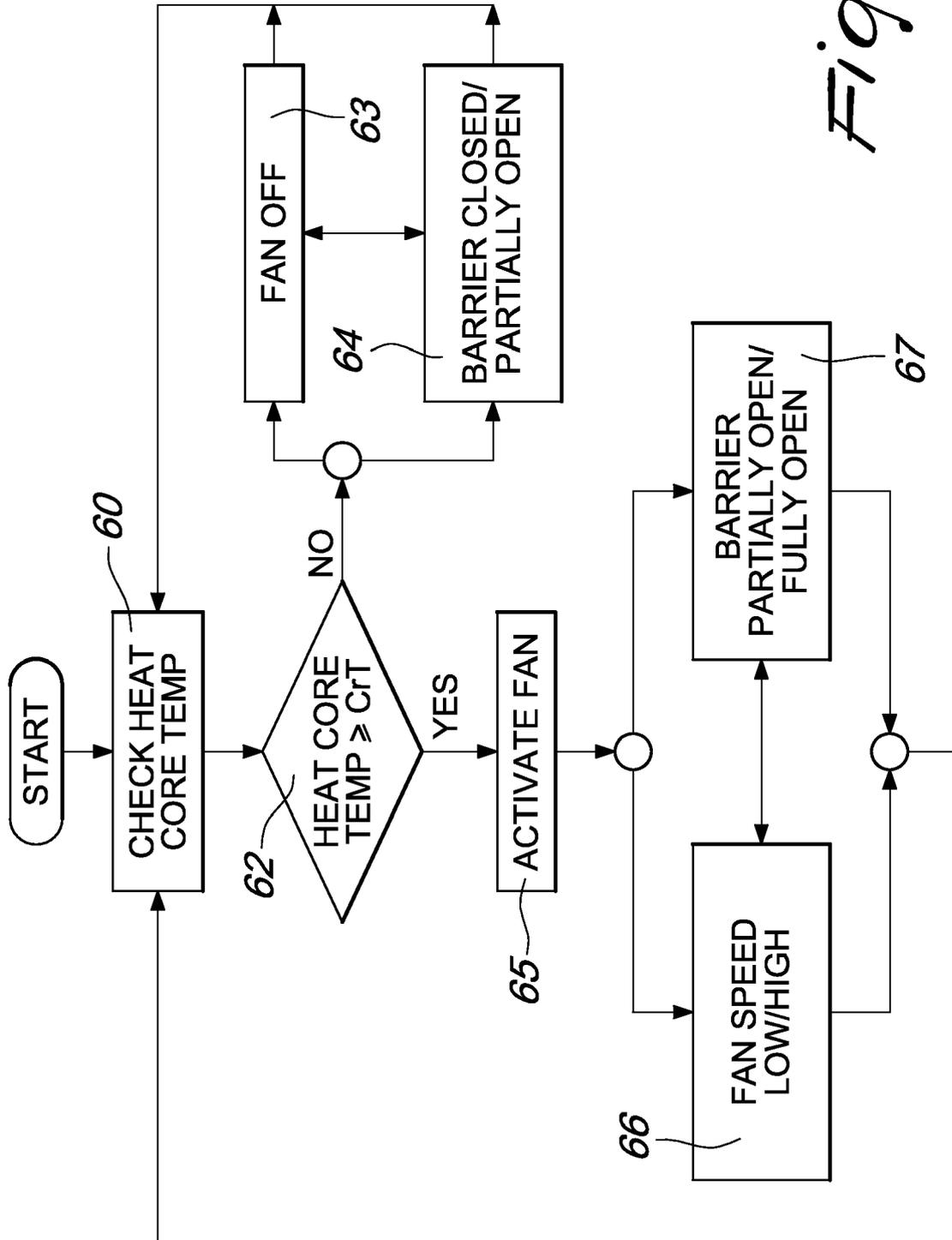


Fig. 8



EUROPEAN SEARCH REPORT

Application Number  
EP 08 16 2596

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Place of search Munich		Date of completion of the search 10 February 2009	Examiner Luta, Dragos
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone                      Y : particularly relevant if combined with another document of the same category                      A : technological background                      O : non-written disclosure                      P : intermediate document</p> <p>T : theory or principle underlying the invention                      E : earlier patent document, but published on, or after the filing date                      D : document cited in the application                      L : document cited for other reasons                      &amp; : member of the same patent family, corresponding document</p>			

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