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(54) SYSTEM AND METHOD FOR COOLING OF AN AFTERTREATMENT MODULE

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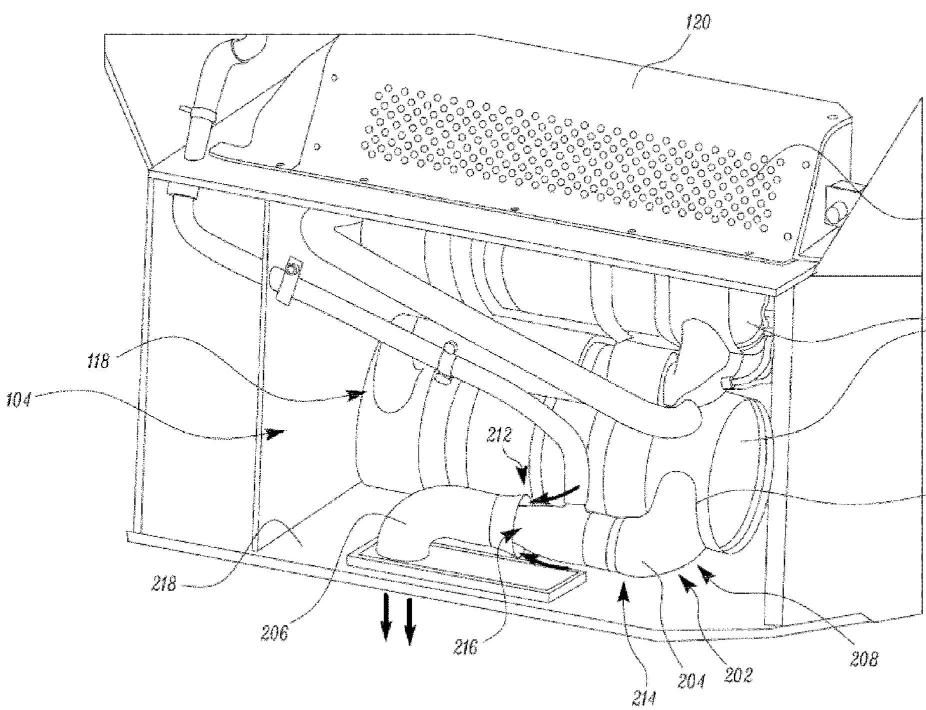
(57) ABSTRACT

A cooling system for an aftertreatment module located within an enclosure is provided. The cooling system includes an exhaust outlet line and a venturi arrangement provided in cooperation with the exhaust outlet line. The venturi arrangement is spaced from a downstream portion of the exhaust outlet line. Moreover, the venturi arrangement relative to the downstream portion of the exhaust outline line is configured to expel heated air from the enclosure.



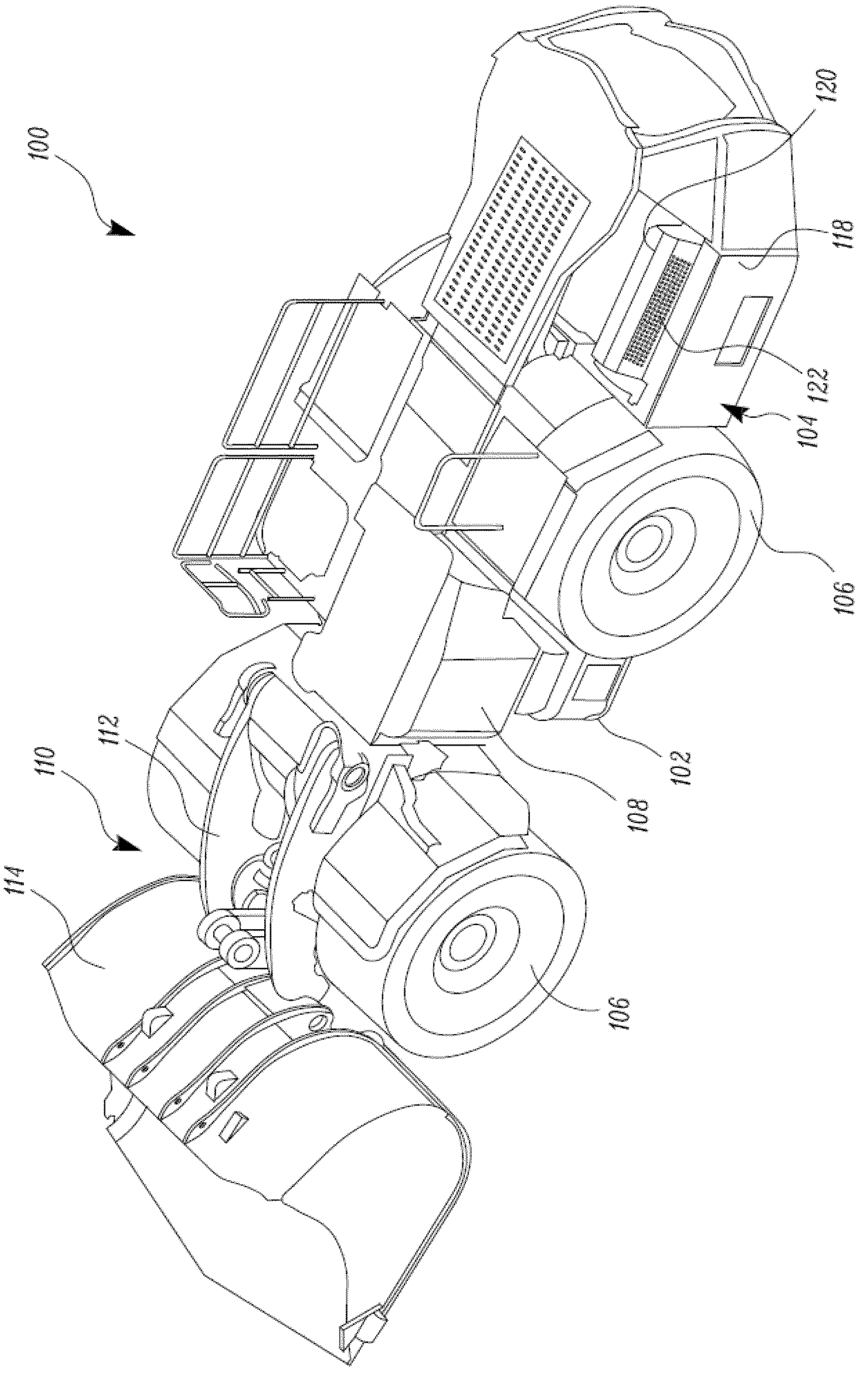


FIG. 1

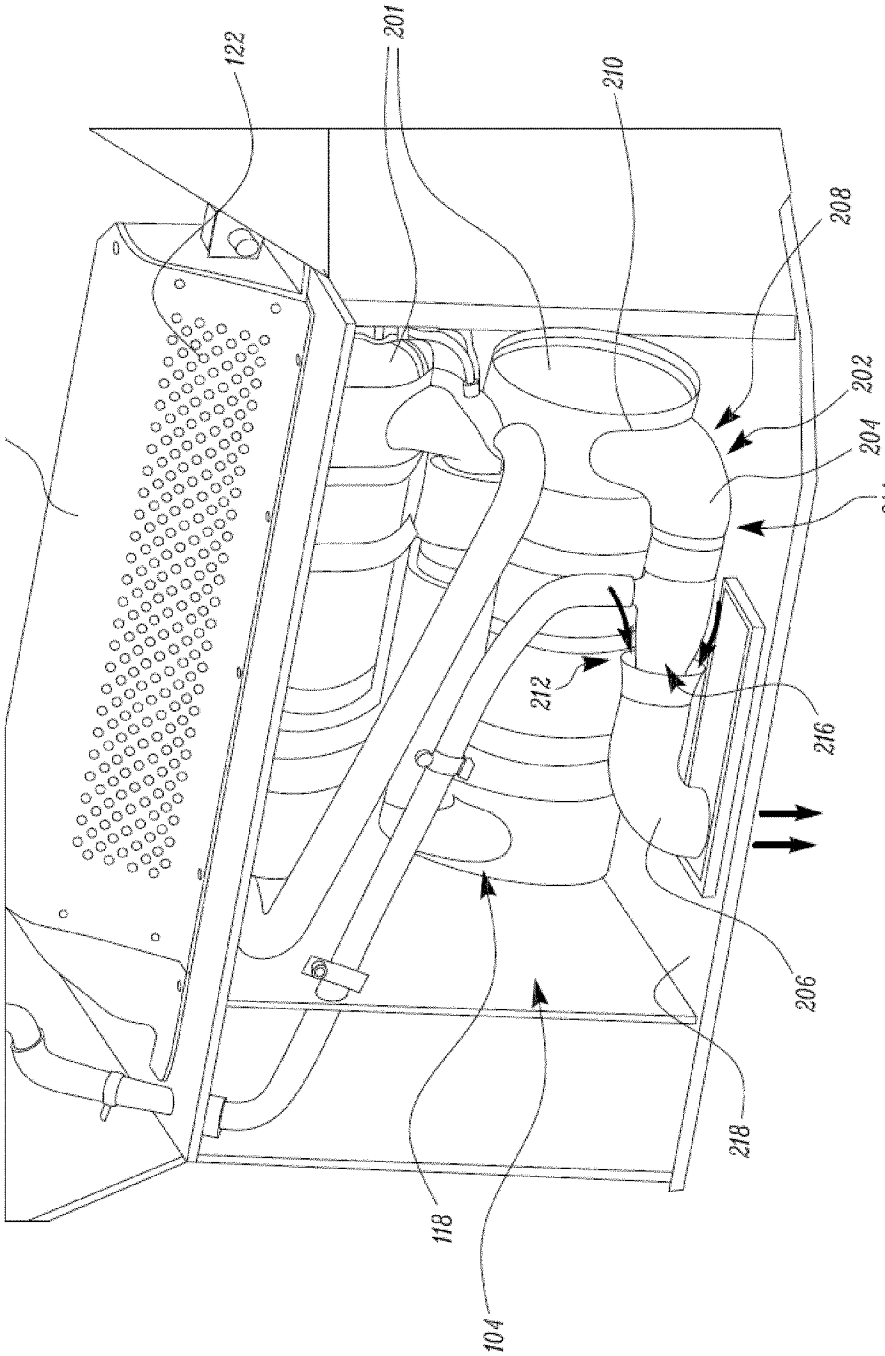


FIG. 2

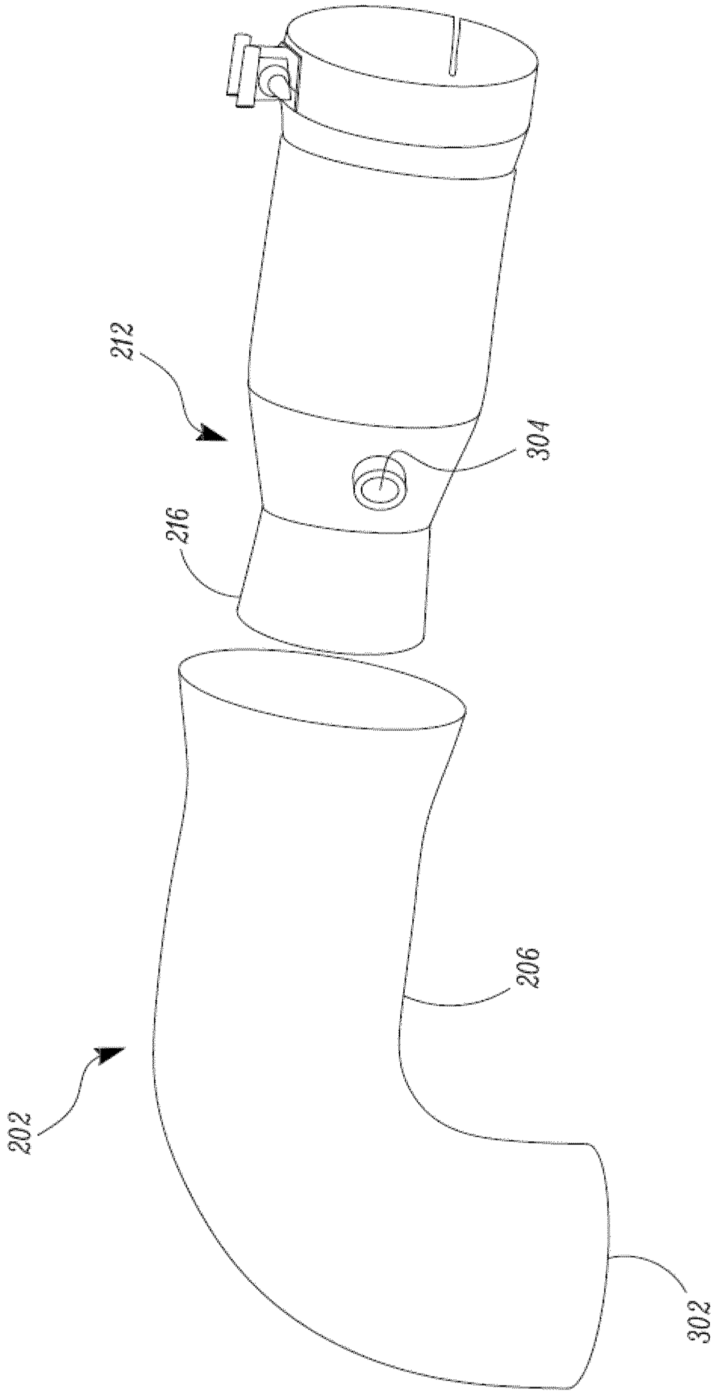


FIG. 3

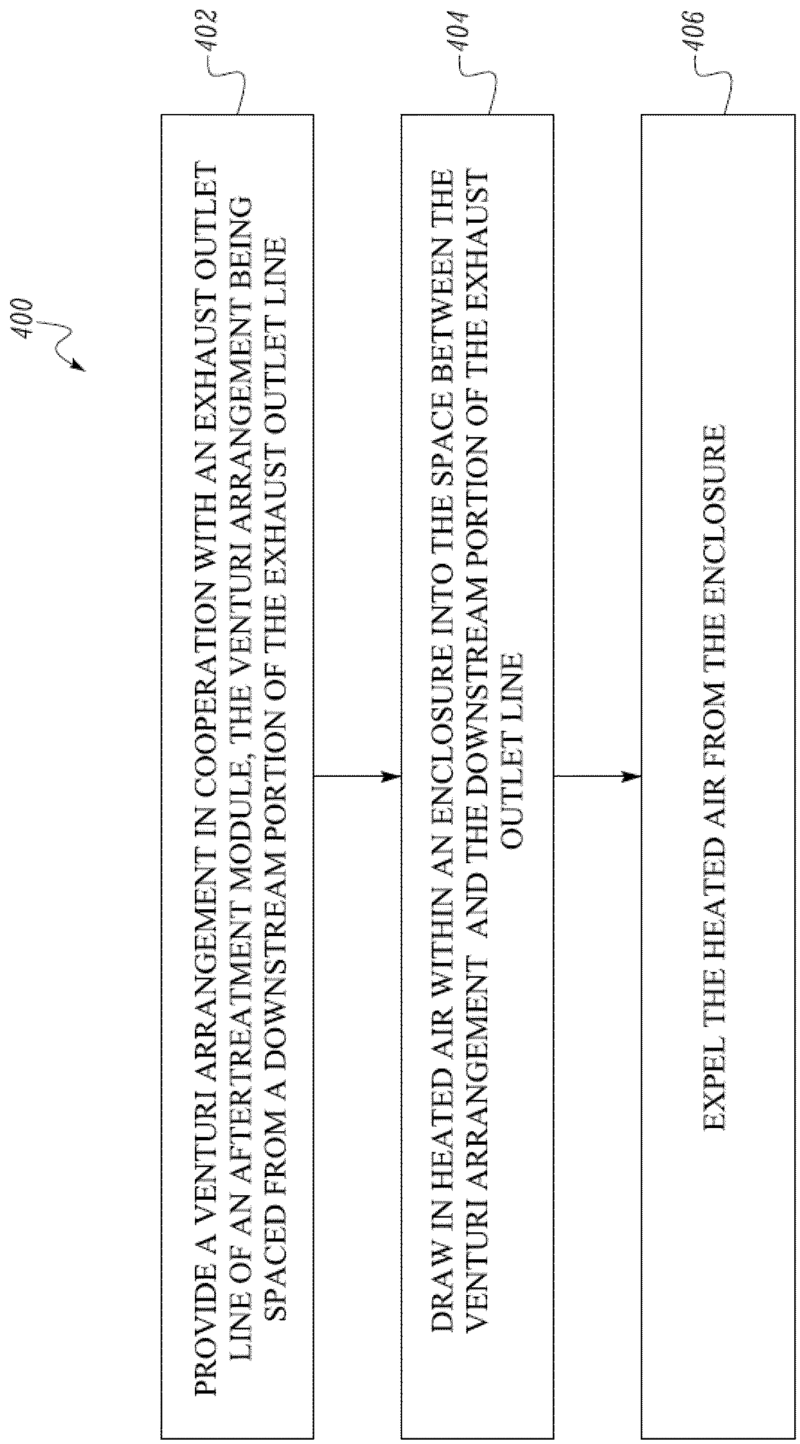

400
402
PROVIDE A VENTURI ARRANGEMENT IN COOPERATION WITH AN EXHAUST OUTLET LINE OF AN AFTERTREATMENT MODULE, THE VENTURI ARRANGEMENT BEING SPACED FROM A DOWNSTREAM PORTION OF THE EXHAUST OUTLET LINE
404
DRAW IN HEATED AIR WITHIN AN ENCLOSURE INTO THE SPACE BETWEEN THE VENTURI ARRANGEMENT AND THE DOWNSTREAM PORTION OF THE EXHAUST OUTLET LINE
406
EXPEL THE HEATED AIR FROM THE ENCLOSURE

FIG. 4

SYSTEM AND METHOD FOR COOLING OF AN AFTERTREATMENT MODULE

TECHNICAL FIELD

[0001] The present disclosure relates to a cooling system, and more particularly to a system and method for cooling of an aftertreatment module located within an enclosure of a machine.

BACKGROUND

[0002] An aftertreatment module is installed on a variety of machines for meeting emission standard requirements. During operation, the aftertreatment module has a tendency to generate large amounts of heat energy. Moreover, the heat generated by the aftertreatment module may lead to an overall increase in temperature within an enclosure of the machine in which the aftertreatment module is housed. Other components, such as, for example, electronic controls present within the enclosure may need to be maintained below a specific temperature for proper functioning. Accordingly, a cooling system may be provided in association with the aftertreatment module in order to dissipate the heat generated by the aftertreatment module.

[0003] For example, U.S. Pat. No. 7,793,495 relates to an exhaust system for a motor vehicle engine including mixing vent flaps in the exhaust pipe which open responsive to exhaust temperature. The vent flap forms a portion of the exhaust pipe when closed and is pivotally attached along one edge to the exhaust pipe to open inwardly into the exhaust pipe to constrict and accelerate flow in the pipe to allow outside air to be drawn into the exhaust pipe. A magnetic catch latches the vent flap in its closed position and a magnetic release responsive to increased temperature of the exhaust stream releases the vent flap.

[0004] In association with certain machine designs such as underground mining machines, the overall machine footprint must be kept within a certain envelope to fit the machine in narrow mine shafts. This in turn affects the relative size of the engine enclosure which is severely compact and often slightly larger than the engine and aftertreatment module provided therein. The close proximity and high heat generated in such a confined space with little or no means to expel the heat can easily cause component failure, loss of engine performance and limited life of the engine and aftertreatment module and components in proximity thereof.

SUMMARY OF THE DISCLOSURE

[0005] In one aspect of the present disclosure, a cooling system for an aftertreatment module located within an enclosure is provided. The cooling system includes an exhaust outlet line and a venturi arrangement provided in cooperation with the exhaust outlet line. The venturi arrangement is spaced from a downstream portion of the exhaust outlet line. Moreover, the venturi arrangement relative to the downstream portion of the exhaust outline line is configured to expel heated air from the enclosure.

[0006] In another aspect, a method for cooling an aftertreatment module located within an enclosure is provided. The method provides a venturi arrangement in cooperation with an exhaust outlet line of the aftertreatment module. The venturi arrangement is spaced from a downstream portion of the exhaust outlet line. The method draws in heated air within the enclosure into the space between the venturi arrangement and the downstream portion of the exhaust outlet line. The method expels the heated air from the enclosure.

[0007] In yet another aspect, a machine is provided. The machine includes a power source and a frame. The machine also includes an aftertreatment module mounted within an enclosure located on the frame. Further, the machine includes a cooling system for the aftertreatment module. The cooling system includes an exhaust outlet line and a venturi arrangement provided in cooperation with the exhaust outlet line. The venturi arrangement is spaced from a downstream portion of the exhaust outlet line. Moreover, the venturi arrangement relative to the downstream portion of the exhaust outline line is configured to expel heated air from the enclosure.

[0008] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a perspective view of an exemplary machine including an aftertreatment module, according to one aspect of the present disclosure;

[0010] FIG. **2** is a perspective view of a cooling system for the machine shown in FIG. **1**;

[0011] FIG. **3** is a perspective view of a venturi arrangement of the cooling system; and

[0012] FIG. **4** is a flowchart of a method for cooling of the aftertreatment module present within an enclosure of the machine.

DETAILED DESCRIPTION

[0013] Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or the like parts. FIG. **1** represents an exemplary machine **100**, according to one embodiment of the present disclosure. More specifically, as shown in the illustrated embodiment, the machine **100** may embody an underground wheel loader. It should be understood that the machine **100** may alternatively include other mining, transportation, forestry or any other industrial, agricultural or construction machinery.

[0014] Referring to FIG. **1**, the machine **100** may include a chassis and/or a frame **102**. A powertrain or a drivetrain (not shown) may be provided on the machine **100** for the production and transmission of motive power. The powertrain may include a power source (not shown) and may be located within an enclosure **104** of the machine **100**. The power source may include one or more engines, power plants or other power delivery systems like batteries, hybrid engines, and the like. It should be noted that the power source could also be external to the machine **100**. A set of ground engaging members **106**, such as wheels, may also be provided on the machine **100** for the purpose of mobility. The powertrain may further include a torque converter, transmission inclusive of gearing, drive shaft and other known drive links provided between the power source and the set of ground engaging members **106** for the transmission of motive power. Further, the machine **100** may include an operator cabin **108** which may house various controls for operating the machine **100**.

[0015] As shown in FIG. **1**, the machine **100** may have a linkage assembly **110** attached to the frame **102**. The linkage assembly **110** may include a lift arm **112**. An implement, such as a bucket **114**, may be pivotally coupled to the lift arm **112**. It may be noted that the linkage assembly **110** and the implement of the machine **100** may vary based on the type of machine **100**, the type of operation or task required to be carried out by the machine **100**. Further, the machine **100** may include an air induction system (not shown) and an exhaust system. The air induction system may be configured to direct air or an air/fuel mixture into the power source for subsequent combustion.

[0016] The exhaust system may treat and discharge byproducts of the combustion process to the atmosphere. The exhaust system may include components that condition and direct exhaust from cylinders of the power source to the atmosphere. For example, and is best seen in FIG. **2**, an aftertreatment module **118** of the exhaust system is connected to receive and treat exhaust from the power source. The aftertreatment module **118** may treat, condition, and/or otherwise reduce constituents of the exhaust before the exhaust is discharged to the atmosphere.

[0017] Referring to FIG. **2**, the aftertreatment module **118** may be located within the enclosure **104** present on the machine **100**. As shown in the accompanying figures, the enclosure **104** may be provided on a side surface of the frame **102** of the machine **100**. In one embodiment, a hooded structure **120** may be positioned on the frame **102** of the machine **100** and extend above the enclosure **104**. The hooded structure **120** may include a plurality of openings **122** configured to allow airflow into and out of the enclosure **104**.

[0018] The aftertreatment module **118** may include one or more components such as, for example, a diesel oxidation catalyst (DOC) chamber, a DEF injector and a selective catalyst reduction (SCR) device. Specifically, the aftertreatment module **118** may include two canisters **201** that are positioned within the compact engine enclosure **104**. These canisters **201** may be required either for compliance with Tier 4 or machines subject to strict low emission standards. The canisters **201** may generate a significant amount of heat that, in turn, may increase the already high temperature within the enclosure **104**. During operation, there may be a rise in a temperature of the aftertreatment module **118**. This increase in temperature may be attributed to various reasons, for example, due to combustion processes taking place inside the auxiliary regeneration device (ARD) and the DOC chamber. Moreover, the rise in the temperature of the components of the aftertreatment module **118** may cause an overall increase in the temperature of the environment surrounding the aftertreatment module **118** placed within the enclosure **104**.

[0019] The present disclosure relates to a cooling system for the aftertreatment module **118**. The cooling system may be provided in association with an exhaust outlet line **202** of the aftertreatment module **118**. The exhaust outlet line **202** may be configured to release exhaust gas discharged from the aftertreatment module **118** into the atmosphere. The exhaust outlet line **202** may have a hollow tube-like structure and may be made of any suitable heat resistant material like a metal, a polymer, and so on. Further, the exhaust outlet line **202** includes a first section **204** and a second section **206**. In the illustrated embodiment, a first end **208** of the first section **204** of the exhaust outlet line **202** may be in fluid communication with an outlet port **210** of the aftertreatment module **118**.

[0020] A venturi arrangement **212** may be spaced from a downstream portion of the exhaust outlet line **202**, hereinafter referred to as a second end **214** of the exhaust outlet line **202**. The venturi arrangement **212** may be coupled to the first section **204** of the exhaust outlet line **202** using any known mechanical fastener means. For example, a snap ring, an 'O' ring, a bolted fitting or any other known snap and fit arrangement may be used to couple the venturi arrangement **212** to the second end **214** of the exhaust outlet line **202**. In one embodiment, the venturi arrangement **212** may be integrated or molded with the second end **214** of the exhaust outlet line **202**. More specifically, one end of the venturi arrangement **212** proximal to the first section **204** of the exhaust outlet line **202** may have a diameter substantially same as a diameter of the first section **204** of the exhaust outlet line **202**. A distal end **216** of the venturi arrangement **212** may be provided in association with the second section **206** of the exhaust outlet line **202**.

[0021] FIG. **3** illustrates an exploded perspective view of the venturi arrangement **212** and the second section **206** of the exhaust outlet line **202**. The venturi arrangement **212** may include a hollow tube like structure made of any suitable material like a metal or a polymer. The distal end **216** of the venturi arrangement **212** may be located within the second section **206** of the exhaust outlet line **202**. Accordingly, a diameter of the second section **206** of the exhaust outlet line **202** may be substantially larger than the diameter of the distal end **216** of the venturi arrangement **212**. The venturi arrangement **212** may serve as transition piece for conveying the exhaust gas flow from the first section **204** to the second section **206** of the exhaust outlet line **202**.

[0022] It should be noted that the venturi arrangement **212** may be provided in fluid communication with the second section **206** of the exhaust outlet line **202**. Moreover, the venturi arrangement **212** may be in a concentric alignment with the second section **206** of the exhaust outlet line **202**. In one embodiment, a plurality of support structures in the form of rods, arms, clips, or extension members may be provided in connection with the venturi arrangement **212** and the second section **206** of the exhaust outlet line **202** in order to maintain the concentric alignment of the venturi arrangement **212** with respect to the second section **206**. For example, support arms may be coupled to a base plate **218** of the enclosure **104** and the venturi arrangement **212** in order to securely hold the venturi arrangement **212** in place.

[0023] A person of ordinary skill in the art will appreciate that the combination of the venturi arrangement **212** and the second section **206** of the exhaust outlet line **202** is configured to cause a substantial drop or decrease in pressure of the exhaust gas flow entering into the second section **206** of the exhaust outlet line **202**. Thus, a suction may be created due to a venturi effect in an area proximate to a junction of the venturi arrangement **212** and the second section **206** of the exhaust outlet line **202**. This suction may draw heated air present within the enclosure **104** into the second end **206** of the exhaust outlet line **202**. Arrows shown in FIG. **2** are indicative of the direction of flow of the heated air present within the enclosure **104**.

[0024] Further, the second section **206** of the exhaust outlet line **202** may have a hollow configuration and may be configured to receive the exhaust gas flow mixed with the heated air flow which is drawn into the second section **206** from within the enclosure **104**. A vent **302** may be provided in fluid communication with the second section **206** of the exhaust outlet line **202**. The vent **302** may be configured to allow the exhaust gas and heated air to be released or expelled from within the enclosure **104** into the atmosphere. The expulsion of the exhaust gas and the heated air is shown with the help of arrows in FIG. **2**.

[0025] One of ordinary skill in the art will appreciate that the plurality of the openings **122** provided on the hooded structure **120** may be configured to facilitate airflow of relatively cool ambient air into the enclosure **104** in order to provide cooling circulation to the enclosure **104** and to avoid vacuum effect that may be created due to the drawing in of the heated air into the second section **206** of the exhaust outlet line **202**. These openings **122** should be disposed within the enclosure **104** in relation to the venturi arrangement **212** in such a manner so as to prevent interference with the operation of the venturi arrangement **212**. Alternatively, one or more apertures may be provided at suitable locations on walls of the enclosure **104** in order to provide the necessary airflow.

[0026] In one embodiment, one or more ports **304** may be provided on the venturi arrangement **212** to allow fluid communication with other exhaust gas outlets present in the system. Parameters related to the exhaust outlet line **202** and the venturi arrangement **212** such as the shape, dimensions, diameter, material used, and so on may vary based on the system requirements. In the illustrated embodiment, the first and second sections **204**, **206** of the exhaust outlet line **202** and the venturi arrangement **212** have a substantially horizontal orientation within the enclosure **104**. The orientation and positioning of the first and second sections **204**, **206** of the exhaust outlet line **202** and the venturi arrangement **212** shown in the accompanying figures is exemplary and does not limit the scope of the present disclosure. Also, in one embodiment, a plurality of the above described venturi arrangements **212** may be provided in association with multiple exhaust outlets present in the system.

[0027] A method **400** for cooling the aftertreatment module **118** located within the enclosure **104** will be discussed in connection with FIG. **4**.

INDUSTRIAL APPLICABILITY

[0028] The present disclosure relates to the cooling system for the aftertreatment module **118**. FIG. **4** illustrates the method **400** for the cooling of the aftertreatment module **118**. At step **402**, the venturi arrangement **212** may be provided in cooperation with the exhaust outlet line **202** such that the venturi arrangement **212** is spaced from the downstream portion of the exhaust outlet line **202**. It is envisioned that the venturi arrangement **212** and an associated exhaust receiving conduit may be configured and attached as a single unit and disposed within the exhaust outlet line **202** or in any other manner known to those with ordinary skill in the art. More specifically, the exhaust gas flow may exit through the outlet port **210** of the aftertreatment module **118** and flow into the first section **204** of the exhaust outlet line **202**.

[0029] As discussed earlier, during operation, the aftertreatment module **118** and the surrounding environment within the enclosure **104** housing the aftertreatment module **118** is typically subject to extremely elevated temperature generated by the aftertreatment module **118**. Hence, the compact enclosure **104** contains heated air that would otherwise stagnate and not provide cooling without the cooling structure of the present disclosure.

[0030] At step **404**, the heated air from within the enclosure **104** may be drawn serially into the space between the venturi arrangement **212** and the downstream portion of the exhaust outlet line **202**, and then into the second section **206** of the exhaust outlet line **202**. It should be noted that the construction and positioning of the venturi arrangement **212** with respect to the second section **206** of the exhaust outlet line **202** may be provided in such a manner that the venturi effect may be created due to the reduction in the diameter of the venturi arrangement **212**. The heated air may be drawn into the second section **206** of the exhaust outlet line **202** due to the venturi effect caused by the flow of exhaust gases exiting the venturi arrangement **212** and triggering the suction of heated enclosure air through the space between the reduced diameter venturi arrangement **212** and the dilated opening of the second section **206** of the exhaust outlet line **202**.

[0031] At step **406**, the heated air once combined with the exhaust gases may be expelled from the enclosure **104**. In one embodiment, the heated air may be expelled via the vent **302** which is provided downstream of the second section **206** of the exhaust outlet line **202**. The heated air being drawn into the venturi arrangement **212** then causes the cool ambient air to be drawn into the enclosure **104** from the plurality of openings **122** within the hooded structure **120**. It will be appreciated that this circulatory movement which draws in cool air and expels the heated air otherwise trapped in the enclosure **104** is especially advantageous for compact enclosure constructs which are typically associated with certain machine types such as, for example, underground mining machines **100**, where overall machine profile size limits engine enclosure capacity.

[0032] While aspects of the present disclosure have been particularly shown and described with reference to the embodiments above, it will be understood by those skilled in the art that various additional embodiments may be contemplated by the modification of the disclosed machines, systems and methods without departing from the spirit and scope of what is disclosed. Such embodiments should be understood to fall within the scope of the present disclosure as determined based upon the claims and any equivalents thereof.

We claim:

1. A cooling system for an aftertreatment module located within an enclosure, the cooling system comprising:

an exhaust outlet line; and

a venturi arrangement provided in cooperation with the exhaust outlet line, the venturi arrangement being spaced from a downstream portion of the exhaust outlet line, wherein the venturi arrangement relative to the downstream portion of the exhaust outline line is configured to expel heated air from the enclosure.

2. The cooling system of claim **1**, wherein the exhaust outlet line further comprises a first section and a second section, the second section provided downstream of the first section, wherein the first section and the second section are in fluid communication via the venturi arrangement.

3. The cooling system of claim **2**, wherein the first section is connected to an outlet port of the aftertreatment module.

4. The cooling system of claim **2**, wherein the venturi arrangement is coupled to the first section using a mechanical fastener.

5. The cooling system of claim **2**, wherein the first section and the second section are made of metal.

6. The cooling system of claim **1** further comprising a plurality of support structures provided in association with the venturi arrangement, the plurality of support structures configured to maintain a concentric alignment of the venturi arrangement with respect to the downstream portion of the exhaust outlet line.

7. The cooling system of claim **1** further comprising a hooded structure which at least partially defines the enclosure and having at least one opening disposed therein, whereby air is circulated through the enclosure through the at least one opening in response to the heated air being drawn into the space between the venturi arrangement and the downstream portion of the exhaust outlet line.

8. The cooling system of claim **1** further comprising a vent provided on the enclosure and in cooperation with the downstream portion of the exhaust outlet line, the vent being configured to release the heated air from the enclosure.

9. The cooling system of claim **1**, wherein the venturi arrangement is made of metal.

10. A method for cooling an aftertreatment module located within an enclosure, the method comprising:

providing a venturi arrangement in cooperation with an exhaust outlet line of the aftertreatment module, the venturi arrangement being spaced from a downstream portion of the exhaust outlet line;

drawing in heated air within the enclosure into the space between the venturi arrangement and the downstream portion of the exhaust outlet line; and

expelling the heated air from the enclosure.

11. A machine comprising:

a power source;

a frame;

an aftertreatment module mounted within an enclosure located on the frame; and

a cooling system for the aftertreatment module, the cooling system comprising:

an exhaust outlet line; and

a venturi arrangement provided in cooperation with the exhaust outlet line, the venturi arrangement being spaced from a downstream portion of the exhaust outlet line, wherein the venturi arrangement relative to the downstream portion of the exhaust outline line is configured to expel heated air from the enclosure.

12. The machine of claim **11**, wherein the exhaust outlet line further comprises a first section and a second section, the second section provided downstream of the first section, wherein the first section and the second section are in fluid communication via the venturi arrangement.

13. The machine of claim **12**, wherein the first section is connected to an outlet port of the aftertreatment module.

14. The machine of claim **12**, wherein the venturi arrangement is coupled to the first section using a mechanical fastener.

15. The machine of claim **12**, wherein the first section and the second section are made of metal.

16. The machine of claim **11** further comprising a plurality of support structures provided in association with the venturi arrangement, the plurality of support structures configured to maintain a concentric alignment of the venturi arrangement with respect to the downstream portion of the exhaust outlet line.

17. The machine of claim **11** further comprising a hooded structure which at least partially defines the enclosure and having at least one opening disposed therein, whereby air is circulated through the enclosure through the at least one opening in response to the heated air being drawn into the space between the venturi arrangement and the downstream portion of the exhaust outlet line.

18. The machine of claim **11** further comprising a vent provided on the enclosure and in cooperation with the downstream portion of the exhaust outlet line, the vent being configured to release the heated air from the enclosure.

19. The machine of claim **11**, wherein the venturi arrangement is made of metal.

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