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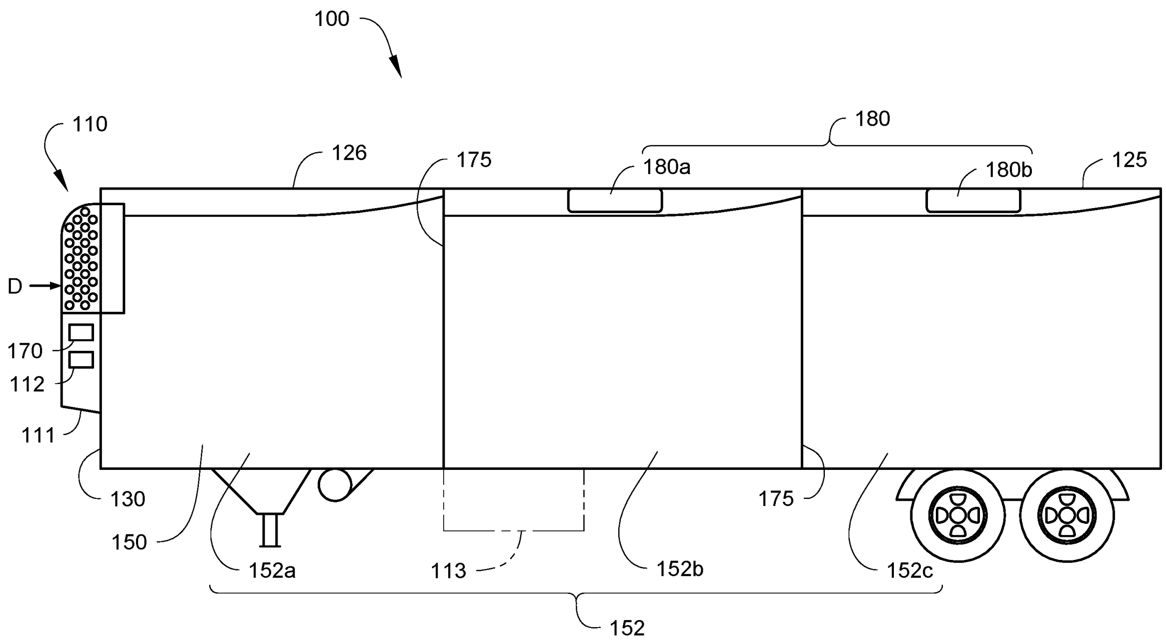
(54) EXHAUST ASSEMBLY FOR A PRIME MOVER OF A TRANSPORT POWER SYSTEM

(57) Exhaust assemblies for emitting an exhaust from a prime mover while in transit are disclosed. The exhaust assembly can include a tail pipe that includes a raiser portion, a soot portion and an undercut outlet. The raiser portion is inclined at a first angle relative to a vertical axis of the exhaust assembly. The raiser portion is configured to receive the exhaust. The soot portion is connected to the raiser portion and is configured to receive the exhaust from the raiser portion. The soot portion is inclined at a second angle relative to the vertical axis. The undercut outlet is disposed at a tail end of the soot portion. The undercut outlet has an upper lip shielding fluid or debris from entering the exhaust assembly via the undercut outlet.

Fig. 1A



Description

FIELD

[0001] This disclosure relates generally to exhaust assemblies for a prime mover of a transport power system. More specifically, the disclosure relates to a swan neck arrangement of the tail pipe of an exhaust assembly for releasing exhaust away from the transport unit and into the air while avoiding fluid (e.g., rain) or debris from entering into the exhaust assembly and avoiding exhaust deposit accumulation within the exhaust assembly.

BACKGROUND

[0002] A transport climate control system (TCCS) can include, for example, a transport refrigeration system (TRS) and/or a heating, ventilation and air conditioning (HVAC) system. A TRS is generally used to control an environmental condition (e.g., temperature, humidity, air quality, and the like) within a cargo space of a transport unit (e.g., a truck, a container (such as a container on a flat car, an intermodal container, etc.), a box car, a semi-tractor, a bus, or other similar transport unit). The TRS can maintain environmental condition(s) of the cargo space to maintain cargo (e.g., produce, frozen foods, pharmaceuticals, etc.). In some embodiments, the transport unit can include a HVAC system to control a climate within a passenger space of the vehicle.

[0003] Auxiliary power units (APUs) can be used with tractors to reduce fuel consumption, maintenance costs, emissions, and noise generated when a tractor prime mover idles during driver rest periods or other periods of vehicle non-movement. Some auxiliary power units are used in conjunction with multiple control systems to power vehicle functions such as heating, cooling, engine warming, lighting, or powering other vehicle functions and operator convenience accessories.

[0004] A prime mover can be used to power the TCCS or APU. The prime mover may generate exhaust that is directed to the exhaust assembly before being emitted into the environment.

SUMMARY

[0005] This disclosure relates generally to exhaust assemblies for a prime mover of a transport power system. More specifically, the disclosure relates to a swan neck arrangement of the tail pipe of an exhaust assembly for releasing exhaust away from the transport unit and into the air while avoiding fluid (e.g., rain) or debris from entering into the exhaust assembly and avoiding exhaust deposit accumulation within the exhaust assembly.

[0006] The exhaust can contain undesirable substances such as soot. Soot can be a mixture of moisture and carbon dusts. When the soot is heated and vaporized into smaller droplets, for example, by the heat in the exhaust assembly, the exhaust can be emitted in a less visible manner providing both cosmetic and/or environmental benefits. For example, the high temperature in the exhaust assembly can vaporize larger soot droplets in the exhaust assembly. Thus, exhaust containing vaporized soot can be less visible at emission, less likely to deposit and accumulate close to the tailpipe outlet, and more aesthetically pleasing.

[0007] To control emission of exhaust (including soot) from the exhaust assembly, the outlet of the exhaust pipe is preferably oriented in a gradual inclined direction to reduce visibility of sudden exhaust being blown out from the exhaust outlet, creating a black cloud of exhaust. The gradual inclining pipe encourages larger droplets of exhaust being heated and vaporized by the heat from the exhaust in the tail pipe before leaving the exhaust assembly.

[0008] In the embodiments described herein, a tail pipe can generally receive exhaust from a vertically mounted muffler in an exhaust assembly for a prime mover of the TCCS or an auxiliary power unit (APU). The tail pipe provides a flow path that directs the flow of exhaust from a generally vertical direction to a gradual incline direction. An advantage of providing a gradual incline rather than a sharp turn (e.g., a 90-degree angle in the tail pipe) in the exhaust assembly is that excessive exhaust deposits at, or following, the sharp turn can be prevented. Thus, the exhaust flow can be prevented from dislodging an excessive exhaust deposit accumulation and blowing out a cloud of visible soot.

[0009] The embodiments described herein can provide a tail pipe coupled to the muffler. The tail pipe includes a raiser portion that can extend upward at a near vertical inclining direction to avoid a sharp turn in the exhaust flow path. The exhaust flow path can than proceed to a soot portion of the tail pipe that is inclined in the same direction, at a smaller slope (e.g., a more gradual incline), as the raiser portion. As such, sharp turns in the tail pipe can be avoided and blow out of excessive exhaust deposit accumulation may be preferably reduced.

[0010] The outlet of the tail pipe can be arranged to avoid fluid (e.g., rain) or debris from entering the exhaust assembly. In some embodiments, an undercut outlet at an outlet end of the tail pipe is provided with an upper lip disposed at the outlet to shield the lower lip of the outlet from falling fluid or debris. Accordingly, the exhaust assembly does not require a fluid or water drain. By not requiring a fluid drain, accumulation of exhaust deposits at any point of impingement of the fluid drain discharge can be avoided. The embodiments described herein can direct all exhaust through a single outlet passage so any exhaust components naturally mix with the atmosphere and do not accumulate at a fluid drain point. Also, noise can be dampened, for example, by a combination of a diesel oxidation catalyst (DOC) matrix and the exhaust assembly. For example, the raiser portion and the soot portion of the tail pipe are extending at different angles relative to a reference axis such that a bended flow path is provided in the tail pipe. Noise soundwaves propagating through the bended flow path of the tail pipe can be reflected off the inner wall of the tail pipe and dampened while traveling through the bended flow path.

[0011] In one embodiment, an exhaust assembly for emitting an exhaust from a prime mover while in transit is provided. The exhaust assembly includes a tail pipe that includes a raiser portion, a soot portion, and an undercut outlet. The raiser portion is inclined at a first angle relative to a vertical axis of the exhaust assembly. The raiser portion is configured to receive the exhaust. The soot portion is connected to the raiser portion and configured to receive the exhaust from the raiser portion. The soot portion is inclined at a second angle relative to the vertical axis. The undercut outlet is disposed at a tail end of the soot portion, the undercut outlet having an upper lip shielding fluid or debris from entering the exhaust assembly via the undercut outlet.

[0012] In another embodiment, a transport power system for providing power while in transit is provided. The transport power system includes a diesel engine and an exhaust assembly. The diesel engine has an engine exhaust outlet configured to release an exhaust. The exhaust assembly is connected to an engine exhaust outlet. The exhaust assembly includes a tail pipe. The tail pipe includes a raiser portion, a soot portion and an undercut outlet. The raiser portion inclines at a first angle relative to a vertical axis of the exhaust assembly. The raiser portion being is configured to receive the exhaust. The soot portion is connected to the raiser portion and configured to receive the exhaust from the raiser portion. The soot portion inclines at a second angle relative to the vertical axis. The undercut outlet is disposed at a tail end of the soot portion. The undercut outlet has an upper lip shielding fluid or debris from entering the exhaust assembly via the undercut outlet.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] References are made to the accompanying drawings that form a part of this disclosure and which illustrate the embodiments in which systems and methods described in this specification can be practiced.

Fig. 1A illustrates a schematic cross sectional side view of a refrigerated transport unit with a multi-temp transport climate control system (MTCS), according to an embodiment.

Fig. 1B illustrates a perspective view of a vehicle with an auxiliary power unit, according to an embodiment.

Fig. 1C illustrates a side view of a truck with a front wall mounted vehicle powered transport refrigeration unit, according to an embodiment.

Fig. 2 illustrates a transport power system, according to an embodiment.

Fig. 3A is a perspective view of an exhaust assembly with a swan neck tail pipe, according to an embodiment.

Fig. 3B is a side view of the exhaust assembly, according to the embodiment of Fig.3A.

Fig. 3C is a front view of the exhaust assembly, according to the embodiment of Fig.3A.

Fig. 4A is a schematic front view of a transport climate control unit (TCCU) having an exhaust assembly that ends below a top wall of the TCCU, according to an embodiment.

Fig. 4B is a schematic front view of a TCCU having an exhaust assembly that protrudes through a top wall of the TCCU, according to an embodiment.

Fig. 4C is a top view of a TCCU according to the embodiments of Fig. 4A and Fig. 4B.

[0014] Like reference numbers represent like parts throughout.

DETAILED DESCRIPTION

[0015] This disclosure relates generally to exhaust assemblies for a prime mover of a transport power system. More specifically, the disclosure relates to a swan neck arrangement of the tail pipe of an exhaust assembly for releasing exhaust away from the transport unit and into the air while avoiding fluid or debris from entering into the exhaust assembly and avoiding exhaust deposit accumulation within the exhaust assembly.

[0016] As defined herein, a prime mover described herein refers to a prime mover of a transport power system (e.g., a prime mover of an auxiliary power unit (APU), a prime mover of a TCCS, or the like), but not to a vehicle prime mover used to move a vehicle. In some embodiments, the prime mover can be a diesel engine. That is, in some embodiments, there can be two or more distinct diesel engines on a same vehicle: one can be a main/vehicle (e.g., tractor, truck, or the like) engine used to move the vehicle, and the other can be an auxiliary engine (e.g., a diesel powered compression ignition engine) of the transport power system.

[0017] Fig. 1A illustrates one embodiment of a multizone transport climate control system (MTCS) 100 for a transport unit (TU) 125 that can be towed, for example, by a tractor (not shown). The MTCS 100 includes a TCCU 110 and a plurality of remote evaporator units 180. The TCCU 110 and each of the remote evaporator units 180 provide climate control (e.g. temperature, humidity, air quality, etc.) within a separate zone of the internal space 150. The TCCU 110 can include, amongst other components, a refrigeration circuit that connects, for example, a compressor, a condenser, an evaporator and an expansion valve to provide climate control within the at least one of the zones of the internal space 150. Each of the evaporator units 180 can also be connected to the refrigeration circuit to provide climate control to a particular zone 152 of the internal space 150.

[0018] The internal space 150 can be divided into a plurality of zones 152. The term "zone" means a part of an area of the internal space 150 separated by walls 175. It will be appreciated that the invention disclosed herein can also be used in a single zone TCCS. It is further appreciated that, the MTCS 100 or the single zone TCCS can be a climate controlled container transported by rail carts, trucks, trailers, and/or ships.

[0019] The MTCS 100 for the TU 125 includes the TCCU 110 and a plurality of remote evaporator units 180 configured to provide climate control within each of the zones 152. For example, the TCCU 110 can provide climate control within zone 152a, the remote evaporator unit 180a can provide climate control within zone 152b, and the remote evaporator unit 180b can provide climate control within zone 152c.

[0020] The MTCS 100 also includes a MTCS controller 170 and one or more sensors (e.g., Hall effect sensors, current transducers, etc.) that are configured to measure one or more parameters (e.g., ambient temperature, compressor suction pressure, compressor discharge pressure, supply air temperature, return air temperature, humidity, etc.) of the MTCS 100 and communicate parameter data to the MTCS controller 170. The MTCS 100 is powered by a transport power system 112. The TCCU 110 is disposed on a front wall 130 of the TU 125. In other embodiments, it will be appreciated that the TCCU 110 can be disposed, for example, on a rooftop 126 or another wall of the TU 125.

[0021] In some embodiments, the MTCS 100 can include an undermount unit 113. In some embodiments, the undermount unit 113 can be a TCCU that can also provide environmental control (e.g. temperature, humidity, air quality, etc.) within the internal space 150 of the TU 125. The undermount unit 113 can work in combination with the TCCU 110 to provide redundancy or can replace the TCCU 110. Also, in some embodiments, the undermount unit 113 can be a transport power system that includes, for example, a generator that can help power the TCCU 110.

[0022] As shown in Fig. 1A, the transport power system 112 is disposed in the TCCU 110. In other embodiments, the transport power system 1 12 can be separate from the TCCU 110. Also, in some embodiments, the transport power system 112 can include two or more different power sources disposed within or outside of the TCCU 110. In some embodiments, the transport power system 112 can include one or more of a prime mover, a battery, an alternator, a generator, a solar panel, a fuel cell, etc. Also, the prime mover can be a combustion engine or a microturbine engine and can operate as a two speed prime mover, a variable speed prime mover, etc. In some embodiments, for the prime mover, an exhaust assembly can be included to collect or burns off particulate such as carbon, soot, or the like that comes out of the tail pipe. The transport power system 112 can provide power to, for example, the MTCS controller 170, a compressor (not shown), a plurality of DC (Direct Current) components (not shown), a power management unit (not shown), etc. The DC components can be accessories or components of the MTCS 100 that require DC power to operate. Examples of the DC components can include, for example, DC fan motor(s) for a condenser fan or an evaporator blower (e.g., an Electrically Commutated Motor (ECM), a Brushless DC Motor (BLDC), etc.), a fuel pump, a drain tube heater, solenoid valves (e.g., controller pulsed control valves), etc.

[0023] The transport power system 112 can include a DC power source (not shown) for providing DC electrical power to the plurality of DC components (not shown), the power management unit (not shown), etc. The DC power source can receive mechanical and/or electrical power from, for example, a utility power source (e.g., Utility power, etc.), a prime mover (e.g., a combustion engine such as a diesel engine, etc.) coupled with a generator machine (e.g., a belt-driven alternator, a direct drive generator, etc.), etc. For example, in some embodiments, mechanical energy generated by a diesel engine is converted into electrical energy via a generator machine. The electrical energy generated via the belt driven alternator is then converted into DC electrical power via, for example, a bi-directional voltage converter. The bi-directional voltage converter can be a bi-directional multi-battery voltage converter.

[0024] One embodiment of the transport power system 112 is described below with respect to Fig. 2.

[0025] Fig. 1B illustrates a vehicle 10 according to one embodiment. The vehicle 10 is a semi-tractor that is used to transport cargo stored in a cargo compartment (e.g., a container, a trailer, etc.) to one or more destinations. Hereinafter, the term "vehicle" shall be used to represent all such tractors and trucks, and shall not be construed to limit the present application solely to a tractor in a tractor-trailer combination. In some embodiments, the vehicle 10 can be, for example, a straight truck, van, etc.

[0026] The vehicle 10 includes a primary power source 20, a cabin 25 defining a sleeping portion 30 and a driving portion 35, an APU 40, and a plurality of vehicle accessory components 45 (e.g., electronic communication devices, cabin lights, a primary and/or secondary HVAC system, primary and/or secondary HVAC fan(s), sunshade(s) for a window/windshield of the vehicle 10, cabin accessories, etc.). The cabin 25 can be accessible via a driver side door (not shown) and a passenger side door 32. The cabin 25 can include a primary HVAC system (not shown) that can be configured to provide conditioned air within driving portion 35 and potentially the entire cabin 25, and a secondary HVAC system (not shown) for providing conditioned air within the sleeping portion 30 of the cabin 25. The cabin 25 can also include a plurality of cabin accessories (not shown). Examples of cabin accessories can include, for example, a refrigerator, a television, a video game console, a microwave, device charging station(s), a continuous positive airway pressure (CPAP) machine, a coffee maker, a secondary HVAC system for providing conditioned air to the sleeping portion 30.

[0027] The primary power source 20 can provide sufficient power to operate (e.g., drive) the vehicle 10 and any of the plurality of vehicle accessory components 45 and cabin accessory components 47. The primary power source 20 can also provide power to the primary HVAC system and the secondary HVAC system. In some embodiments, the primary power source can be a prime mover such as, for example, a combustion engine (e.g., a diesel engine, etc.).

[0028] In the illustrated embodiment, the APU 40 is a secondary power unit for the vehicle 10 when the primary power source 20 is unavailable. When, for example, the primary power source 20 is unavailable, the APU 40 can be configured to provide power to one or more of the vehicle accessory components, the cabin accessories, the primary HVAC system and the secondary HVAC system. In some embodiments, the APU 40 can be an electric powered APU. In other embodiments, the APU 40 can be a prime mover powered APU. The APU 40 can be attached to the vehicle 10 using any attachment method. In some embodiments, the APU 40 can be turned on (i.e., activated) or off (i.e., deactivated) by an occupant (e.g., driver or passenger) of the vehicle 10. The APU 40 generally does not provide sufficient power for operating (e.g., driving) the vehicle 10. The APU 40 can be controlled by an APU controller 41. In some embodiments, the APU 40 can include a transport power system as described below with respect to Fig. 2.

[0029] Fig. 1C depicts a temperature-controlled straight truck 11 that includes a conditioned load space 12 for carrying cargo. A transport climate control unit (TCCU) 14 is mounted to a front wall 16 of the load space 12. The TCCU 14 is controlled via a controller 15 to provide temperature control within the load space 12. The truck 11 further includes a vehicle power bay 18, which houses a truck prime mover 21, such as a combustion engine (e.g., diesel engine, etc.), that provides power to move the truck 11. In some embodiments, the truck prime mover 21 can work in combination with an optional machine 22 (e.g., an alternator). The TCCU 14 includes a transport power system 13. In an embodiment, the transport power system 13 can include a combustion engine (e.g., diesel engine, etc.) to provide power to the TCCU 14. In one embodiment, the TCCU 14 includes a vehicle electrical system. Also, in some embodiments, the TCCU 14 can be powered by the transport power system 13 in combination with a battery power source or by the optional machine 22. In some embodiments, the TCCU 14 can also be powered by the truck prime mover 21 in combination with a battery power source or the optional machine 22. One embodiment of the transport power system 13 is described below with respect to Fig. 2.

[0030] While Fig. 1C illustrates a temperature-controlled straight truck 11, it will be appreciated that the embodiments described herein can also apply to any other type of transport unit including, but not limited to, a van, a container (such as a container on a flat car, an intermodal container, etc.), a box car, or other similar transport unit.

[0031] Fig. 2 illustrates a transport power system 200 that includes a prime mover assembly 210 and an exhaust assembly 250, according to an embodiment. The transport power system 200 also includes a cooling system 220, a fuel filter 230, and an air filter 240. In an embodiment, the transport power system 200 can also include a control module, a diesel particulate filter (DPF), a blower, a pressure sensor, a control switch, a system indicator, an ambient temperature sensor, and/or the like for controlling and operating the transport power system 200.

[0032] The transport power system 200 can be used, for example, as the transport power system 112 shown in Fig. 1A, a transport power system for the APU 40 shown in Fig. 1B, and/or the transport power system 13 shown in Fig. 1C.

[0033] For example, in one embodiment, the transport power system 200 can be disposed inside the housing 111 of the TCCU 110. The illustrative example of Fig. 2 can be a view of the transport power system 200 in the TCCU 110 of Fig. 1A from the direction D (shown in Fig. 1A) within the housing 111. In an embodiment, the direction of D can be the opposite of the traveling direction of the carrier transporting the TCCU 110. It is appreciated that the housing 111 might include other components such at climate control system components (e.g., compressor, condenser, evaporator, controller, and/or the like).

[0034] The prime mover assembly 210 is configured to provide mechanical power, for example, to power an electrical generator for providing the electricity supplied by the transport power system 200. The prime mover assembly 210 receives a fuel (e.g., diesel fuel), mixes the fuel with air, ignites the fuel-air mixture, and captures energy from fuel combustion to power the electrical generator. In the illustrated example, the prime mover assembly 210 includes a prime mover 215. The prime mover assembly 210 is coupled to the exhaust assembly 250.

[0035] In some embodiments, the prime mover 215 is a diesel engine in which fuel mixes with intake air and ignites within the prime mover 215. The fuel combustion creates an exhaust that may include pollutants such as particulate matters, fuel droplets, carbon oxides, nitrogen oxides, or the like. The exhaust leaves the prime mover 215 at a temperature at about the combustion temperature of the fuel. The particulate matters can include soot from incomplete combustion of the fuel. The exhaust leaves the prime mover assembly 210 via an exhaust outlet 235 of the prime mover assembly 210. In some embodiments, the diesel engine produces at least 18.9 kW of mechanical power.

[0036] In an embodiment, the exhaust outlet 235 is coupled to the prime mover 215. The exhaust outlet 235 is also coupled with the exhaust assembly 250 for emitting the exhaust from the prime mover assembly 210. The exhaust travels through the exhaust outlet 235 and the exhaust assembly 250 before being emitted and dispersed in the environment. In an embodiment, the prime mover 215 is mounted to a housing (e.g., housing

111 of Fig. 1A) of a TCCU. In an embodiment, the exhaust outlet 235 is an exhaust manifold of the prime mover 210. During operation, the prime mover 210 can create noise and vibration that may be transferred to the housing and/or the exhaust assembly 250.

[0037] The cooling system 220 is configured to cool the prime mover assembly 210 during operation. For example, the cooling system 220 can circulate engine coolants between the prime mover assembly 210 and a radiator (not shown) to remove heat from the prime mover assembly 210 and expel the heat to the environment via a radiator (not shown). The fuel filter 230 is configured to filter contaminates from a fuel system before the fuel enters the prime mover assembly 210. The air filter 240 is configured to filter intake air to be supplied to the prime mover 215.

[0038] The exhaust assembly 250 is configured to process the exhaust to reduce pollutants before dispersing the exhaust to the environment. The exhaust assembly 250 can be provided for protecting air quality, for cosmetic purposes, for meeting regulatory requirements, and/or the like. In the illustrated example, the exhaust assembly 250 is coupled to the exhaust outlet 235 of the prime mover 215 to receive the exhaust from the prime mover 215. In an embodiment, the exhaust assembly can include a mid-pipe 236 to route exhaust from the prime mover 215 to processing components of the exhaust assembly such as a diesel particulate filter (DPF), a diesel oxidation catalyst (DOC), a muffler 258, a tail pipe 260, and the like.

[0039] The tail pipe 260 includes an undercut outlet 255. The end of the undercut outlet 255 of the exhaust assembly 250 is a tail end of the tail pipe 260 and thereby the exhaust assembly 250. The tail end is therefore also an end opposite of the end of the exhaust assembly 250 that couples to the engine system outlet 235. The undercut outlet 255 is configured to be exposed to the environment and is designed to prevent fluid (e.g., rainfall) or debris from entering into the exhaust assembly 250.

[0040] The muffler 258 is configured to dampen noise traveling through the exhaust assembly 250. In the illustrative example, the muffler 258 may be disposed downstream from a DPF and/or a DOC.

[0041] The tail pipe 260 is disposed on the end of the exhaust assembly 250 opposite to the end coupled to the prime mover assembly 210. The tail pipe 260 can include one or more connected pipes selectively arranged to release the exhaust into the environment, while preventing deposit accumulation within the exhaust assembly 250. The tail pipe 260 can be arranged to avoid fluid and/or debris from entering into the exhaust assembly 250 as further discussed with respect to the following drawings.

[0042] In the illustrative example of Fig. 2, the exhaust assembly 250 includes one or more mounting brackets 259 for installing the exhaust assembly 250 and/or components of the exhaust assembly 250 directly or indirectly to a housing (e.g., housing 111 of Fig. 1A). In an embodiment, upon installation, the mounting bracket 250 rigidly attaches the exhaust assembly 250 to the housing. For example, the mounting bracket 259 can attach a vertical connector pipe 256, between the DOC 237 and the tail pipe 260, to the housing. In an embodiment, the mounting bracket 259 can attach a DOC and/or a DPF to the housing. For example, the mounting bracket 259 may be one or more L-brackets.

[0043] Figs. 3A, 3B, and 3C are views of a tail pipe 360 for an exhaust assembly 350 (e.g., exhaust assembly of 250 of Fig. 2), according to an embodiment. Fig. 3A shows a perspective view, Fig. 3B shows a side view, and Fig. 3C shows a front view of the tail pipe 360. It is appreciated that the tail pipe 360 of Figs. 3A-C can be the tail pipe 260 of Fig. 2 as shown and described above.

[0044] As shown in Fig. 3A, the tail pipe 360 is disposed at the tail end of the exhaust assembly for preventing deposit accumulation within the exhaust assembly 250. The tail pipe 360 includes one or more tubes, or tube sections, for directing the exhaust flow within the tail pipe 360. The tail pipe 360 can change in flow direction of the exhaust pipe in a gradual manner while creates back pressure for supporting the operation of a prime mover system (e.g., the prime mover system 210 shown in Fig. 2).

[0045] In the illustrated example of Figs. 3A-C, the tail pipe 360 connects to an outlet end 358A of the muffler 358. The outlet end 358A of the muffler 358 includes an end cap 358B reducing the diameter of the muffler 358 to a diameter of a muffler outlet pipe 358C. The muffler outlet pipe 358C connects to the end cap 358B. One or more brackets 359 connect the exhaust assembly and/or the tail pipe 360 to a housing (e.g., housing 111 of Fig. 1A). In an embodiment, the bracket 359 can be the brackets 259 shown in Fig. 2 and described above.

[0046] The tail pipe 360 includes a raiser portion 370, a soot portion 380, and an undercut outlet 390 disposed downstream (relative to the exhaust flow direction) of the muffler 358.

[0047] The raiser portion 370 is a conduit extending upward from the muffler 358 for directing the flow path of the exhaust flowing in the tail end of the exhaust assembly. In an embodiment, the raiser portion 370 is a tubular conduit. The raiser portion 370 arranges the flow direction of the exhaust to follow a first inclining direction in the raiser portion 370. A first angle is between the inclining direction and the direction D_V of exhaust flow exiting the muffler 358.

[0048] In an embodiment, where the muffler 358 having a tubular body, the direction D_V can correspond with the direction of the central axis of the muffler 358. In an embodiment, a central axis of muffler 358 is generally disposed perpendicular to the group level when the exhaust assembly 350 is installed onto the housing. In such embodiment, the direction D_V and/or the central axis of the muffler 358 can generally correspond with, or be parallel to, a vertical axis of the housing of, for example, a TCCU or an APU.

[0049] A muffler outlet elbow 371 is provided for connecting the raiser portion 370 to the muffler outlet pipe 358C. The muffler outlet elbow 371 is disposed between the muffler outlet pipe 358C and the raiser portion 370 for connecting. In an embodiment, the raiser portion 370 includes a raiser portion elbow 375 for connecting the raiser portion 370 to the soot portion 380. The raiser portion elbow 375 is disposed between the raiser portion 370 and the soot portion 380 for connecting and adjusting the direction of the soot portion 380 with respect to the raiser portion 370.

[0050] The soot portion 380 is a conduit extending upward from the raiser portion 380 for directing the flow path of the exhaust flowing in the tail end of the exhaust assembly 350. In an embodiment, the raiser portion 370 is a tubular conduit. The soot portion 380 is configured to direct the flow direction of the exhaust to follow in a generally second inclining direction within the soot portion 380. A second angle is defined between the direction of exhaust flow exiting the muffler D_V, the vertical axis of the housing of the TCCU or the APU, and the like. In an embodiment, the second angle is greater than the first angle so that the exhaust flows in the soot portion 380 at a greater angle (relative to direction D_V) than that in the raiser portion 370.

[0051] It is appreciated that the first and second inclining directions are arranged to prevent deposit accumulation (including soot) onto an inner surface of the raiser portion 370 and/or the soot portion 380. In some embodiments, the exhaust leaving exhaust assembly 350can be at or near a combustion temperature of the fuel traveling through the prime mover assembly 210. In the tail pipe 360, the exhaust can heat any deposits accumulated on the inner surface of tail pipe 360 and can vaporize any accumulated deposits. The vaporized deposits can then be carried by the exhaust and emitted to the environment.

[0052] Fig. 3B is a side view of the tail pipe 360 and oriented such that, when the exhaust assembly is installed onto a housing that is attached to a transport unit, the transport unit would be traveling in a direction into or out of the page. Fig. 3C is a front view of the tail pipe 360 and oriented such that, when the exhaust assembly is installed onto the housing that is attached to the transport unit, the transport unit would be travelling to the left or right relative to the page. That is, the tail pipe 360 is designed to emit exhaust in a direction perpendicular to a direction that the transport unit is travelling.

[0053] As shown in Fig. 3B and 3C, the undercut outlet 390 is disposed at the tail end of the exhaust assembly to prevent fluid (e.g., rainfall) and/or debris from entering the exhaust assembly and in particular the tail pipe 360. In an embodiment, the undercut outlet 390 can be the undercut outlet 255 of Fig. 2. The undercut outlet 390 can have an upper lip 394 disposed over a lower lip 392, and the upper lip 392 extends outward such that the upper lip 394 can shield the lower lip 392 from above, thereby preventing any fluid (e.g., rain) falling from above from entering the exhaust assembly from the undercut outlet 390 on the tail pipe 360.

[0054] The inclining direction of the tail pipe 360 is illustrated relative to the direction D_V. A first angle 410 is defined between the direction D_V and a raiser portion extending direction 420. A second angle 430 is defined between the direction D_V and a soot portion extending direction 440. An undercut angle 450 is defined between the direction D_V and a direction 460 connecting the upper lip 394 and the lower lip 392. In an embodiment, the first angle 410 can be about 10.6 degrees, the second angle 430 can be about 55 degrees, and the undercut angle 450 can be about 10 degrees.

[0055] An angle 470 can be defined as an amount of undercut relative to the soot portion 380. In an embodiment, the angle 470 can be about 45 degrees or less such that the rigidity of the undercut outlet 390 can be maintained, for example, to resist debris knocking on the undercut outlet 490 and causing deformation of the tail pipe 360. In an embodiment, the upper lip 394 can shield the lower lip 392 such that the tail pipe 360 does not require a drain hole to drain fluid (e.g., rain water) out to of the exhaust assembly. By not requiring a drain hole, which can be generally disposed in the housing (e.g., the housing of the TCCU), the risk of exhaust leakage out of the drain hole can be prevented.

[0056] As shown in Fig. 3C, the inclining direction of the raiser portion 370 is generally disposed in the same plane as the inclining direction of the soot portion 380. The plane can be a plane perpendicular to the illustration of Fig. 3C and intersecting with the direction D_V.

[0057] It is appreciated that, when the first angle 410 and/or the second angle 430 is/are smaller than some of the embodiments discussed above, the tail pipe 360 may be disposed generally more vertically. If the first angle 410 and/or the second angle 430 are too small, the generally more vertical configuration can increase the risk of fluid ingress at the undercut outlet 390. When the first angle 410 and/or the second angle 430 is/are larger than some of the embodiments discussed above, the tail pipe 360 may be disposed generally more horizontally and the undercut outlet 390 may be disposed at a location more visible from the ground. If the first angle 410 and/or the second angle 430 are too large, the generally more horizontal configuration may increase the risk of making any unsightly exhaust discharged from the exhaust assembly more visible to an observer on the ground, and thus less favorable cosmetically.

[0058] It is also appreciated that, when the undercut angle 450 is smaller than some of the embodiments discussed above, the undercut outlet 390 may be disposed more vertically. If the undercut angle 450 is too small, the generally more vertical configuration may result in the upper lip 394 extending less over the undercut outlet 390. Thus, the effect of the upper lip 394 shielding the undercut outlet 390 from fluid ingress may be reduced. When the undercut angle 450 is larger than some of the embodiments discussed above, the undercut outlet 390 may be disposed more horizontally. When the undercut angle 450 is too large, the generally more horizontal configuration may result in the upper lip 394 shielding the undercut outlet 390 too much such that the risk of exhaust accumulation can be increased. This can increase the risk of deposits (e.g., soot) dripping down into the housing when the prime mover is off.

[0059] It is further appreciated that the combination of the first angle 410, the second angle 430, and/or the undercut angle 450 may be arranged such that the soot portion 380 approaches a horizontal position. In such an arrangement, the risk of exhaust accumulation can be increased, increasing the risk of deposits (e.g., soot) dripping down into the housing when the prime mover is off.

[0060] Figs. 4A and 4B illustrate schematic front views of a housing 500 according to two different embodiments. The housing 500 includes a top wall 510 that includes an opening 540. The housing 500 can be a housing for a TCCU, an APU, etc. In an embodiment, the top wall 510 can be a top fascia for the housing 500.

[0061] In the embodiment shown in Fig. 4A, an exhaust assembly 515A (e.g., an exhaust assembly such as the exhaust assembly 250 shown in Fig. 2) includes a tail pipe 520A (e.g., a tail pipe such as the tail pipe 260 shown in Fig. 2, the tail pipe 360 shown in Figs. 3A-C, etc.). The tail pipe 520A is configured to end below a top wall 510 of the housing 500 and thereby does not extend through the opening 540.

[0062] In the embodiment shown in Fig. 4B, an exhaust assembly 515B (e.g., an exhaust assembly such as the exhaust assembly 250 shown in Fig. 2) includes a tail pipe 520B (e.g., a tail pipe such as the tail pipe 260 shown in Fig. 2, the tail pipe 360 shown in Figs. 3A-C, etc.). The tail pipe 520B protrudes through the top wall 510 of the housing 500 by extending through the opening 540.

[0063] Fig. 4C is a top view of the housing 500 shown in Figs. 4A and 4B. As shown in Fig. 4C, the top wall 510 includes the opening 540 disposed such that the tail pipe 520A or 520B can freely disperse the exhaust to the environment unblocked and unhindered. In an embodiment, the opening 540 includes a clearance 530 around at least a tail end 550 of the tail pipe 520A or 520B for dispersing heat released from the exhaust assembly 520A or 520B. The clearance can help to avoid heat damage to the top wall 510. It is appreciated that the clearance 530 can provide room for soot in the exhaust to disperse and reduce the risk of deposit accumulation on edges of the opening 540 of the top wall 510.

[0064] Aspects:

It is appreciated that any of aspects 1-7 and 8-16 can be combined.

[0065] Aspect 1. An exhaust assembly for emitting an exhaust from a prime mover, the exhaust assembly comprising:

a tail pipe that includes a raiser portion, a soot portion, and an undercut outlet;

wherein the raiser portion is inclined at a first angle relative to a vertical axis of the exhaust assembly, the raiser portion being configured to receive the exhaust,

wherein the soot portion is connected to the raiser portion and configured to receive the exhaust from the raiser portion, the soot portion is inclined at a second angle relative to the vertical axis, and

wherein the undercut outlet is disposed at a tail end of the soot portion, the undercut outlet having an upper lip shielding fluid or debris from entering the exhaust assembly via the undercut outlet.

[0066] Aspect 2. The exhaust assembly of aspect 1, wherein the second angle is greater than the first angle.

[0067] Aspect 3. The exhaust assembly of any one of aspects claims 1 and 2, wherein an inclining direction of the soot portion and an inclining direction of the raiser portion are disposed along a same plane.

[0068] Aspect 4. The exhaust assembly of any one of aspects 1-3, further comprising a muffler outlet pipe elbow that is configured to receive the exhaust in a direction of the vertical axis and direct the exhaust to exit the muffler outlet pipe elbow at an inclining direction of the raiser portion.

[0069] Aspect 5. The exhaust assembly of any one of aspects 1-4, wherein the tail pipe includes a raiser portion elbow disposed between the raiser portion and the soot portion, wherein the raiser portion elbow is curved to receive the exhaust travelling in an inclining direction of the raiser portion and configured to direct the exhaust to exit the raiser portion elbow at an inclining direction of the soot portion.

[0070] Aspect 6. The exhaust assembly of any one of aspects 1-5, wherein the undercut outlet further comprises a lower lip disposed below the upper lip, the lower lip recessing into the soot portion such that the upper lip shields the lower lip from falling fluid or debris.

[0071] Aspect 7. The exhaust assembly of any one of aspects 1-6, wherein the tail pipe does not include a fluid drain.

[0072] Aspect 8. A transport power system for providing power while in transit, the transport power system comprising:

a diesel engine having an engine exhaust outlet configured to release an exhaust; and

an exhaust assembly connected to the engine exhaust outlet, the exhaust assembly comprising a tail pipe, the tail pipe including:

a raiser portion inclining at a first angle relative to a vertical axis of the exhaust assembly, the raiser portion being configured to receive the exhaust;

a soot portion connected to the raiser portion and configured to receive the exhaust from the raiser portion, the soot portion inclining at a second angle relative to the vertical axis; and an undercut outlet disposed at a tail end of the soot portion, the undercut outlet having an upper lip shielding fluid or debris from entering the exhaust assembly via the undercut outlet.

[0073] Aspect 9. The transport power system of aspect 8, wherein the second angle is greater than the first angle.

[0074] Aspect 10. The transport power system of any one of aspects 8-9, wherein an inclining direction of the soot portion and an inclining direction of the raiser portion are disposed along a same plane.

[0075] Aspect 11. The transport power system of any one of aspects 8-10, further comprising a muffler outlet pipe elbow receiving the exhaust in a direction of the vertical axis and curving the exhaust to exit the muffler outlet pipe elbow in an inclining direction of the raiser portion.

[0076] Aspect 12. The transport power system of any one of aspects 8-11, wherein the tail pipe includes a raiser portion elbow disposed between the raiser portion and the soot portion, wherein the raiser portion elbow is curved to receive the exhaust travelling in an inclining direction of the raiser portion and configured to direct the exhaust to exit the raiser portion elbow at an inclining direction of the soot portion.

[0077] Aspect 13. The transport power system of any one of aspects 8-12, wherein the undercut outlet further comprises a lower lip disposed below the upper lip, the lower lip recessing into the soot portion such that the upper lip shields the lower lip from falling fluid or debris.

[0078] Aspect 14. The power of any one of aspects 8-13, wherein the tail pipe does not include a fluid drain.

[0079] Aspect 15. The transport power system of any one of aspects 8-14, wherein the prime mover is configured to provide generate power for a transport climate control system.

[0080] Aspect 16. The transport power system of any one of aspects 8-14, wherein the prime mover is configured to generate power for an auxiliary power unit.

[0081] The terminology used in this specification is intended to describe particular embodiments and is not intended to be limiting. The terms "a," "an," and "the" include the plural forms as well, unless clearly indicated otherwise. The terms "comprises" and/or "comprising," when used in this specification, specify the presence of the stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, and/or components.

[0082] With regard to the preceding description, it is to be understood that changes may be made in detail, especially in matters of the construction materials employed and the shape, size, and arrangement of parts without departing from the scope of the present disclosure. This specification and the embodiments described are exemplary only, with the true scope and spirit of the disclosure being indicated by the claims that follow.

Claims

1. An exhaust assembly for emitting an exhaust from a prime mover while in transit, the exhaust assembly comprising:

   a tail pipe that includes a raiser portion, a soot portion, and an undercut outlet;
   wherein the raiser portion is inclined at a first angle relative to a vertical axis of the exhaust assembly, the raiser portion being configured to receive the exhaust,
   wherein the soot portion is connected to the raiser portion and configured to receive the exhaust from the raiser portion, the soot portion is inclined at a second angle relative to the vertical axis, and
   wherein the undercut outlet is disposed at a tail end of the soot portion, the undercut outlet having an upper lip shielding fluid or debris from entering the exhaust assembly via the undercut outlet.

2. The exhaust assembly of claim 1, wherein the second angle is greater than the first angle.

3. The exhaust assembly of any one of claims 1 and 2, wherein an inclining direction of the soot portion and an inclining direction of the raiser portion are disposed along a same plane.

4. The exhaust assembly of any one of claims 1-3, further comprising a muffler outlet pipe elbow that is configured to receive the exhaust in a direction of the vertical axis and direct the exhaust to exit the muffler outlet pipe elbow at an inclining direction of the raiser portion.

5. The exhaust assembly of any one of claims 1-4, wherein the tail pipe includes a raiser portion elbow disposed between the raiser portion and the soot portion, wherein the raiser portion elbow is curved to receive the exhaust travelling in an inclining direction of the raiser portion and configured to direct the exhaust to exit the raiser portion elbow at an inclining direction of the soot portion.

6. The exhaust assembly of any one of claims 1-5, wherein the undercut outlet further comprises a lower lip disposed below the upper lip, the lower lip recessing into the soot portion such that the upper lip shields the lower lip from falling fluid or debris.

7. The exhaust assembly of any one of claims 1-6, wherein the tail pipe does not include a fluid drain.

8. A transport power system for providing power while in transit, the transport power system comprising:

a diesel engine having an engine exhaust outlet configured to release an exhaust; and

an exhaust assembly connected to the engine exhaust outlet, the exhaust assembly comprising a tail pipe, the tail pipe including:

a raiser portion inclining at a first angle relative to a vertical axis of the exhaust assembly, the raiser portion being configured to receive the exhaust;

a soot portion connected to the raiser portion and configured to receive the exhaust from the raiser portion, the soot portion inclining at a second angle relative to the vertical axis; and

an undercut outlet disposed at a tail end of the soot portion, the undercut outlet having an upper lip shielding fluid or debris from entering the exhaust assembly via the undercut outlet.

9. The transport power system of claim 8, wherein the second angle is greater than the first angle.

10. The transport power system of any one of claims 8 and 9, wherein an inclining direction of the soot portion and an inclining direction of the raiser portion are disposed along a same plane.

11. The transport power system of any one of claims 8-10, further comprising a muffler outlet pipe elbow receiving the exhaust in a direction of the vertical axis and curving the exhaust to exit the muffler outlet pipe elbow in an inclining direction of the raiser portion.

12. The transport power system of any one of claims 8-11, wherein the tail pipe includes a raiser portion elbow disposed between the raiser portion and the soot portion, wherein the raiser portion elbow is curved to receive the exhaust travelling in an inclining direction of the raiser portion and configured to direct the exhaust to exit the raiser portion elbow at an inclining direction of the soot portion.

13. The transport power system of any one of claims 8-12, wherein the undercut outlet further comprises a lower lip disposed below the upper lip, the lower lip recessing into the soot portion such that the upper lip shields the lower lip from falling fluid or debris.

14. The power of any one of claims 8-13, wherein the tail pipe does not include a fluid drain.

15. The transport power system of any one of claims 8-14, wherein the prime mover is configured to provide generate power for a transport climate control system; and/or

wherein the prime mover is configured to generate power for an auxiliary power unit.

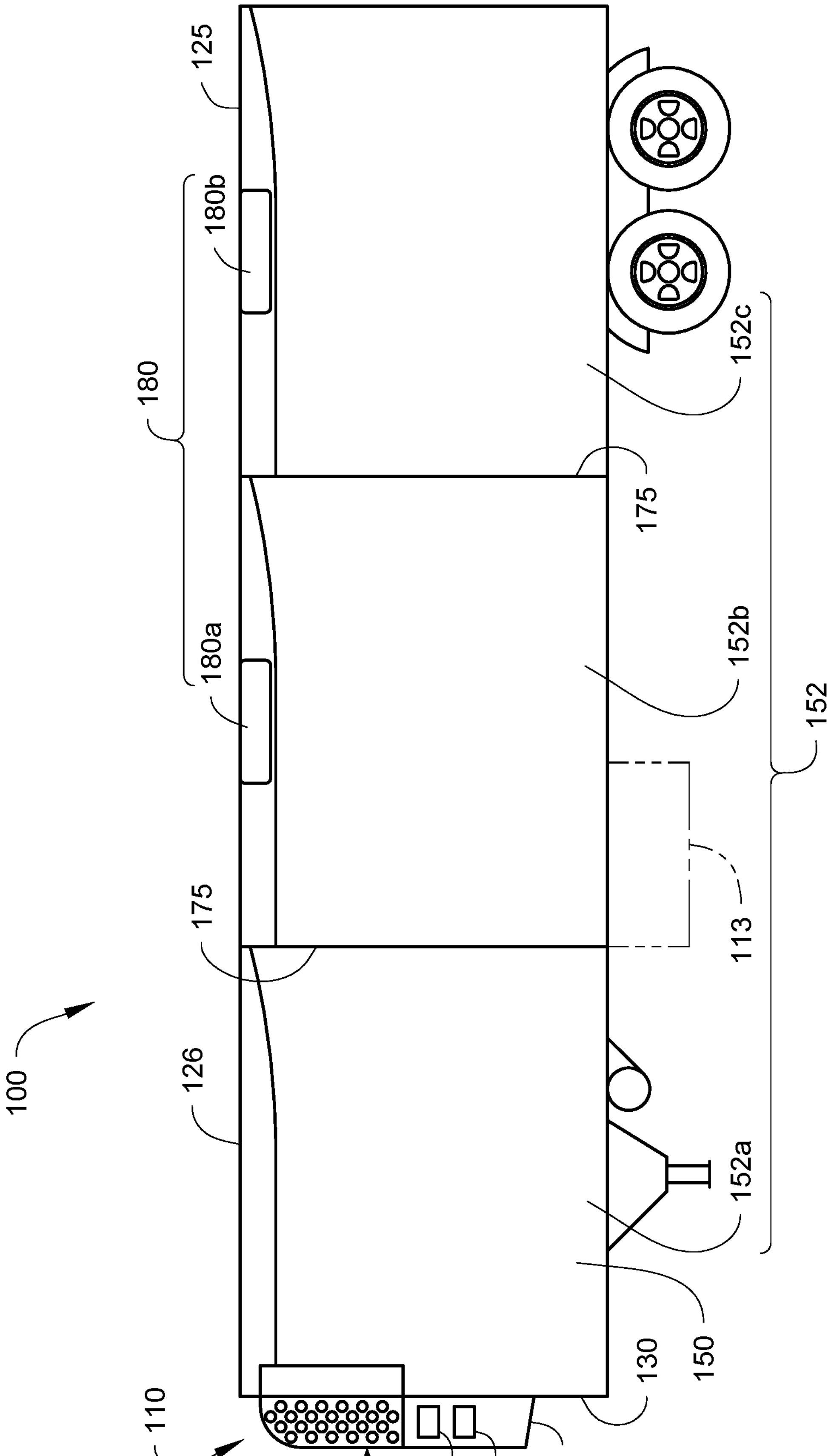

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Fig. 1A

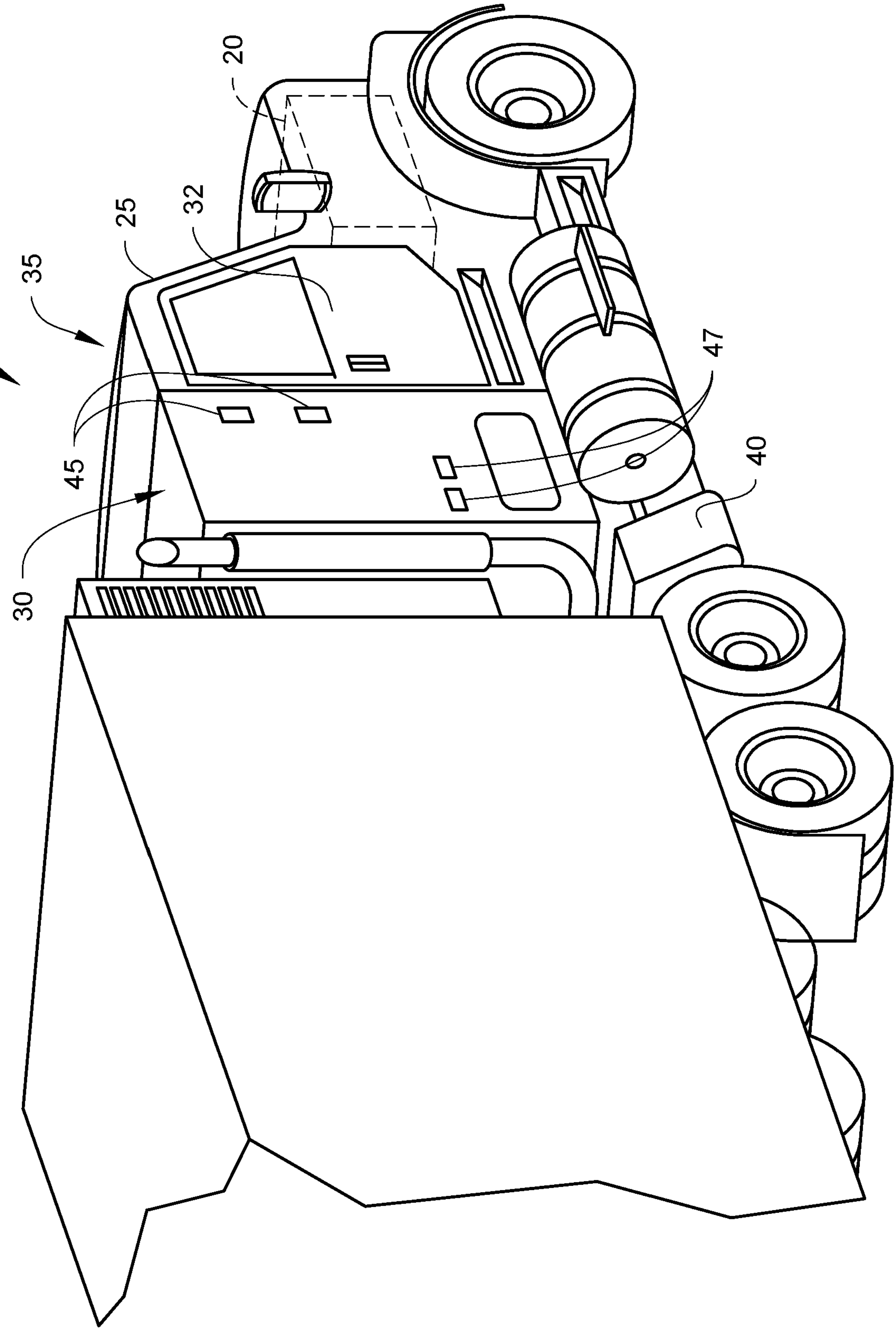

Fig. 1B

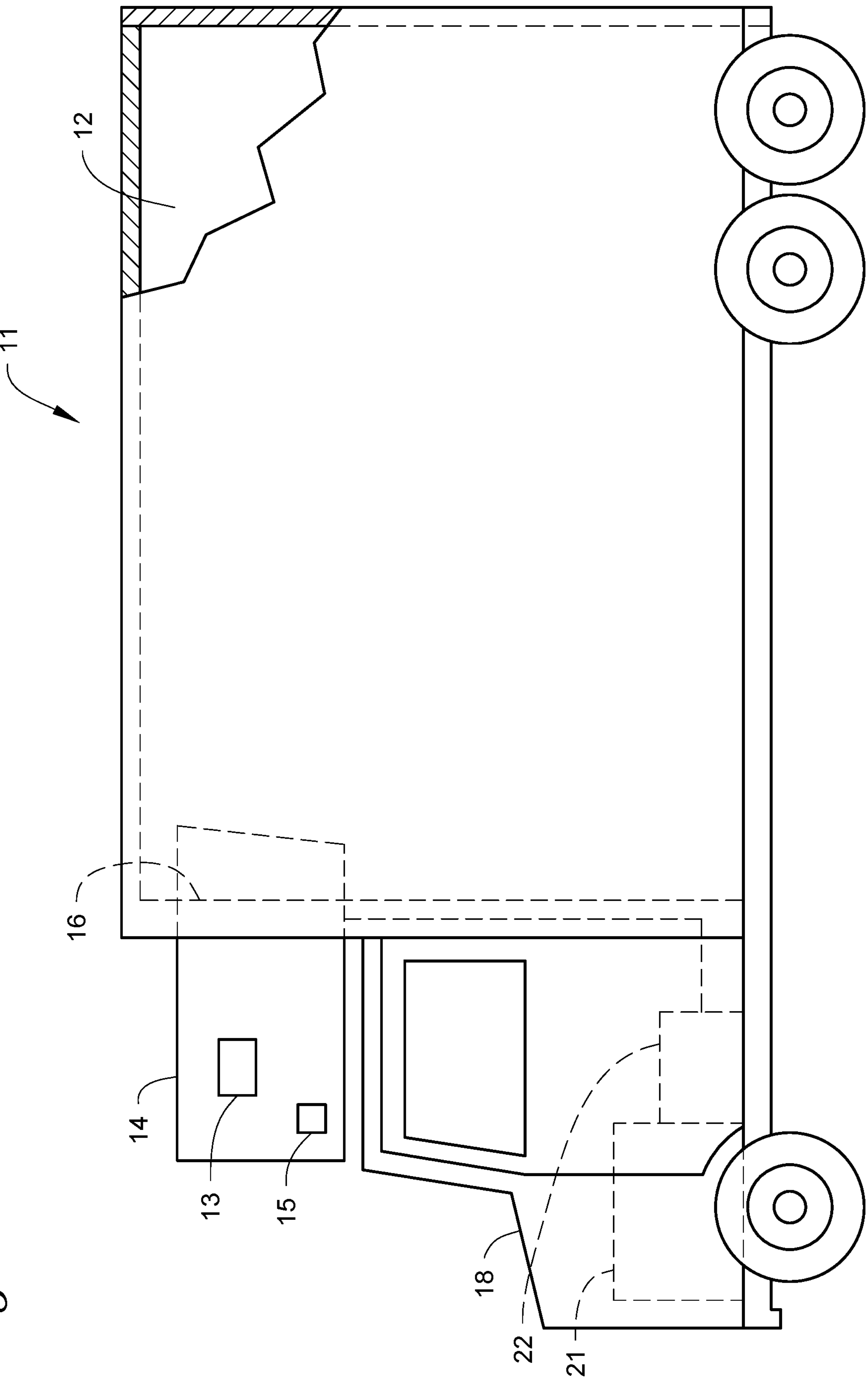

Fig. 1C

Fig. 2

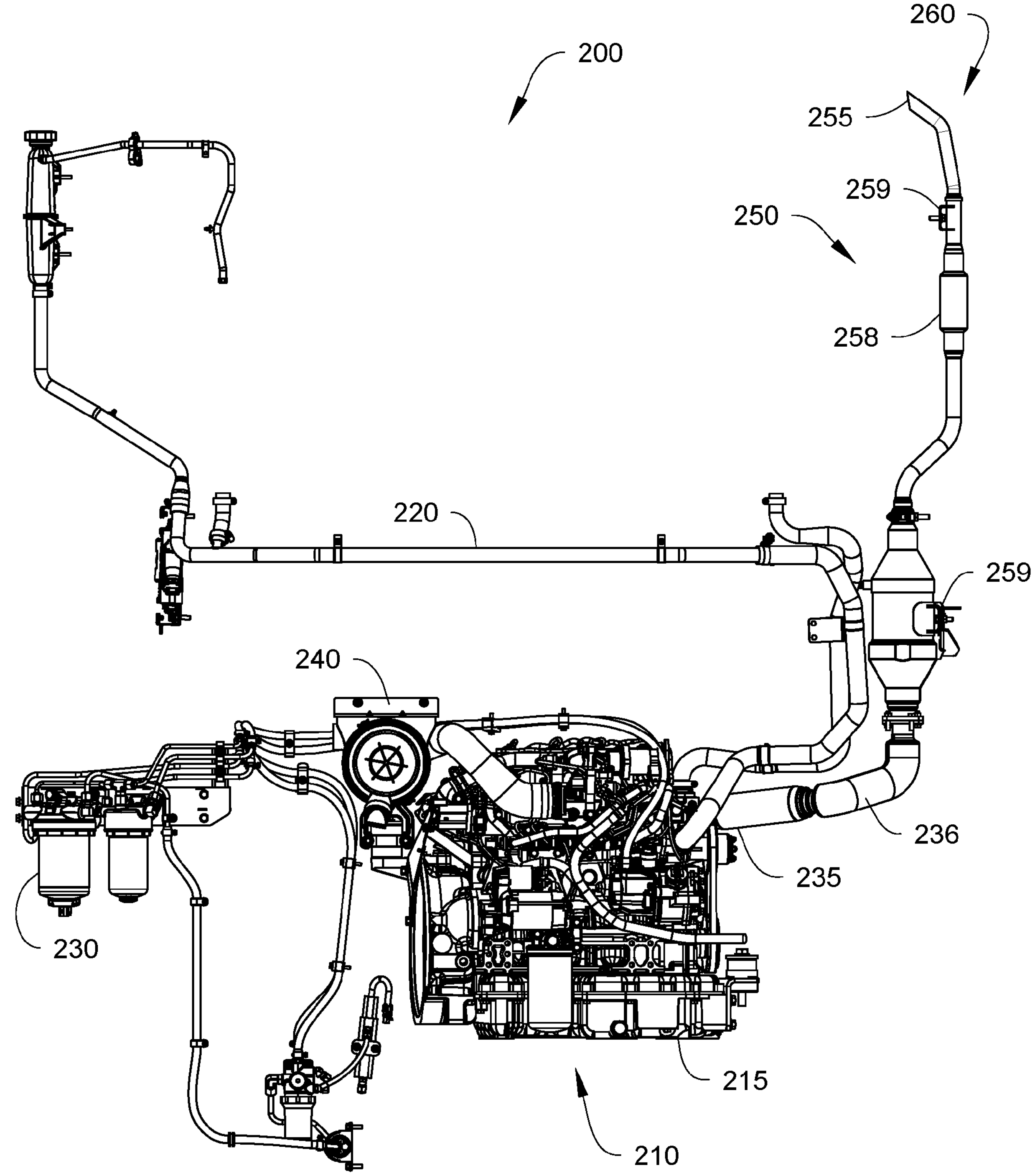

Fig. 3A

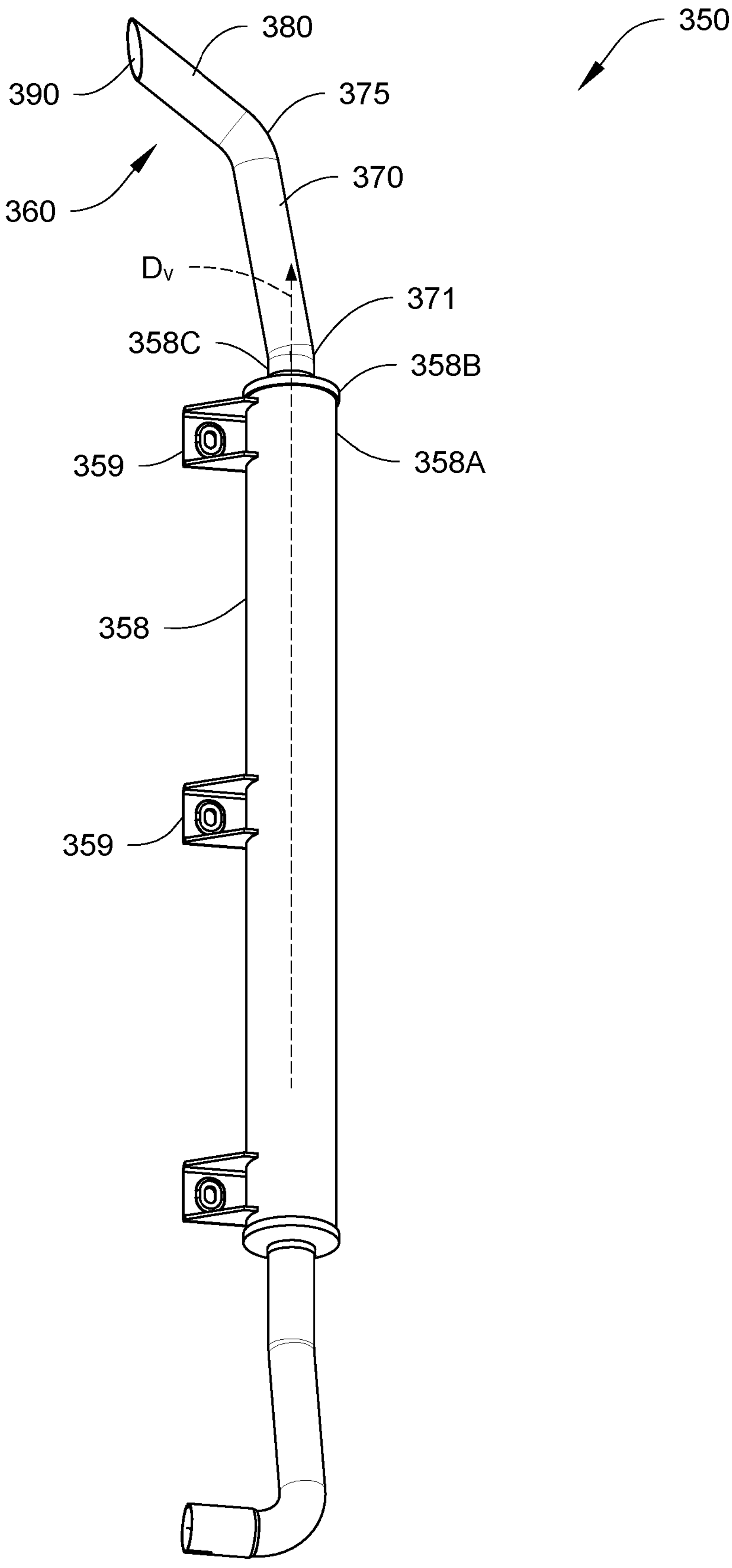

Fig. 3B

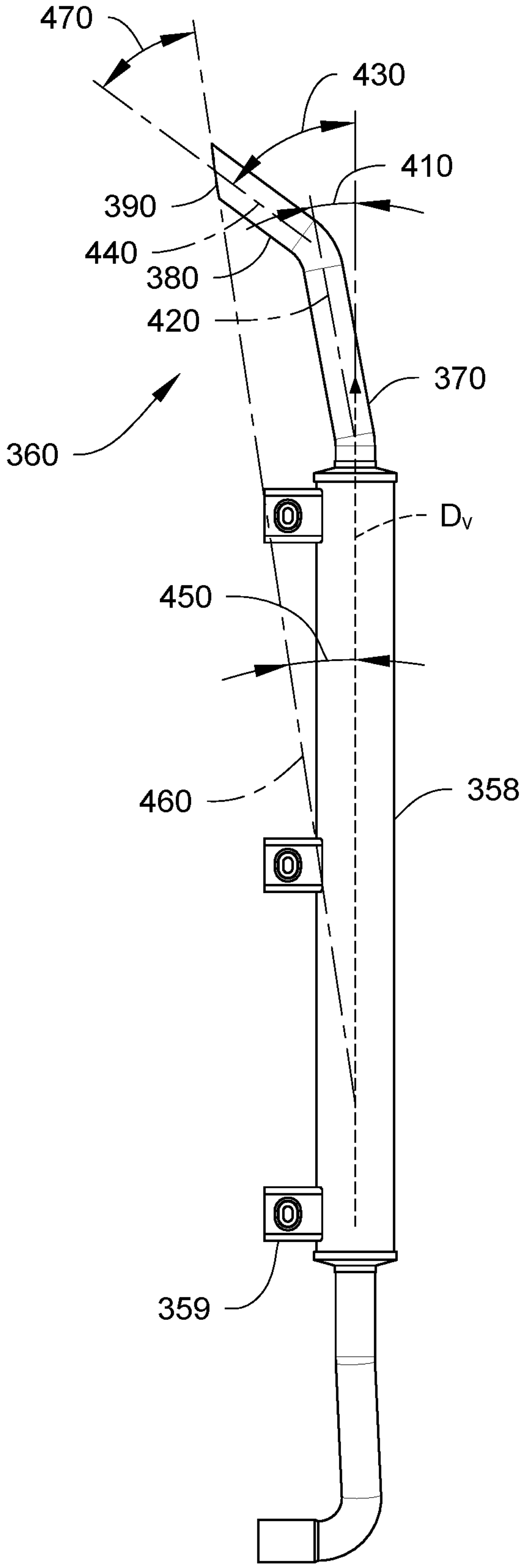
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Fig. 3C

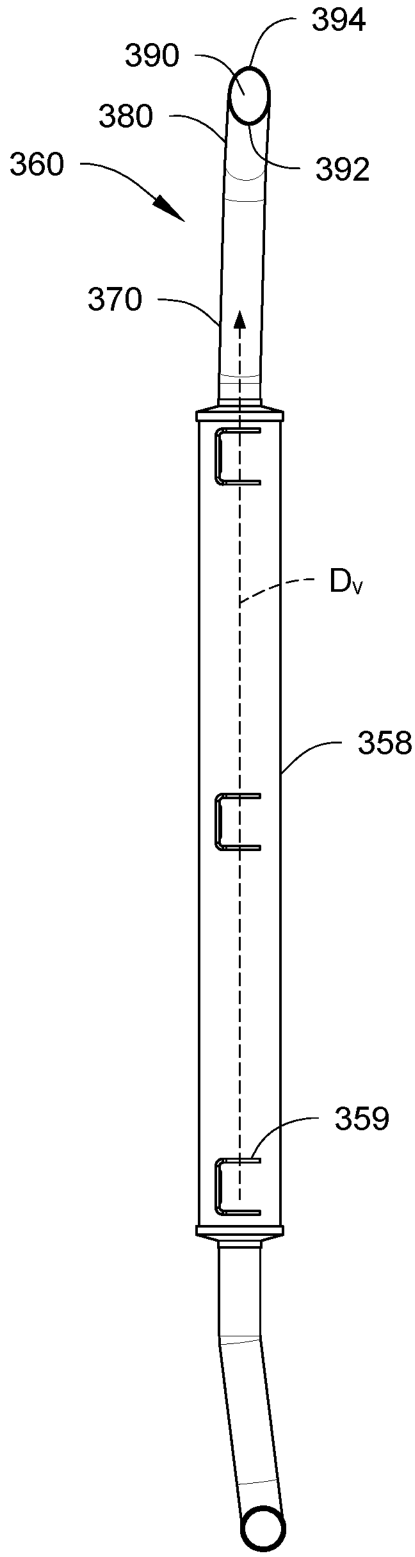
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Fig. 4A

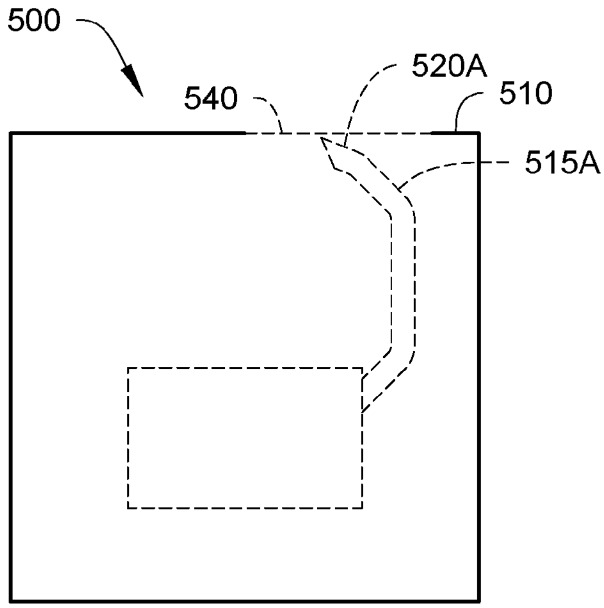


Fig. 4B

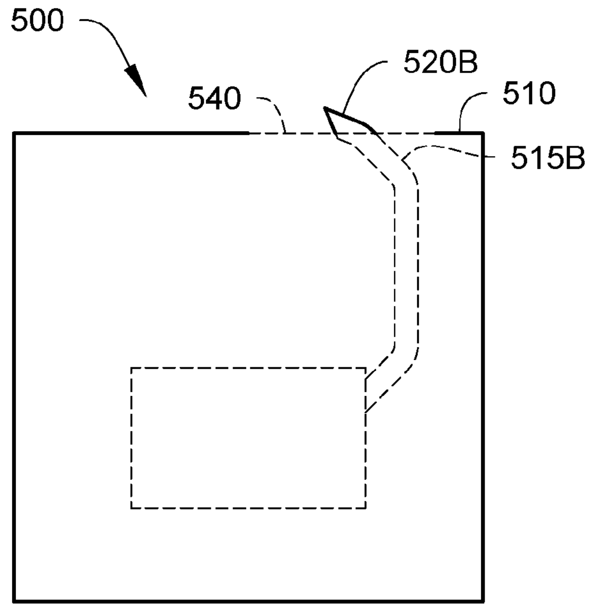
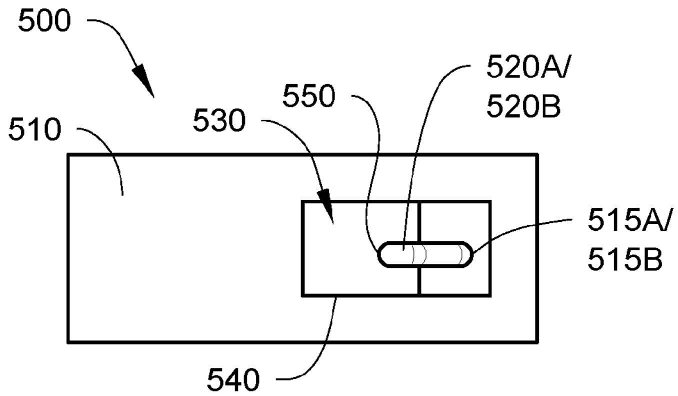


Fig. 4C



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EUROPEAN SEARCH REPORT

Application Number
EP 24 19 8910

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2 887 032 A (WACHTER JR PAUL H) 19 May 1959 (1959-05-19) * column 1, line 57 - column 2, line 71; figures 1-4 * -----	1,5,6,8, 12,13,15	INV. F01N13/08
X	US 2014/020638 A1 (PARK SEONG-CHEOL [KR]) 23 January 2014 (2014-01-23) * paragraph [0028] - paragraph [0055]; figures 1,4 * -----	1-4, 7-11,14, 15	

TECHNICAL FIELDS SEARCHED (IPC)
F01N

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	27 November 2024	Zebst, Marc

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

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27-11-2024

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