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(54) **Title**: REDUCTANT HEATER

(57) **Abstract**: A reductant heating system may include a reductant tank, a reductant tank flange and a hollow tube residing within the reductant tank and passing through the reductant tank flange in two locations to carry coolant into and out of the reductant tank. The reductant heating system may further include a resistive wire wrapped around the hollow tube within the reductant tank and an electrical supply cord located outside of the reductant tank that supplies electrical power to the resistive wire. A temperature detector may be disposed within the reductant tank to detect a temperature within the reductant tank and govern electricity flow to the resistive wire. That is, the temperature detector may be wired in-line in the resistive wire and may be a thermal switch attached to the hollow tube. In another embodiment, the temperature detector may be a thermocouple that senses a temperature within the reductant tank.

REDUCTANT HEATER

FIELD

[0001] The present disclosure relates to an apparatus and a method of control for heating a reductant in an exhaust treatment system.

BACKGROUND

[0002] This section provides background information related to the present disclosure which is not necessarily prior art. Selective Catalytic Reduction (SCR) is a widely accepted technology for treating emission of nitrogen oxides (NOx) from lean engine exhaust. The most common, commercially available SCR deNOx system is urea-SCR which uses aqueous urea solution and employs a thermolysis/hydrolysis procedure to generate ammonia (NH3) from urea for NOx reduction over the SCR catalyst. The major challenges for the liquid urea system are its relatively high hardware costs and complicated control requirements. Another disadvantage is that the urea solution contains excess water (more than needed for hydrolysis), which necessitates a large storage tank. Still yet, another disadvantage is that reductants, such as urea, may freeze within the storage tank. If such a reductant is unable to thaw, a reductant pump may not prime and there is potential for a reductant injector on the exhaust pipe to fail.

[0003] What is needed then is a device and method for heating a reductant.

SUMMARY

[0004] This section provides a general summary of disclosure material, and is not a comprehensive disclosure of full scope or of all disclosure features. A reductant heating system may include a reductant tank, a reductant tank flange and a hollow tube residing within the reductant tank that passes through the reductant tank flange in a first location to carry coolant into the reductant tank. The hollow tube may pass through the reductant tank flange at a second location to carry coolant from the reductant tank. The reductant heating system may further include a resistive wire wrapped around the hollow tube within the reductant tank and an electrical supply cord located outside of the reductant tank that supplies electrical power to the resistive wire. A temperature detector may be disposed within the reductant tank to detect a temperature within the reductant tank and govern electricity flow to the resistive wire. The temperature detector may be wired in-line in the resistive wire and may be a thermal switch attached to the hollow tube. Alternatively, the temperature detector may be a thermocouple that senses a temperature within the reductant tank. Heating the resistive wire heats a reductant within the tank.

[0005] A 120 volt electrical source may supply electrical energy to a 120 electrical supply cord that supplies power to the resistive wire. A controller may be disposed outside of the reductant tank and may be wired in-line with the electrical supply cord and receive communications from the thermocouple. An engine block heater may also be electrically wired to the 120 volt electrical source such that both, the engine block heater and the resistive wire are powered by 120 volt household or commercial power source. The engine block heater and the resistive wire may be operated at the same time.

[0006] A method of controlling a reductant heating system may entail providing a hollow tube, such as for passage of an engine coolant, wrapped with a resistive wire into a reductant tank, providing an electrical supply cord located outside the reductant tank that supplies electricity to the resistive wire located inside the reductant tank, providing a temperature detector in-line in the resistive wire, and connecting the electrical supply cord to a 120 volt electrical source.

[0007] The method of controlling a reductant heating system may further entail detecting a temperature with the temperature detector and closing electrical contacts within the temperature detector permitting electricity to flow through the resistive wire, thus heating the resistive wire and interior volume of the reductant tank, including a reductant. The method may further entail detecting a temperature with the temperature detector and opening electrical contacts within the temperature detector thereby causing electricity to stop flowing through the resistive wire thereby preventing any supply of heat.

[0008] The temperature detector may be a thermocouple and the method may further entail providing a controller in-line with the electrical supply cord, and providing a communication wire between the thermocouple and the controller. The method may then involve detecting a temperature with the thermocouple and providing a signal from the thermocouple to the controller and permitting electricity to flow through the resistive wire. Alternatively, providing a signal from the thermocouple to the controller may cause the controller to control in such a way thereby preventing electricity from flowing through the resistive wire.

[0009] Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

[0010] The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

[0011] Figure 1 is a schematic view of a control system for reducing nitrogen oxides in an engine exhaust on a vehicle in accordance with the present disclosure;

[0012] Figure 2 is an enlarged side view depicting a reductant heater and associated controls in accordance with the present disclosure;

[0013] Figure 3 is an enlarged perspective view depicting a reductant heater in accordance with the present disclosure;

[0014] Figure 4 is an enlarged view of a reductant tube wrapped by an electric heating element in accordance with the present disclosure;

[0015] Figure 5 is a flowchart depicting a method of control for heating a reductant of an emission control system; and

[0016] Figure 6 is a flowchart depicting a method of control for heating a reductant of an emission control system.

[0017] Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

[0018] Example embodiments will now be described more fully with reference to Figures 1-6 of the accompanying drawings. Figure 1 depicts an emissions control system 10 situated within and utilized by an exemplary vehicle

12, such as an automobile or a truck. Regardless of a particular weight class within which vehicle 12 may be categorized, vehicle 12 may be equipped with an engine 14, which may be appropriately sized. Engine 14 may be a gasoline fueled spark ignition engine or may be a diesel fueled compression engine. Fuels for a gasoline engine may include gasoline, E85, E95 or other similar fuels. Fuels for a diesel engine may include diesel fuel, bio fuel B5, B10, B20 or other similar fuels. Engine 14 may have an exhaust port 16 that discharges combusted exhaust gases into an exhaust conduit 18, also known as an exhaust pipe. An exhaust stream 20 of engine 14 flows from exhaust port 16 of engine 14 and through exhaust conduit 18 to an injector 22. Injector 22 may be a reductant injector that is positioned upon or through a wall of exhaust conduit 18 to inject a reductant into exhaust stream 20 flowing through exhaust conduit 18. An emissions catalyst 24 having an emissions catalyst inlet 26 and an emissions catalyst outlet 28 may be positioned downstream of injector 22 and is in receipt of exhaust stream 20 such that exhaust stream 20 is required to flow through emissions catalyst 24.

[0019] A fuel tank 30 may be mounted to vehicle 12 to store fuel, such as diesel fuel, for engine 14. Fuel tank 30 may supply fuel to engine 14 via a fuel supply line 32 such that fuel may be selectively supplied to combustion chambers of engine 14. A reductant tank 34 also may be mounted to vehicle 12 and may store a reductant such as urea, or the like. In one example, and with reference including Figure 2, a user may fill reductant tank 34 by conventional methods such as by dispensing reductant through a dedicated reductant tank filler neck 38 that permits access to fill reductant tank 34. Reductant tank filler neck 38 may be equipped with a removable filler neck cap 40. A reductant level sensor 42 may be provided in reductant tank 34 to communicate a reductant volume signal through a signal line 44 to a controller 66, or other controller associated with injector 22. A reductant supply line 36 may be configured to fluidly communicate the reductant from reductant tank 34 to injector 22 as long as reductant level sensor 42 senses reductant 45. An optional recirculation line 48 may be used to allow high injection pressures and/or maintain reductant flow through injector 22 for injector cooling purposes.

[0020] As depicted in Figures 1 and 2, a reductant heating system 50 may be part of emission control system 10. Reductant heating system 50 may include reductant tank 34, a coolant in tube 52, a coolant out tube 54, a coolant u-tube 56, and a reductant tank flange 58. Coolant in tube 52 and coolant out tube 54 may both pass through reductant tank flange 58, which may be easily removable from a top surface 60 of reductant tank 34, or other surface of reductant tank 34, such as a bottom surface 59. A threaded engagement may make the reductant tank flange 58 easily removable from reductant tank 34. Coolant in tube 52, coolant out tube 54, and coolant u-tube 56 may be formed as a monolithic one-piece hollow tube 82.

[0021] Other components of reductant heating system 50 may include a resistive heating wire 62, which may be wrapped around tubing within reductant tank 34. When resistive heating wire 62 is energized with electricity, heat produced by electrical resistance transfers to tubing of u-tube 56 and surrounding frozen or liquid reductant, as will be further explained later. Resistive heating wire 62 may be circular in cross-section or may be relatively flat or oval in cross-section. Other cross-sectional shapes of resistive heating wire 62 are conceivable. While resistive heating wire 62 may be located inside a volume of reductant tank 34, a 120 volt electrical supply cord 64 may be located outside of a volume of reductant tank 34 and carry or supply electricity to resistive heating wire 62. Controller 66 may be located in an in-line fashion within 120 volt electrical supply cord 64, which may be divided into two electrical branches as depicted in Figure 2.

[0022] One-hundred twenty (120) volt electrical supply cord 64 may derive its electrical energy through a 120 volt electrical plug 70, which may be the same or similar to those used in residential or commercial businesses in the United States or equivalent outside of the USA. 120 volt electrical supply cord 64 may also supply or provide electrical energy to electrical cord 72 which supplies electrical energy to a block heater 74, which may reside in an engine block of engine 14.

[0023] Figures 3 and 4 depict enlarged perspective views of portions of reductant heating system 50. Figure 3 depicts coolant in tube 52, coolant out tube 54, and coolant u-tube 56. Figure 3 also depicts a reductant level sending unit 84, which may be an alternative to level sensor 42. Reductant level sending unit 84 may be a manual float type of system which may detect a level of reductant within reductant tank 34. A base 86 of reductant level sending unit 84 may contact a bottom inside surface 87 of reductant tank 34 when flange 58 resides on tank top surface 60. Figure 2 depicts base 86 removed from u-tube 56 for clarity. Figure 4 depicts resistive wire 62 wrapped around a straight portion of tube 82 such that an outside surface of resistive wire 62 contacts an outside surface of tube 82. More specifically, resistive wire 62 may be encased in an insulator, which may contact an outside surface of tube 82. Although u-tube 56 is depicted in various figures in conjunction with a coolant passage through a volume of reductant tank 34, various configurations or shapes other than u-tube 56 are envisioned in connection with the present disclosure. Such configurations may be dictated by the shape of reductant tank 34 or heat transfer characteristics of tube 82 and heat transfer characteristics of resistive wire 62.

[0024] Figure 5 is a flowchart 100 depicting a method of control for heating a reductant of an emission control system. Method steps of flowchart 100 begin at start block 102 and proceed to block 104 where a 120 volt electrical plug 70 of a block heater 74 may be plugged into a 120 volt source, such as a wall receptacle 88 of a residential or commercial building wall 91 that is supplied with 120 volt electrical power. Before plugging in 120 volt electrical plug 70, engine 14 may be turned off. When electrical plug 70 is plugged into a receptacle 88, electrical energy may pass through 120 volt electrical supply cord 64. Upon connecting electrical plug 70 of block heater 74 into a 120 volt source, the method proceeds to block 106 where an inquiry is made as to whether a temperature of reductant is less than a predetermined threshold temperature. If the response to the inquiry of inquiry block 106 is affirmative, then the method proceeds to block 108 where a temperature detector such as a thermal switch 90 closes thereby causing electrical energy to activate or energize the resistive wire 62 wrapped around tube 82 within reductant tank 34. However, if the response to the inquiry of inquiry block 106 is negative, then the method proceeds to block 110 where thermal switch 90 opens or remains open thereby preventing electrical energy from activating or energizing resistive wire 62 wrapped around tube 82 within reductant tank 34.

[0025] To either cause electrical energy to activate or energize resistive wire 62 wrapped around tube 82 or to not activate and prevent electrical energy from energizing resistive wire 62 wrapped around tube 82, switch 90 may be a thermally-activated in-line switch that opens or closes switch contacts in accordance with a predetermined temperature to which switch 90 is subjected or exposed. Closing of contacts may permit electrical energy to flow through resistive wire 62 thereby heating reductant within reductant tank 34, while opening of contacts may prevent electrical energy from flowing through resistive wire 62 thereby preventing any heating of reductant within reductant tank 34.

[0026] Figure 6 is a flowchart 200 depicting a method of control for heating a frozen or liquid reductant of an emission control system. The method of flowchart 200 begins at start block 202 and proceeds to block 204 where a 120 volt electrical plug 70 of a block heater 74 is plugged into a 120 volt source, such as a wall receptacle 88 of a residential or commercial building wall 91 that is supplied with 120 volt electrical power. When electrical plug 70 is plugged into a receptacle 88, electrical energy may pass through 120 volt electrical supply cord 64. Upon connecting electrical plug 70 of block heater 74 into a 120 volt source, the method proceeds to block 206 where a thermocouple 92 reads or detects a temperature of frozen reductant or liquid (non-frozen) reductant within reductant tank 34. Thermocouple 92 may communicate directly with reductant tank heat controller 66 via a communication wire 94 (Figures 1 and 2).

[0027] Control within flowchart 200 proceeds to inquiry block 208 where an inquiry is made as to whether a temperature of reductant sensed by thermocouple 92 is less than a predetermined threshold temperature, such as a threshold “ON” temperature. If the response to the inquiry of inquiry block 208 is affirmative, then the method proceeds to block 210 where controller 66 permits the flow of electricity to resistive wire 62 wrapped around tube 82 within reductant tank 34. Flow of electricity causes heating of resistive wire 62 and tube 82 to heat reductant within reductant tank 34. However, if the response to the inquiry of inquiry block 208 is negative, then the method proceeds to block

212 where controller 66 prevents the flow of electricity to resistive wire 62 wrapped around tube 82 within reductant tank 34. With no flow of electricity to resistive wire 62, resistive wire 62 and tubing 82 do not heat within reductant tank 34, thereby preventing any heating of reductant within reductant tank 34 by resistive wire 62. Thus, reductant tank heat controller 66 may act as a gateway for electricity supplied to resistive wire 62 wrapped around tube 82, which may be formed into coolant u-tube 56, for example. Thus, controller 66 and thermocouple 92 communicate via communication wire 94.

[0028] Reductant heating system 50 may employ reductant tank 34, hollow tube 82 passing into and from reductant tank 34 that carries a flowing coolant, such as an engine coolant, resistive wire 62 wrapped around hollow tube 82, and temperature detector 90 disposed within reductant tank 34 to detect a temperature within reductant tank 34 and govern electricity flow to resistive wire 62. Reductant tank flange 58 may be arranged over a hole or aperture in reductant tank 34 such that hollow tube 82 residing within the reductant tank may pass through reductant tank flange 58 in a first location to carry coolant into reductant tank 34 and through reductant tank flange 58 at a second location to carry coolant from reductant tank 58. Coolant flowing through tube 82 may be an engine coolant that warms reductant within reductant tank 34 when engine 14 is running and engine 14 heats engine coolant. Coolant flowing through reductant tank flange 58 in a first location and through reductant tank flange 58 at a second location may be part of an engine coolant loop, which includes coolant circulating through a water jacket around engine block of engine 14.

[0029] Temperature detector 90 may be a thermal switch disposed in-line in resistive wire 62 to control electricity flow in accordance with a sensed temperature. Resistive wire 62 may be electrically connected to a 120 volt electrical source, such as at a household or commercial building. In some instances, resistive wire 62 only may be electrically connected to a 120 volt electrical source (i.e. household or commercial building current), and not vehicle-supplied or vehicle-generated current. The temperature detector may be thermocouple 92 and controller 66 may be wired in-line with 120 volt electrical source that communicates with the thermocouple. Controller 66 may be disposed outside of reductant tank 34. The temperature detector may be wired in-line in resistive wire 62. The temperature detector, regardless of whether it is a thermal switch or a thermocouple, may be attached to hollow tube 82.

[0030] Engine block heater 74 may be electrically wired to 120 volt electrical source receptacle 88, which may supply electrical power to engine block heater 74 and resistive wire 62 at the same time through electrical supply cord 64. That is, engine block heater 74 and resistive wire 62 may not be powered by vehicle-generated electricity (e.g. a generator) and may not be powered by an on-board battery.

[0031] A method of controlling a reductant heating system 50 may entail providing hollow tube 82 wrapped with resistive wire 62 into reductant tank 34, providing electrical supply cord 64 located outside reductant tank 34 to supply electricity to resistive wire 62 located inside reductant tank 34, providing a temperature detector 90, 92, which may be in-line in resistive wire 62, and connecting electrical supply cord 64 to a 120 volt electrical source.

[0032] The method may further entail detecting a temperature with temperature detector 92 and closing electrical contacts within temperature detector 92 thereby permitting electricity to flow through resistive wire 62, or detecting a temperature with temperature detector 92 and opening electrical contacts within temperature detector 92 thereby preventing electricity from flowing through resistive wire 62. Temperature detector 92 may, for example, work on the principles of a bi-metallic strip such that one or more metal tabs move (e.g. closing or opening contact) as a result of temperature changes.

[0033] The temperature detector may be thermocouple 92 and the method may further entail providing controller 66 in-line with electrical supply cord 64, providing communication wire 94 between thermocouple 92 and controller 66, detecting a temperature with thermocouple 92, and providing a signal from thermocouple 92 to controller 66 and permitting electricity to flow through resistive wire 62 or providing a signal from thermocouple 92 to controller 66 and preventing electricity from flowing through resistive wire 62.

[0034] While the present disclosure may utilize 120 volt power supplied by a 120 volt household or commercial power source, an auxiliary power unit 214 (“APU”) may be utilized as an alternative to a 120 volt household or commercial power source. The auxiliary power unit 214 (“APU”) may be an on-board power unit. That is, an on-board power unit may be a power unit, such as an internal combustion engine coupled with an electrical generator that is completely contained upon a vehicle, with no wires or other connections to a residential or commercial building. More specifically, as depicted in Figure 1, an auxiliary power unit 214 may be employed to supply electrical power through an auxiliary power unit cord 216, which may derive its electrical energy. Auxiliary power unit cord 216 may also supply or provide electrical energy to electrical cord 72 which supplies electrical energy to a block heater 74, which may reside in an engine block of engine 14, as described above.

[0035] Auxiliary power unit 214 may be a gasoline or diesel engine and may employ a generator that is capable of providing a range of power. For example, auxiliary power unit 214 may supply 6500 Watts of power to power block heater 74 and reductant heating system 50. However, auxiliary power unit 214 may be sized to supply any level of power (e.g. watts) or a range of power, depending upon the electrical draw or load of block heater 74 and reductant heating system 50. Auxiliary power unit 214 may be equipped with electric start, remote start, remote glow plug if powered by a diesel engine, and may be equipped with 20A breakers, for example, although precise configuration may be determined by the loads (e.g. block heater 74 and reductant heating system 50) to be supplied. An advantage of utilizing APU 214 is that vehicle 12 may be able to power block heater 74 and reductant heating system 50 even when 120 volt household or commercial power source is not available. Thus, vehicle 12 may be completely self-sustaining with regard to powering block heater 74 and reductant heating system 50. In one configuration, APU 214 may utilize an 11 HP diesel engine, which when equipped with a 6500 W generator, may generate 46A at 120V, 23A at 240V, and 8.3A at 12V. Other power output configurations are conceivable. When APU 214 is operating and supplying electrical power to block heater 74 and reductant heating system 50, 120 volt electrical plug 70 will not be plugged into a 120 volt household or commercial power source.

[0036] There are multiple advantages of the present disclosure. One aspect is that the electrical heating wrap may be plugged into land-based electrical supply voltage (e.g. residential or commercially available 120v voltage source) to permit heating of frozen, semi-frozen, or liquid reductant within reductant tank 34 at the same time that an engine block heater is operating from the same 120 volt electrical supply to warm an engine 14, such as a diesel engine used within a diesel road tractor, on-road equipment or off-road equipment. Another aspect is that instead of utilizing a land-based electrical supply voltage (e.g. residential or commercially available 120v voltage source), APU 214 may utilize an on-board diesel or gasoline engine equipped with a power generator, which may generate the requisite amperes and voltage to power block heater 74 and reductant heating system 50. In such a manner, reductant within a reductant tank may thaw and will not be frozen and thus be waiting and ready to be used for NOx reduction upon starting of an engine employing reductant tank 34. Thus, waiting for frozen reductant to thaw will not be necessary which greatly reduces the time necessary for an emission control system 10 to begin emitting environmentally friendly exhaust from an exhaust tail pipe outlet.

[0037] Methods depicted in Figures 5 and 6 may be applied to a vehicle whose engine is not running or operating. Thus, engine 14 may be turned off as a process step of the processes described above in conjunction with Figures 5 and 6. When engine 14 starts, controller 66 may or may not be configured to stop electricity from flowing through resistive wire 62.

[0038] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

CLAIMS

What is claimed is:

1. A reductant heating system comprising:

a reductant tank;

a hollow tube passing into and from the reductant tank, the hollow tube containing a coolant;

a resistive wire wrapped around the hollow tube; and

a temperature detector disposed within the reductant tank to detect a temperature within the reductant tank and govern electricity flow to the resistive wire.

2. The reductant heating system according to claim 1, wherein the temperature detector is a thermal switch.

3. The reductant heating system according to claim 2, wherein the thermal switch is disposed in-line in the resistive wire to control electricity flow in accordance with a sensed temperature.

4. The reductant heating system according to claim 3, wherein the resistive wire is electrically connected to a 120 volt electrical source.

5. The reductant heating system according to claim 1, wherein the temperature detector is a thermocouple and the reductant heating system further comprises:

a 120 volt electrical source; and

a controller wired in-line with the 120 volt electrical source that communicates with the thermocouple.

6. The reductant heating system according to claim 5, further comprising:

an engine block heater electrically wired to the 120 volt electrical source, wherein the 120 volt electrical source supplies electrical power to the engine block heater and the resistive wire at the same time.

7. The reductant heating system according to claim 5, further comprising:

an auxiliary power unit, wherein the auxiliary power unit is the 120 volt electrical source.

8. The reductant heating system according to claim 7, further comprising:

a vehicle, wherein the auxiliary power unit is completely contained upon the vehicle.

9. A reductant heating system comprising:

a reductant tank;

a reductant tank flange;

a hollow tube residing within the reductant tank and passing through the reductant tank flange in a first location to carry coolant into the reductant tank and through the reductant tank flange at a second location to carry coolant from the reductant tank;

a resistive wire wrapped around the hollow tube within the reductant tank;

an electrical supply cord located outside of the reductant tank that supplies electrical power to the resistive wire; and

a temperature detector disposed within the reductant tank to detect a temperature within the reductant tank and govern electricity flow to the resistive wire.

10. The reductant heating system according to claim 9, wherein the temperature detector is wired in-line in the resistive wire.

11. The reductant heating system according to claim 10, wherein the temperature detector is a thermal switch attached to the hollow tube.

12. The reductant heating system according to claim 10, wherein the temperature detector is a thermocouple that senses a temperature within the reductant tank.

13. The reductant heating system according to claim 12, further comprising:

a 120 volt electrical source, the electrical supply cord electrically connected to the 120 volt electrical source; and

a controller wired in-line with the electrical supply cord, the controller in communication with the thermocouple.

14. The reductant heating system according to claim 13, further comprising:

an engine block heater, wherein the engine block heater is electrically wired to the 120 volt electrical source.

15. The reductant heating system according to claim 14, wherein the controller is disposed outside of the reductant tank.

16. The reductant heating system according to claim 15, further comprising:

a reductant level sensor connected to the hollow tube residing within the reductant tank.

17. The reductant heating system according to claim 13, further comprising:

an auxiliary power unit, wherein the auxiliary power unit is the 120 volt electrical source.

18. The reductant heating system according to claim 17, further comprising:

a vehicle, wherein the auxiliary power unit is completely contained upon the vehicle.

19. A method of controlling a reductant heating system, the method comprising:

providing a hollow tube wrapped with a resistive wire into a reductant tank;

providing an electrical supply cord located outside the reductant tank that supplies electricity to the resistive wire located inside the reductant tank;

providing a temperature detector in-line in the resistive wire;

connecting the electrical supply cord to a 120 volt electrical source;

detecting a temperature with the temperature detector; and

selectively supplying electricity from the source to the resistive wire based on the detected temperature.

20. The method of controlling a reductant heating system according to claim 19, the method further comprising:

closing electrical contacts within the temperature detector permitting electricity to flow through the resistive wire.

21. The method of controlling a reductant heating system according to claim 19, the method further comprising:

opening electrical contacts within the temperature detector causing electricity to stop flowing through the resistive wire.

22. The method of controlling a reductant heating system according to claim 19, wherein the temperature detector is a thermocouple, the method further comprising:

providing a controller in-line with the electrical supply cord; and

providing a communication wire between the thermocouple and the controller.

23. The method of controlling a reductant heating system according to claim 22, the method further comprising:

detecting a temperature with the thermocouple; and providing a signal from the thermocouple to the controller and permitting electricity to flow through the resistive wire.

24. The method of controlling a reductant heating system according to claim 22, the method further comprising:

detecting a temperature with the thermocouple; and

providing a signal from the thermocouple to the controller and preventing electricity from flowing through the resistive wire.

25. The method of controlling a reductant heating system according to claim 19, further comprising:

providing an auxiliary power unit, wherein the auxiliary power unit is the 120 volt electrical source.

26. The method of controlling a reductant heating system according to claim 25, further comprising:

providing a vehicle, wherein the auxiliary power unit is completely contained upon the vehicle.

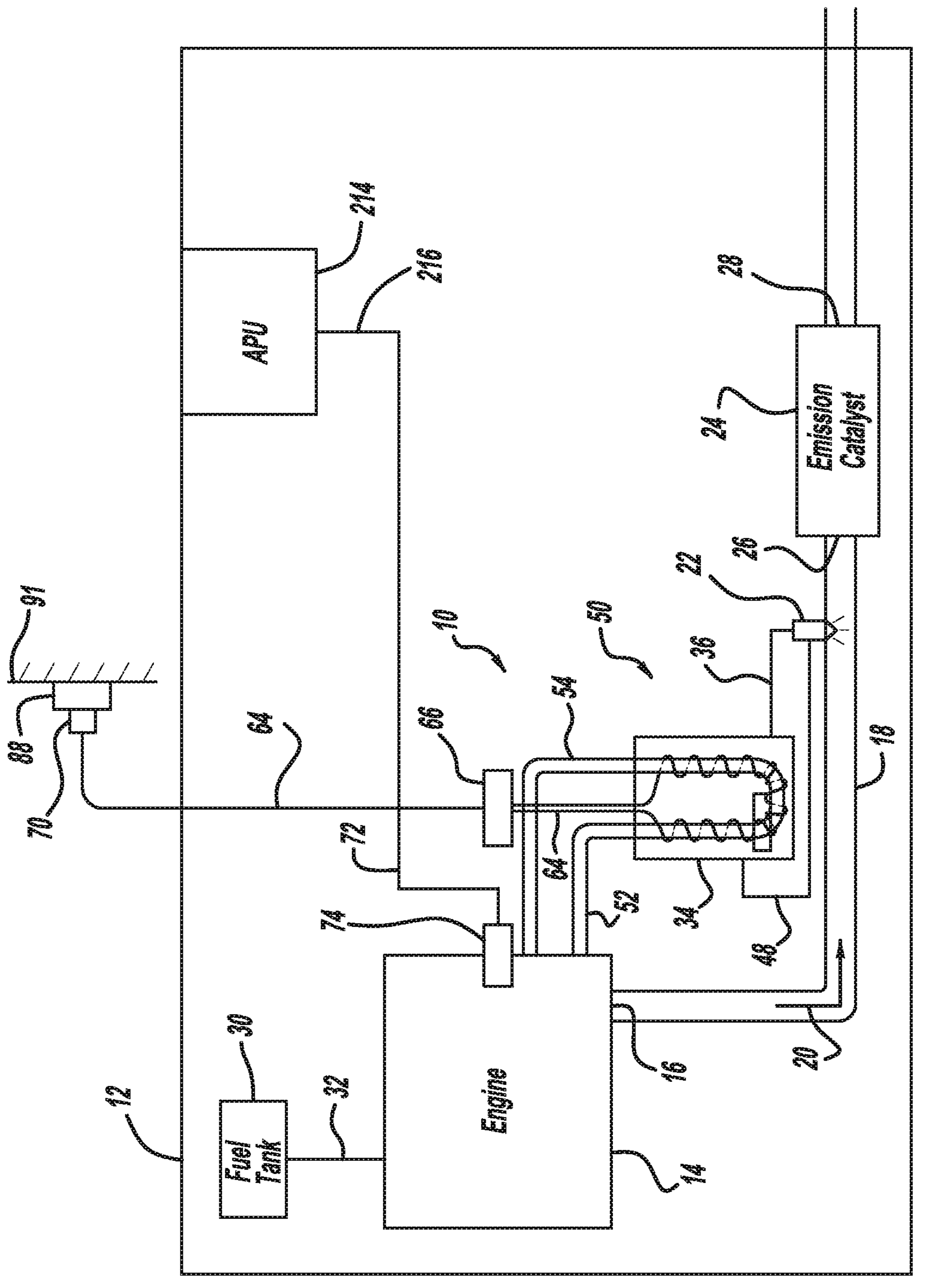
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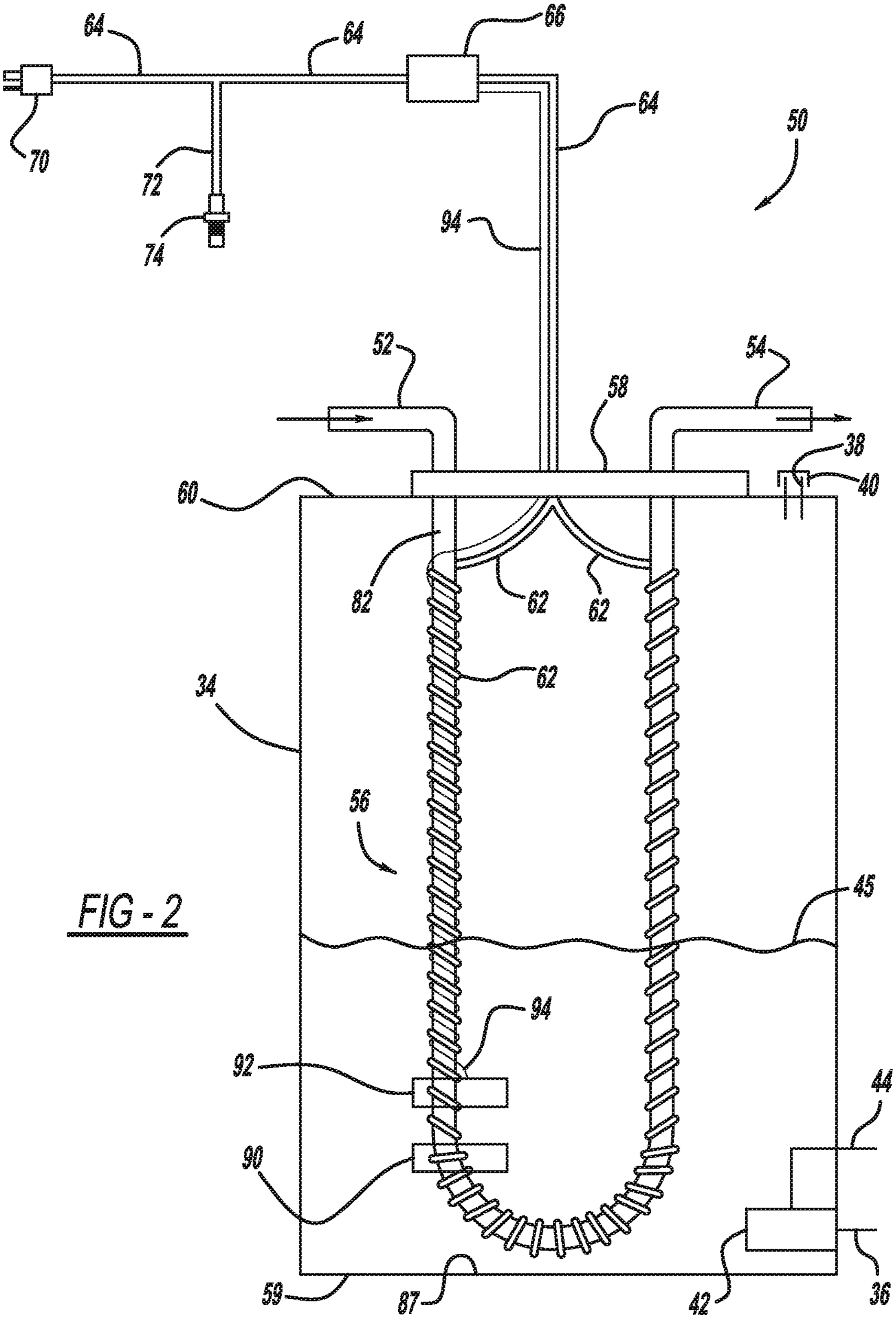
FIG - 1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38
40
60
82
62
62
62
34
56
45
94
92
90
44
42
36
59
87

FIG - 2

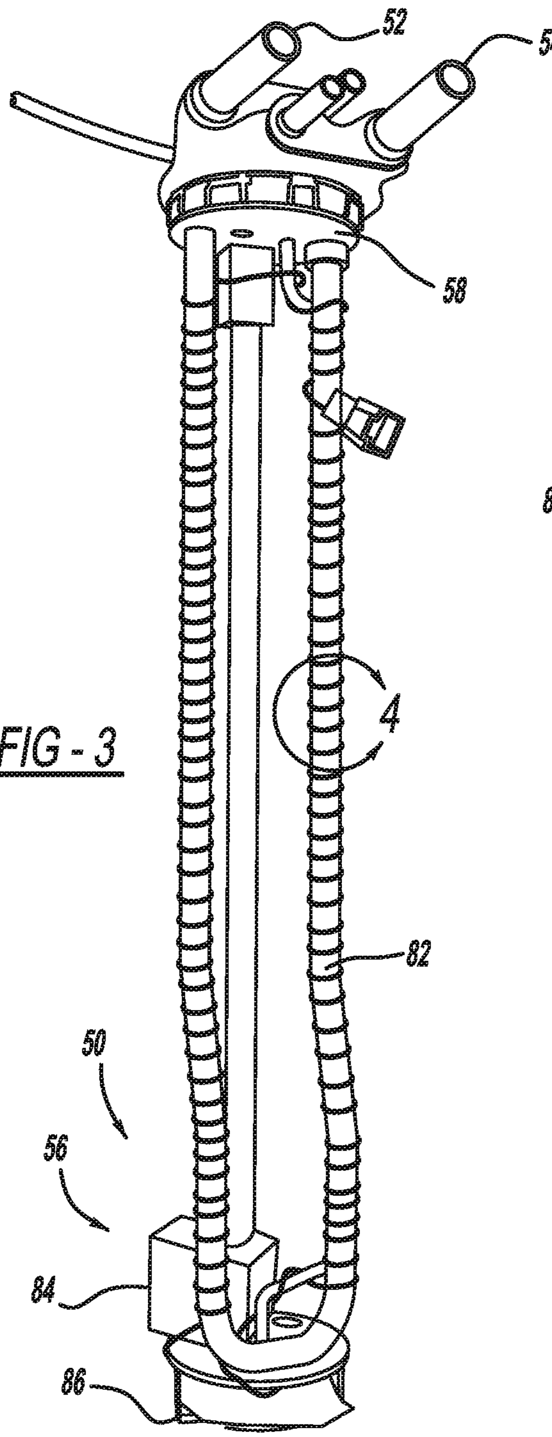

FIG - 3

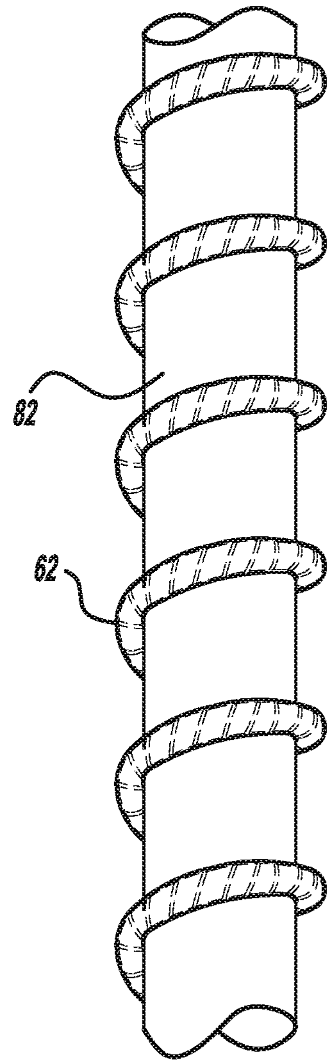

FIG - 4

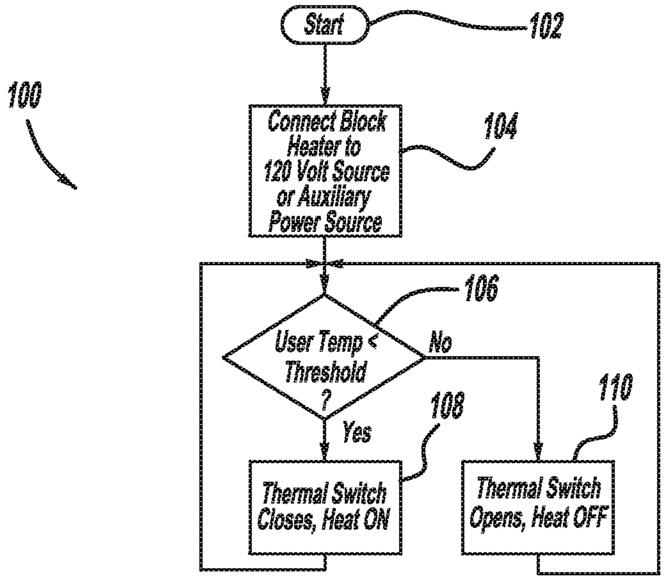
Start
102
100
Connect Block Heater to 120 Volt Source or Auxiliary Power Source
104
106
User Temp < Threshold ?
No
Yes
108
110
Thermal Switch Closes, Heat ON
Thermal Switch Opens, Heat OFF

FIG - 5

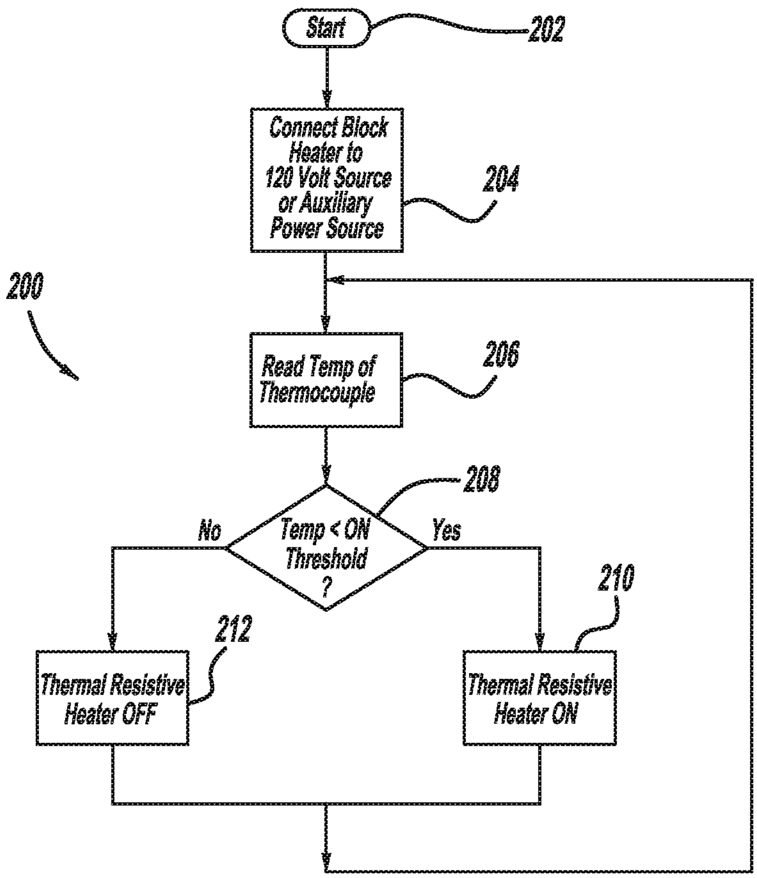
Start
202
Connect Block Heater to 120 Volt Source or Auxiliary Power Source
204
200
Read Temp of Thermocouple
206
208
Temp < ON Threshold ?
No
Yes
210
212
Thermal Resistive Heater OFF
Thermal Resistive Heater ON

FIG - 6