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(54) **Title:** AUXILIARY POWER UNIT AND HEATING SYSTEM FOR A VEHICLE CABIN

(57) Abstract: An auxiliary power unit APU (2) is adapted to be in fluid communication with a fuel-fired water heater (6). A valve (10) is provided to selectively control fluid flow between the APU, a primary engine (8), the fuel-fired water heater, and an HVAC system (4).

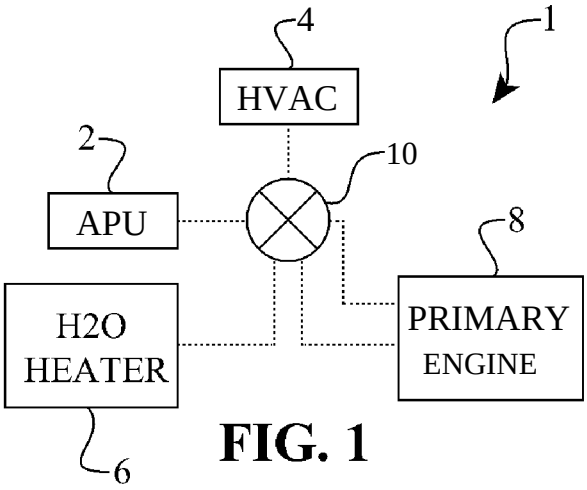

FIG. 1

AUXILIARY POWER UNIT AND HEATING SYSTEM FOR A VEHICLE CABIN

[0001] This application claims the benefit of, and hereby incorporates by reference in its entirety, U.S. Provisional Application 61/583,071, filed on January 4, 2012.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The field of the invention relates generally to devices and methods for providing auxiliary air conditioning, heating, and power to a vehicle.

Description of the Related Art

[0003] Auxiliary power units are often used in cross-country trucks that are equipped with a sleeper compartment located behind a truck cab so that the driver has a convenient place to sleep while in route. An Auxiliary Power Unit (APU) allows the driver to use its truck amenities like heat, air conditioning, microwave, television, etc. without running the engine, which reduces emissions. See, for example, U.S. Patent No. 5,333,678 to Mellum. APUs are also used extensively in refrigerated trailers for maintaining cargo temperatures during transport and delivery.

[0004] APUs have become significantly more important in the heavy duty trucking industry because the Environmental Protection Agency (EPA) and the California Air Resource Board (CARB) have been developing and passing regulations that impact idling in an attempt to reduce emissions and pollution. The passage of these different regulations has impacted the trucking industry. In particular, it has affected the heavy duty (Class 8) sleeper tractor drivers who typically idle their vehicle for many hours each day. It is estimated that drivers are on the road five days per week. The federal law states that drivers are only allowed to be on the road a maximum of 14 hours a day with 10 hours down time required. Therefore, the sleeper cab industry has a large potential for APUs to reduce idling during the required downtime. Over half of the states in the U.S. have anti-idling regulations in place, and this number is projected to increase as more states adopt CARB regulations. Beyond the numerous federal and state regulations against idling, the industry is also facing idling regulations at the local and municipal levels as well. While their regulations vary by location, they all prohibit trucks from idling over three to five minutes. Some industry experts believe that the environmental agencies are gaining momentum in their initiative to put more pressure on the Federal government as well as on states

to make the idling regulations even more stringent in the coming years. If the environmental agencies succeed, some form of anti-idling technology (not just APUs) will become a necessity for truck drivers expanding beyond Class 8 sleeper tractors.

[0005] The rise and fall of diesel fuel prices continues to play a role in the adoption of idle reduction technology as users (particularly fleets) seek to lower their fuel consumption especially when diesel prices are high. When diesel fuel prices reached an all time high in 2008, demand for idle reduction technology increased because of the roughly 8% fuel savings they offer. In the long run, most industry experts expect diesel fuel prices to rise, which will again spark interest in APUs as they help to reduce fuel consumption as well as reducing wear and tear on the engine.

[0006] Most commercially available APU systems are provided with an auxiliary engine and an auxiliary generator that provide basic electrical support for a truck. The truck typically has a cab and a sleeper to which the APU provides auxiliary air conditioning and heating. The truck, in some cases, has a cab evaporator, a sleeper evaporator, a compressor, a condenser, and a plurality of refrigerant lines, a cab heater, a sleeper heater, and a plurality of coolant lines. Most APU's have a plurality of auxiliary coolant lines which are interconnected with the truck's coolant lines. The interconnection is accomplished in such a way that the APU can provide heat to the sleeper heater when the truck engine is running or when the truck is not running. See for example U.S. Patent No. 5,333,678 to Cummins. However, heat generation with the APU when the truck is not running can be inefficient. Therefore, there is a need for generating efficient and sufficient heat for the truck cab.

SUMMARY OF THE INVENTION

[0007] The systems and methods herein described have several features, no single one of which is solely responsible for its desirable attributes. Without limiting the scope as expressed by the claims that follow, its more prominent features will now be discussed briefly. After considering this discussion, and particularly after reading the section entitled "Detailed Description of Certain Inventive Embodiments" one will understand how the features of the system and methods provide several advantages over traditional systems and methods.

[0008] One aspect of the invention relates to an auxiliary power unit (APU) for a vehicle having a primary engine and a HVAC system. In one embodiment, the APU has an auxiliary engine and a valve in fluid communication with the auxiliary engine and the primary engine. The APU can have a fuel-fired water heater in fluid communication with the valve. The valve is adapted to selectively control flow between the auxiliary engine, the primary engine, the fuel-fired water heater, and the HVAC system.

[0009] Another aspect of the invention is directed to a method of controlling a heating system of a vehicle having a primary engine and a heater core. In one embodiment, the method includes the steps of providing an auxiliary power unit having an auxiliary engine and providing a water heater. The method can include providing a valve. The valve is in fluid communication with the water heater and the auxiliary engine. The method can include providing a controller in electrical communication with the auxiliary engine, the water heater, and the valve. In some embodiments, the method includes the step of receiving a signal indicative of a desired temperature of the heater core. The method can have the step of adjusting the valve to control a heated fluid flow to the heater core.

[0010] Yet another aspect of the invention concerns a heating system for a vehicle. The heating system has an engine operably coupled to the vehicle. The heating system has a heater core operably coupled to the interior of the vehicle. In one embodiment, the heating system has a valve hydraulically coupled to the engine. The valve is hydraulically coupled to the heater core. The heating system is provided with a fuel-fired heater hydraulically coupled to the valve. The valve is adapted to selectively divert a fluid flow from the fuel-fired heater to the heater core.

BRIEF DESCRIPTION OF THE FIGURES

[0011] Figure 1 is a schematic illustration of one embodiment of an auxiliary power unit (APU).

[0012] Figure 2 is a schematic diagram of an APU having a control system.

[0013] Figure 3 is a schematic diagram of a heating system for a truck.

[0014] Figure 4 is a schematic diagram of a heating system for a truck.

DETAILED DESCRIPTION OF CERTAIN INVENTIVE EMBODIMENTS

[0015] The preferred embodiments will be described now with reference to the accompanying figures, wherein like numerals refer to like elements throughout. The terminology used in the descriptions below is not to be interpreted in any limited or restrictive manner simply because it is used in conjunction with detailed descriptions of certain specific embodiments of the invention. Furthermore, embodiments of the invention can include several novel features, no single one of which is solely responsible for its desirable attributes or which is essential to practicing the inventions described. Certain APU embodiments described here are generally related to the type disclosed in U.S. Patent Application No 61/471,585. The entire disclosure of each of these patents and patent applications is hereby incorporated herein by reference.

[0016] As used here, the terms "operationally connected," "operationally coupled", "operationally linked", "operably connected", "operably coupled", "operably linked," and like terms, refer to a relationship (mechanical, linkage, coupling, etc.) between elements whereby operation of one element results in a corresponding, following, or simultaneous operation or actuation of a second element. It is noted that in using said terms to describe inventive embodiments, specific structures or mechanisms that link or couple the elements are typically described. However, unless otherwise specifically stated, when one of said terms is used, the term indicates that the actual linkage or coupling may take a variety of forms, which in certain instances will be readily apparent to a person of ordinary skill in the relevant technology.

[0017] One aspect of the invention disclosed here relates to auxiliary power units wherein a prime mover drives various driven devices. Auxiliary power units disclosed here can be used in various trucking and transport vehicles including, but not limited to, refrigeration trucks, recreational vehicles, buses, locomotives, service vehicles, trash trucks, marine vehicles, Class 3 and Class 8 trucks, among others. The prime mover can be, for example, an electrical motor and/or a combustion engine. For purposes of description here, an accessory includes any machine or device that can be powered by a prime mover. For purposes of illustration and not limitation, said machine or device can be a power takeoff device (PTO), pump, compressor, generator, auxiliary electric motor, etc. Accessory devices configured to be driven by a prime mover may also include refrigeration systems, alternators, water pumps, power steering pumps, fuel pumps, oil pumps, air conditioning compressors, cooling fans, superchargers, turbochargers and any other device that is typically powered by a prime mover. Embodiments disclosed here can be used to control the power delivered to the accessories powered by a prime mover.

[0018] Referring now to **Figure 1,** in one embodiment, a vehicle can be equipped with a system 1 that includes an auxiliary power unit 2, a heating-ventilation-air conditioning (HVAC) system 4, and a water heater 6. In some embodiments, the water heater 6 is a fuel-fired water heater. The HVAC system 4 and water heater 6 can be in fluid communication with the APU 2 and a primary engine 8. In one embodiment, a valve 10 is implemented to control fluid flow between the primary engine 8, the APU 2, the water heater 6, and the HVAC system 4. In some embodiments, the valve 10 is a bypass-type valve. In other embodiments, the valve 10 can be a 3-way type valve or any other suitable hydraulic valve for directing and proportioning flow to and from a hydraulic source.

[0019] Turning now to **Figure 2,** the APU 2 can include, among other things, an auxiliary engine 12 operably coupled to an auxiliary generator 14. In one embodiment, an auxiliary control system 20 can be used with, for example, the APU 2. For description purposes, the auxiliary engine 12 and the auxiliary generator 14, among other hardware, are depicted as

blocks in Figure 2. In some embodiments, the primary engine 8 is provided with a control system 16. The water heater 6 can be provided with a control system 18. In one embodiment, the control system 20 includes a controller 22 in electrical communication with a number of sensors 24, a data display and user interface 26, and an auxiliary engine actuator 28. The auxiliary engine actuator 28 can be operably coupled to the auxiliary engine 12 to thereby facilitate a change in operating condition of the auxiliary engine 14. In one embodiment, the controller 22 is in electrical communication with a valve actuator 29. The valve actuator 29 is adapted to facilitate adjustment of the valve 10. In one embodiment, the controller 22 includes electronic hardware 30 in electrical communication with control logic 32. In some embodiments, the sensors 24 are adapted to sense conditions of the auxiliary engine 12, the auxiliary generator 14, the primary engine 8, the HVAC system 4, and/or the water heater 6. For example, the sensors 24 can sense engine speed, generator speed, generator voltage, generator current, engine temperature, cabin temperature, water temperature, and any other variable common to operating an engine, an HVAC system, and/or a generator. In some embodiments, the data display and user interface 26 can be assessable on the interior of a vehicle, for example. In other embodiments, the data display and user interface 26 can be remotely mounted or in wireless communication with the controller 22, for example.

[0020] In yet other embodiments, the APU 2 can include a battery pack (not shown) configured to supply power to components of the HVAC system 4. The battery pack can in some embodiments take the place of at least the auxiliary engine 12, and provide power to the APU 2. The battery pack can be provided with a battery controller (also not shown) in communication with the controller 22 and electronic hardware 30.

[0021] Turning to **Figure 3** now, in one embodiment, a heating system 40 can include a primary engine 42 in fluid communication with a bypass valve 44. The bypass valve 44 can be in fluid communication with a heater core 46 and a fuel-fired heater 48. The heater core 46 can be installed in the cabin of a truck, for example. In one embodiment, the heating system 40 is provided with a controller 50 in electrical communication with the bypass valve 44. In some embodiments, the controller 50 is in electrical communication with a plurality of sensors and/or actuators operably coupled to, for example, the fuel-fired heater 48 and the primary engine 42.

[0022] During operation of the heater system 40, the fuel-fired heater 48 can supply heated fluid to the bypass valve 44 through a hydraulic supply line 52. The bypass valve 44 can route the heated fluid to the heater core 46 through a hydraulic supply line 54. During certain operating conditions, the primary engine 42 can supply heated fluid to the bypass valve 44 in unison with the fuel-fired heater 48 through a hydraulic supply line 56. The controller 50 can be

adapted to modulate the mixing of heated fluid from the fuel-fired heater 48 and the primary engine 42. In some embodiments, the fluid flow from the fuel-fired heater 48 and the primary engine 42 is mixed at the valve 44. The mixing of the fluid facilitates the delivery of heated fluid to the heater core 46 at a prescribed temperature. The temperature of the heated fluid delivered to the heater core 46 is based at least in part on a desired cabin temperature set by the user via, for example, a user interface such as the user interface 26. In one embodiment, fluid is returned to the bypass valve 44 from the heater core 46 through a hydraulic line 58. In some embodiments, fluid can be routed from the primary engine 42 to the fuel-fired heater 48 through a hydraulic line 60.

[0023] In one embodiment, the fuel-fired heater 48 can self-cycle based on an internal thermostat. The controller 50 may be used to monitor the temperature of the primary engine 42. If the temperature of the primary engine 42 falls below a preset level during operation, then the bypass valve 44 can divert fluid to the primary engine 42. In some embodiments, the controller 50 can shut off the fuel-fired heater if the cabin temperature is at its set point and the primary engine 42 is at a preset level. In other embodiments, the controller 50 can control the bypass valve 44 to divert fluid to the cabin when the cabin temperature and the primary engine 42 are below a preset temperature.

[0024] Passing now to **Figure 4,** in one embodiment, a truck (not shown) can be provided with a primary engine 70. The primary engine 70 can be hydraulically coupled to a fuel-fired water heater 72 and a heater core 76 using a bypass valve 76. In some embodiments, a temperature sensor 77 can be provided to indicate a temperature of the primary engine 70. During operation of the system depicted in Figure 4, a user may select heat from either or both an auxiliary power unit (APU), for example a 1500w electric element and blower from an HVAC system via a manual input at a control interface, for example user interface 26. During operation of the fuel-fired water heater 72 and a truck blower system (not shown), the bypass valve 76 diverts flow to the cabin of the truck. When the desired truck cabin temperature is achieved, the APU/HVAC heater turns off, thereby initiating the bypass valve 76 to divert flow to the primary engine 70 if the temperature indicated by sensor 77 is below a desired engine block temperature. In some embodiments, a user can program an auto-start routine with the controller 50 or user interface 26, for example, to maintain the temperature of the primary engine 70. When the water heater 62 is on, the bypass valve 76 blocks flow until the desired engine block temperature is achieved, after which heating is turned off. In other embodiments, a user can program an auto-start routine with the controller 50 or user interface 26, for example, for heating the cabin of the truck. The APU/HVAC heater and blower can be turned on, while

the water heater 72 is turned on. The bypass valve 76 can divert flow to the truck cabin until the desired truck cabin temperature is achieved and then heating is turned off.

[0025] Those of skill will recognize that the various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein, including with reference to the controller 20, for example, may be implemented as electronic hardware, software stored on a computer readable medium and executable by a processor, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present invention. For example, various illustrative logical blocks, modules, and circuits described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. Software associated with such modules may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other suitable form of storage medium known in the art. An exemplary storage medium is coupled to the processor such the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. For example, in one embodiment, the controller 22 comprises a processor (not shown).

[0026] It should be noted that the description above has provided dimensions for certain components or subassemblies. The mentioned dimensions, or ranges of dimensions, are provided in order to comply as best as possible with certain legal requirements, such as best mode. However, the scope of the inventions described herein are to be determined solely by the language of the claims, and consequently, none of the mentioned dimensions is to be considered

limiting on the inventive embodiments, except in so far as anyone claim makes a specified dimension, or range of thereof, a feature of the claim.

[0027] The foregoing description details certain embodiments of the invention. It will be appreciated, however, that no matter how detailed the foregoing appears in text, the invention can be practiced in many ways. As is also stated above, it should be noted that the use of particular terminology when describing certain features or aspects of the invention should not be taken to imply that the terminology is being re-defined herein to be restricted to including any specific characteristics of the features or aspects of the invention with which that terminology is associated.

WHAT WE CLAIM IS:

1. A heating system for a vehicle, the vehicle including an engine, the heating system comprising:

a heater core operably coupled to an interior of the vehicle;

a water heater; and

a valve in fluid communication with each of the engine, the heater core, and the water heater, wherein the valve is adapted to selectively divert a fluid flow from the water heater to the heater core.

2. The heating system of Claim 1, wherein the valve is adapted to:

selectively divert a fluid flow from the engine to the heater core; or

block flow from the engine to the heater core.

3. The heating system of Claim 1 or 2, wherein the valve is adapted to block flow to the engine under certain operating conditions.

4. The heating system of Claim 1 or 2, wherein the valve is adapted to, based at least in part on a temperature of the interior of the vehicle:

selectively divert a fluid flow from the water heater to the heater core; or

selectively divert a fluid flow from the water heater to the engine.

5. The heating system of any of Claims 1-4, further comprising a controller in electrical communication with the valve.

6. The heating system of Claim 5, wherein the controller is in electrical communication with the water heater.

7. The heating system of Claim 5 or 6, further comprising a temperature sensor adapted to provide a signal to the controller, the signal indicative of a temperature of the engine.

8. The heating system of any of Claims 1-7, further comprising a valve actuator coupled to the valve.

9. The heating system of any of Claims 1-4, wherein the engine comprises a primary engine, the system including an auxiliary engine, wherein the valve is in fluid communication with the auxiliary engine, and wherein the valve is adapted to selectively control flow between the auxiliary engine, the primary engine, the water heater, and the heater core.

10. The heating system of claim 8, wherein the valve is adapted to block flow to the auxiliary engine under certain operating conditions.

11. The heating system of claim 9 or 10, further comprising a controller in electrical communication with the valve, wherein the controller is in electrical communication with at least one of the auxiliary engine and the water heater.

12. The heating system of any of claims 9-11, further comprising a valve actuator coupled to the valve, wherein the valve is electrically coupled to the heating system.

13. The heating system of any of claims 1-12, further comprising a battery pack adapted to supply power to the heating system.

14. The heating system of any of claims 1-13, wherein:

the valve is a three-way valve; or

the water heater is a fuel-fired water heater.

15. A method of controlling a heating system of a vehicle, the vehicle comprising a primary engine, a water heater, a heater core, a valve in fluid communication with the water heater, the heater core, and a controller in electrical communication with the water heater and the valve, the method comprising:

receiving a signal indicative of a desired temperature of the heater core; and

adjusting the valve to control a heated fluid flow to the heater core.

16. The method of claim 15, wherein the vehicle additionally includes an auxiliary power unit including an auxiliary engine, wherein the valve is additionally in fluid communication with at least one of the primary engine and the auxiliary engine, wherein the controller is additionally in electrical communication with at least one of the primary engine and the auxiliary engine, and wherein adjusting the valve comprises the step of:

adjusting a fluid flow from the water heater;

adjusting a fluid flow from the auxiliary engine;

adjusting a fluid flow from the primary engine; or

adjusting a fluid flow to the heater core.

17. The method of claim 15 or 16, further comprising, based at least in part on a temperature of a cabin of the vehicle:

selectively diverting a fluid flow from the water heater to the heater core; or

selectively diverting a fluid flow from the water heater to the engine.

18. The method of any of claims 15-17, wherein:

the valve comprises a three-way valve; or

the water heater comprises a fuel-fired water heater

19. An auxiliary power unit (APU) for a vehicle having a primary engine and a HVAC system, the APU comprising:

an auxiliary engine;

a valve in fluid communication with the auxiliary engine and the primary engine; and

a fuel-fired water heater in fluid communication with the valve, wherein the valve is adapted to selectively control flow between the auxiliary engine, the primary engine, the fuel-fired water heater, and the HVAC system.

20. The APU of Claim 19, further comprising an auxiliary engine operably coupled to the valve.

21. The APU of Claim 19, further comprising a battery pack adapted to supply power to the HVAC system.

22. The APU of Claim 19, wherein the valve is a three-way valve.

23. The APU of Claim 19, wherein the valve is adapted to block flow to the primary engine under certain operating conditions.

24. The APU of Claim 23, wherein the valve is adapted to block flow to the auxiliary engine under certain operating conditions.

25. The APU of Claim 19, further comprising a controller in electrical communication with the valve.

26. The APU of Claim 25, wherein the controller is in electrical communication with the auxiliary engine.

27. The APU of Claim 26, wherein the controller is in electrical communication with the fuel-fired water heater.

28. The APU of Claim 27, further comprising a temperature sensor adapted to provide a signal to the controller, the signal indicative of a temperature of the primary engine.

29. The APU of Claim 25, further comprising a valve actuator coupled to the valve.

30. The APU of Claim 29, wherein the valve is electrically coupled to the APU.

31. A method of controlling a heating system of a vehicle having a primary engine and a heater core, the method comprising the steps of:

providing an auxiliary power unit;

providing a water heater;

providing a valve, the valve in fluid communication with the water heater and the auxiliary power unit;

providing a controller in electrical communication with the auxiliary power unit, the water heater, and the valve;

receiving a signal indicative of a desired temperature of the heater core; and

adjusting the valve to control a heated fluid flow to the heater core.

32. The method of Claim 31, wherein adjusting the valve comprises the step of adjusting a fluid flow from the water heater.

33. The method of Claim 32, wherein adjusting the valve comprises the step of adjusting a fluid flow from the auxiliary power unit.

34. The method of Claim 33, wherein adjusting the valve comprises the step of adjusting a fluid flow from the primary engine.

35. The method of Claim 31, wherein providing a valve comprises the step of providing a 3-way valve.

36. The method of Claim 35, wherein adjusting the valve comprises the step of adjusting a fluid flow to the heater core.

37. The method of Claim 31, wherein providing a water heater comprises the step of providing a fuel-fired water heater.

38. A heating system for a vehicle, the heating system comprising:

an engine operably coupled to the vehicle;

a heater core operably coupled to the interior of the vehicle; and

a valve hydraulically coupled to the engine, the valve hydraulically coupled to the heater core;

a fuel-fired heater hydraulically coupled to the valve, wherein the valve is adapted to selectively divert a fluid flow from the fuel-fired heater to the heater core.

39. The heating system of Claim 38, wherein the valve is adapted to selectively divert a fluid flow from the engine to the heater core.

40. The heating system of Claim 38, wherein the valve is adapted to block flow from the engine to the heater core.

41. The heating system of Claim 38, wherein the valve diverts the fluid flow from the fuel-fired heater to the heater core based at least in part on a temperature of the interior of the vehicle.

42. The heating system of Claim 38, wherein the valve diverts the fluid flow from the fuel-fired heater to the engine based at least in part on a temperature of the interior of the vehicle.

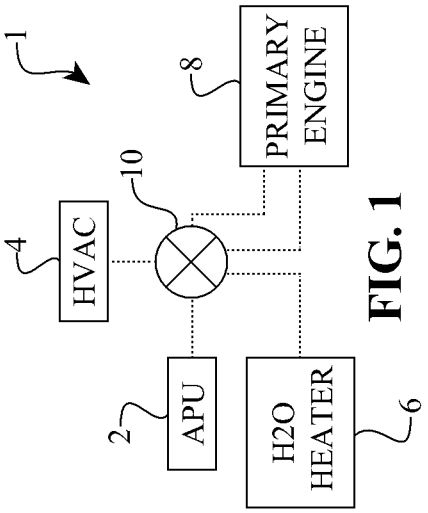
1
8
PRIMARY ENGINE
10
4
HVAC
2
APU
H2O HEATER
6

FIG. 1

20
28
AUXILIARY ENGINE ACTUATOR
22
CONTROL LOGIC
32
AUXILIARY CONTROL SYSTEM
CONTROLLER
ELECTRONIC HARDWARE
30
24
SENSORS
29
VALVE ACTUATOR
12
AUXILIARY ENGINE
10
VALVE
AUXILIARY GENERATOR
14
26
DISPLAY DATA STORAGE USER INTERFACE
4
HVAC
8
PRIMARY ENGINE
6
H2O HEATER
16
PRIMARY ENGINE CONTROL SYSTEM
18
HEATER CONTROL SYSTEM

FIG. 2

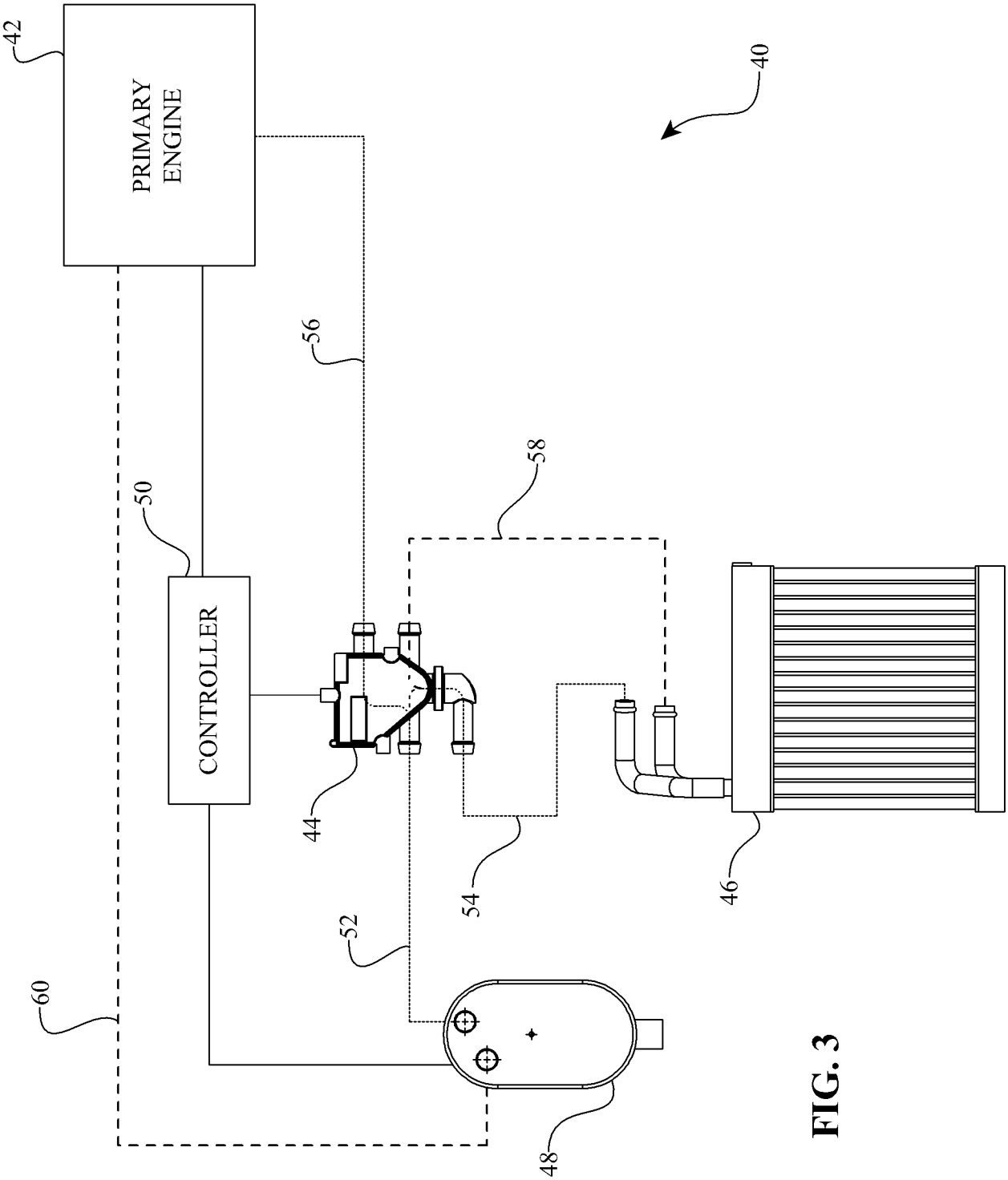

FIG. 3

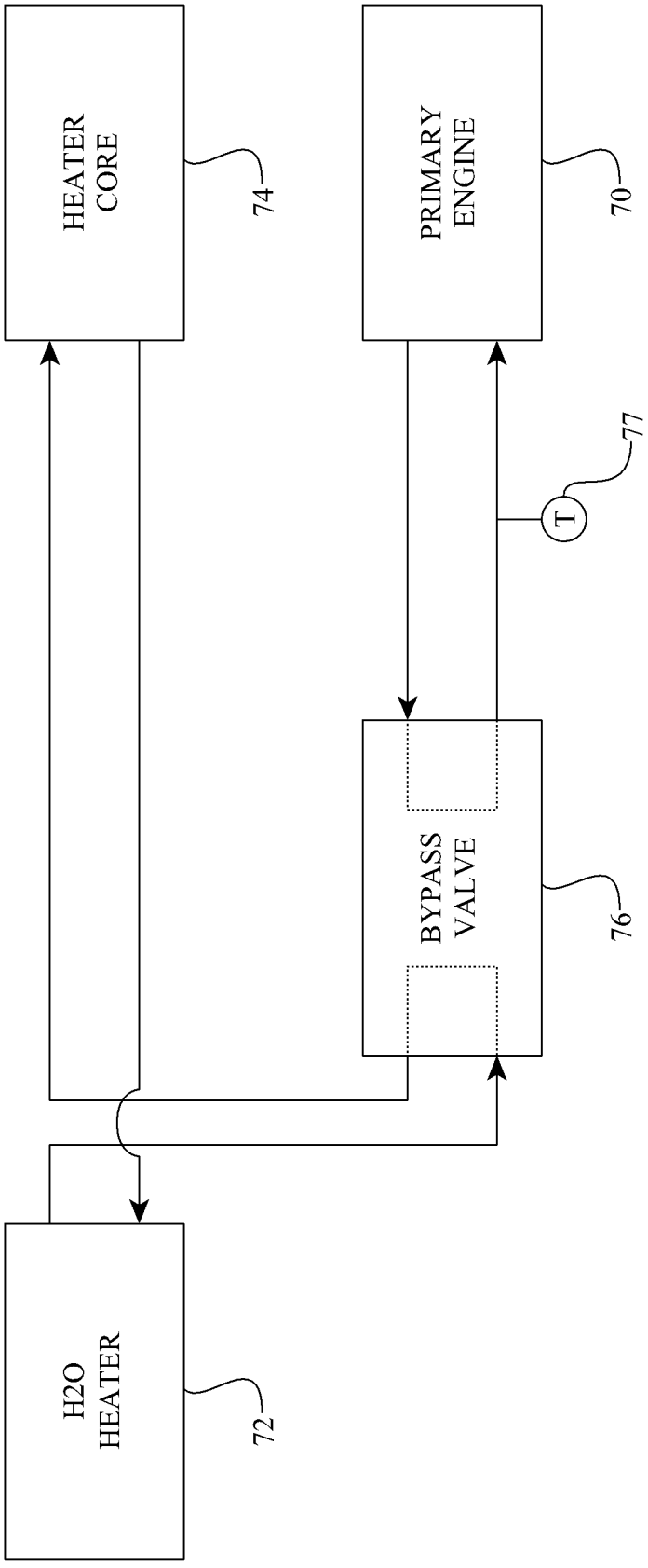
HEATER CORE
74
PRIMARY ENGINE
70
77
T
BYPASS VALVE
76
H2O HEATER
72

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/020052

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60H1/03 B60H1/00 B60H1/32 B60H1/22
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/202046 Al (EBERSPACH GUNTER [DE] EBERSPACH GUENTER [DE]) 14 September 2006 (2006-09-14)	1-8, 13-18, 38-42
Y	paragraphs [0034] , [0043] - [0052] ; figures 1,2	9-12 , 19-37
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☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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