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(54) **LOCOMOTIVE FLUID HEATER CONTROL SYSTEM**

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F01P 5/10	(2006.01)
F01P 5/04	(2006.01)
F01P 3/18	(2006.01)

(52) **U.S. Cl.**
CPC ***F01P 7/167*** (2013.01); ***F01P 3/18*** (2013.01); ***F01P 5/04*** (2013.01); ***F01P 5/10*** (2013.01); *F01P 2025/32* (2013.01); *F01P 2025/60* (2013.01)

(58) **Field of Classification Search**
CPC F01P 7/167; F01P 2025/32; F01P 2025/60; F01P 5/10; F01P 5/04; F01P 3/18
USPC 123/41.02
See application file for complete search history.

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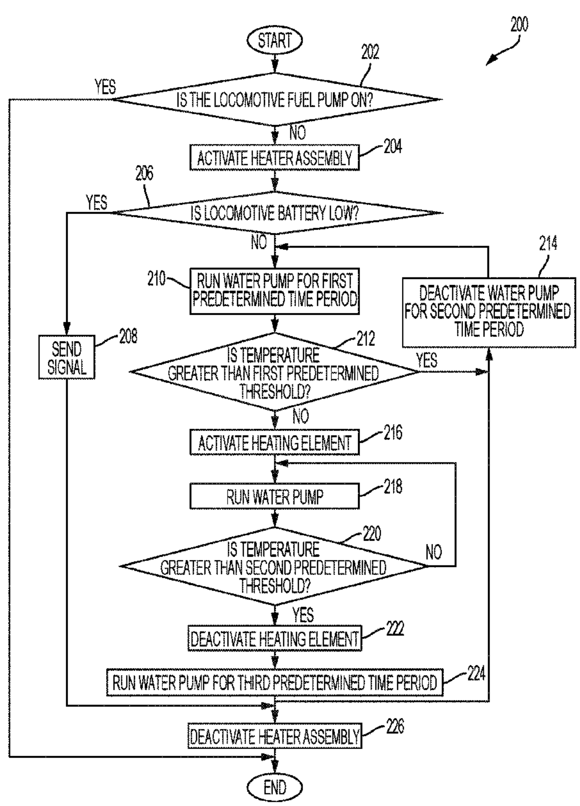
(57) **ABSTRACT**

A method of controlling a fluid heater control system for a locomotive, the fluid heater control system including a heater assembly including a water pump and a heating element, the method including determining if a fuel pump of the locomotive is on, if the fuel pump is off, activating the heater assembly, running the water pump for a first predetermined period of time, determining if a temperature of the fluid is greater than a first predetermined threshold, and if the temperature of the fluid is greater than the first predetermined threshold, deactivating the water pump for a second predetermined time period.

20 Claims, 5 Drawing Sheets



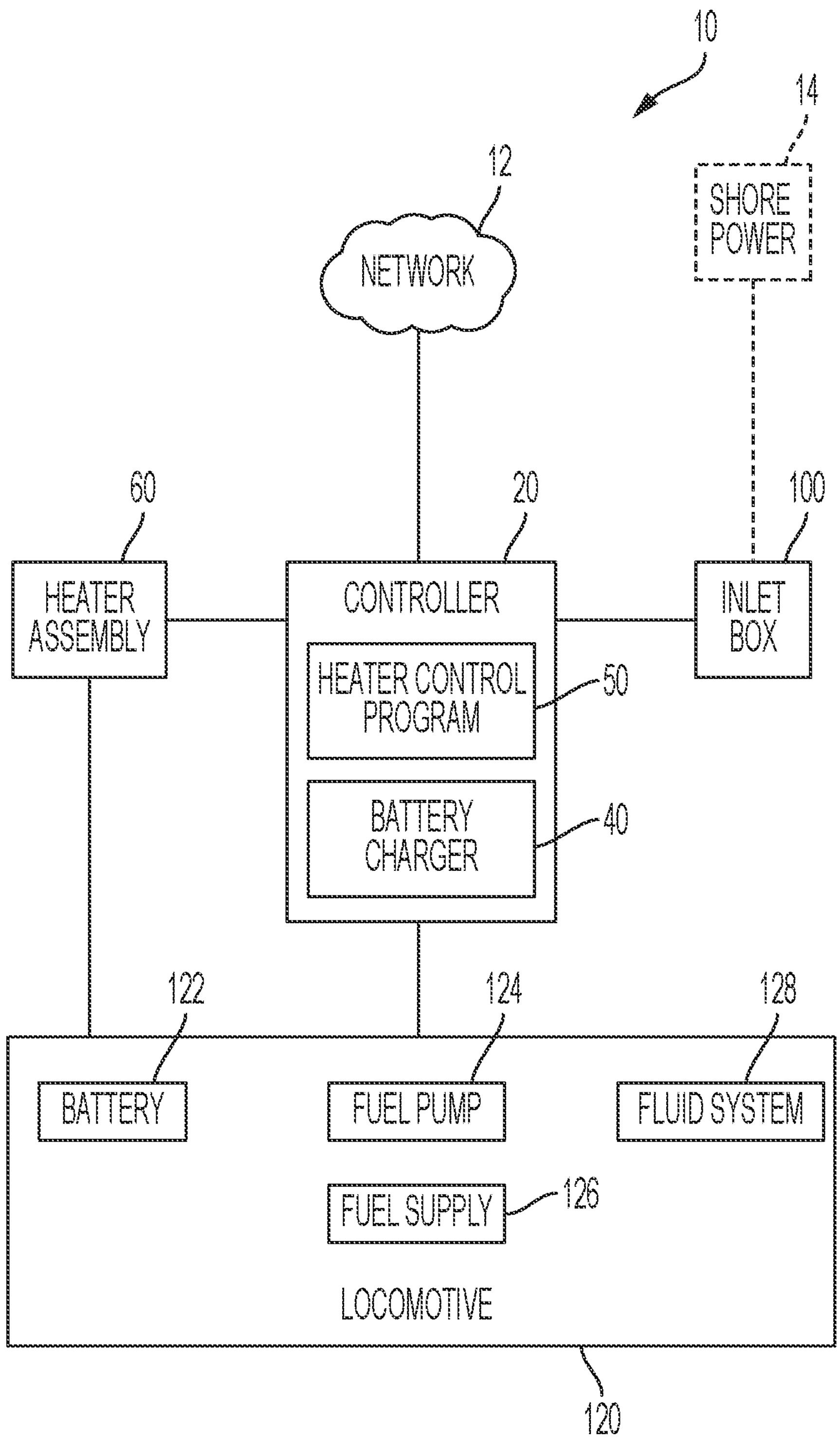

10
14
12
SHORE POWER
NETWORK
60
20
100
HEATER ASSEMBLY
CONTROLLER
INLET BOX
HEATER CONTROL PROGRAM
50
BATTERY CHARGER
40
122
124
128
BATTERY
FUEL PUMP
FLUID SYSTEM
FUEL SUPPLY
126
LOCOMOTIVE
120

FIG. 1

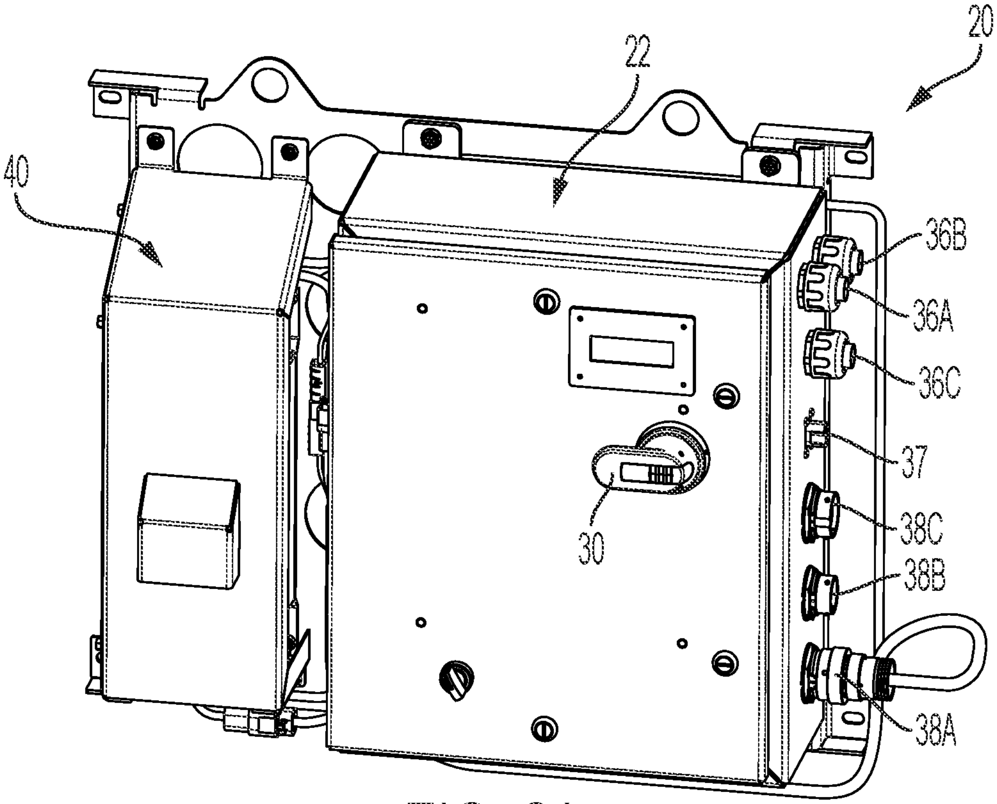

20
22
40
36B
36A
36C
37
30
38C
38B
38A

FIG. 2A

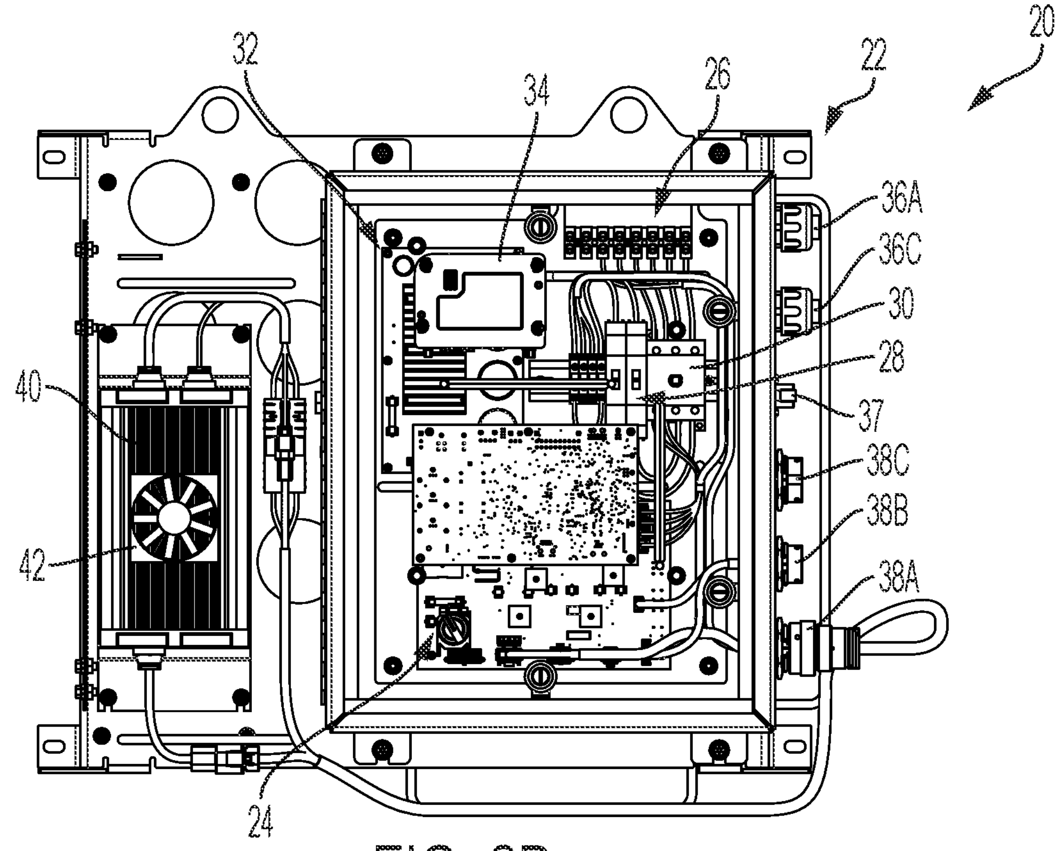

32
34
26
22
20
36A
36C
30
28
40
37
38C
42
38B
38A
24

FIG. 2B

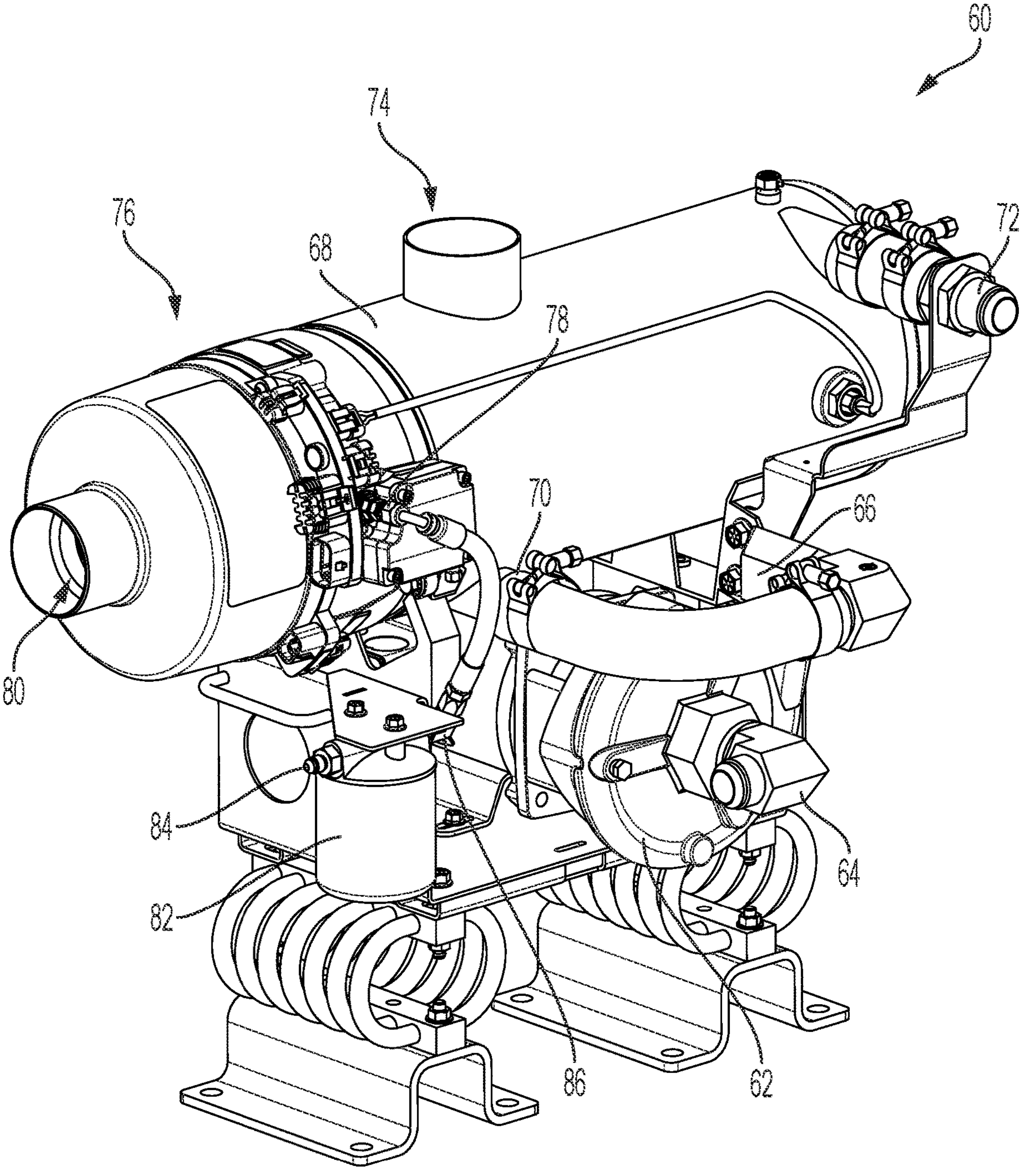


FIG. 3

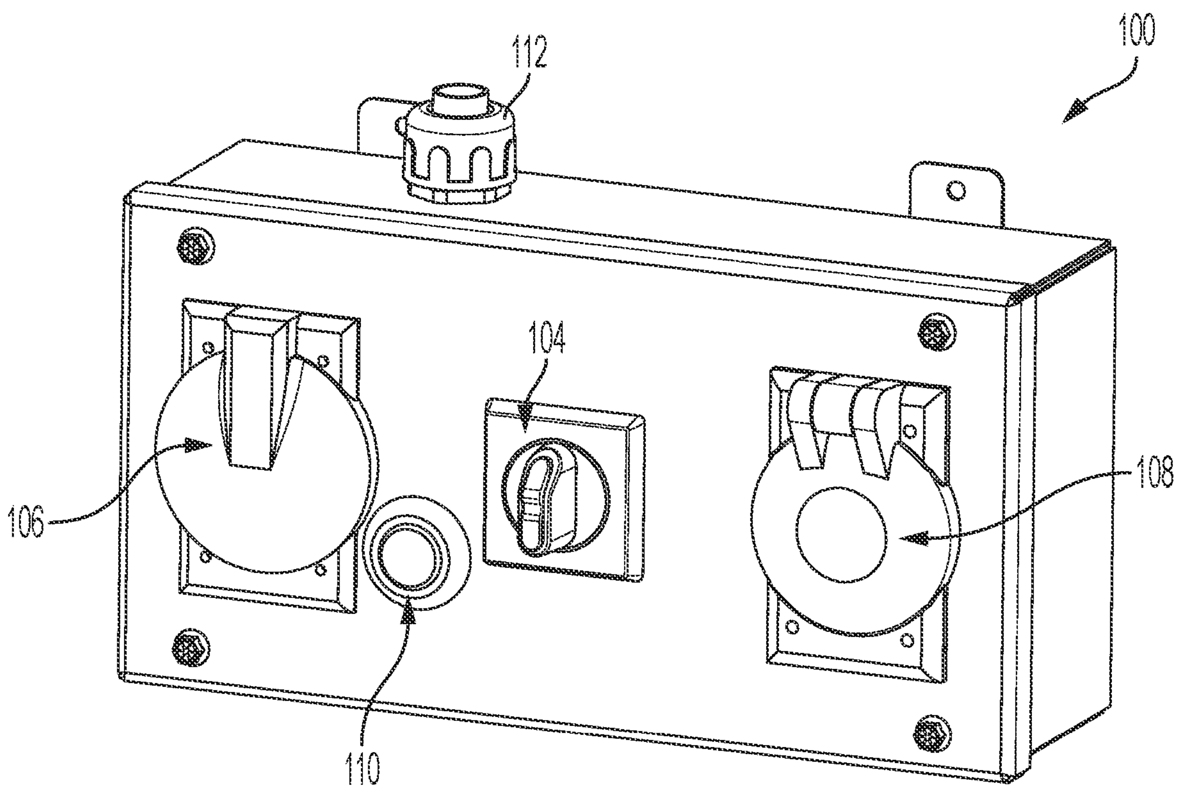


FIG. 4A

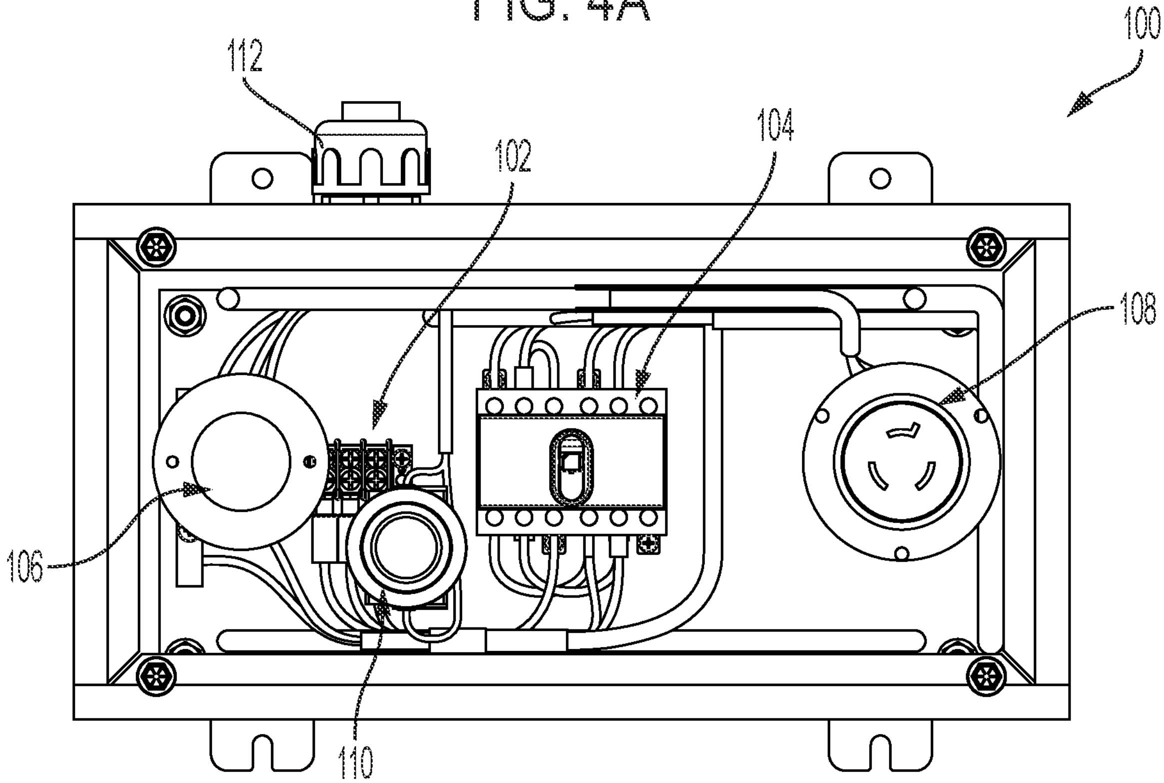
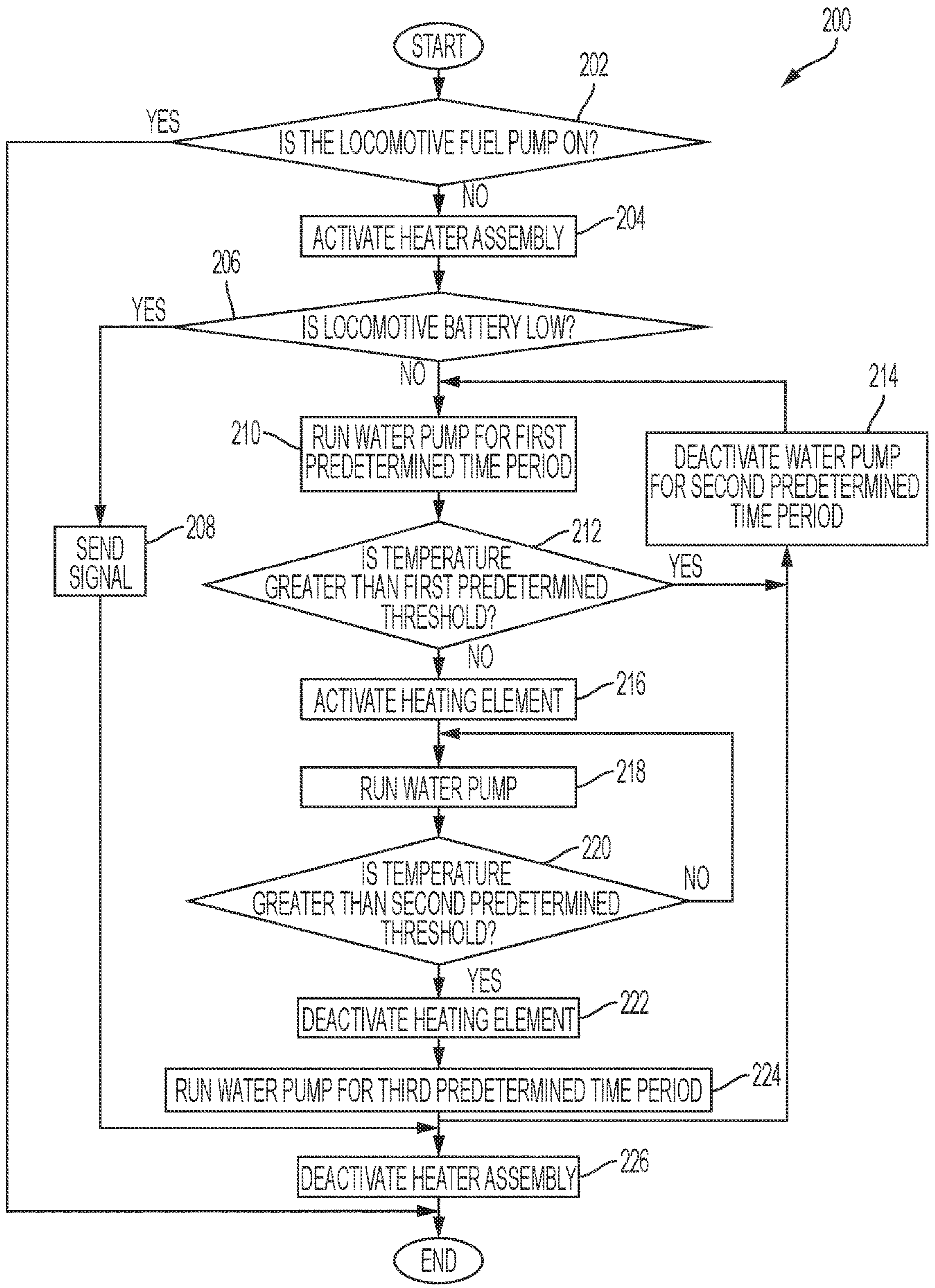


FIG. 4B


200
START
202
IS THE LOCOMOTIVE FUEL PUMP ON?
YES
NO
ACTIVATE HEATER ASSEMBLY
204
206
IS LOCOMOTIVE BATTERY LOW?
YES
NO
RUN WATER PUMP FOR FIRST PREDETERMINED TIME PERIOD
210
214
DEACTIVATE WATER PUMP FOR SECOND PREDETERMINED TIME PERIOD
SEND SIGNAL
208
IS TEMPERATURE GREATER THAN FIRST PREDETERMINED THRESHOLD?
212
YES
NO
ACTIVATE HEATING ELEMENT
216
RUN WATER PUMP
218
IS TEMPERATURE GREATER THAN SECOND PREDETERMINED THRESHOLD?
220
NO
YES
DEACTIVATE HEATING ELEMENT
222
RUN WATER PUMP FOR THIRD PREDETERMINED TIME PERIOD
224
DEACTIVATE HEATER ASSEMBLY
226
END
FIG. 5

LOCOMOTIVE FLUID HEATER CONTROL SYSTEM

FIELD

The present disclosure relates to locomotive fluid heaters, and, more particularly, to fluid systems that heat internal components of locomotives, and even more particularly, to a system for controlling a locomotive fluid heater.

BACKGROUND

Generally, current locomotive designs utilize diesel engines. This is also true of other freight vehicles such as semi-trailer trucks and ships/boats. Locomotives and other vehicles, when off, require that engine components do not drop below a certain temperature so they can more easily start. For example, if the engine block of a semi-trailer truck drops below a certain temperature (e.g., 40° F.) in the winter, it will be difficult if not impossible to start until the engine components, and more importantly, the diesel fuel, reach a minimum start temperature. The same is true of locomotives. Thus, heating systems are utilized to help maintain a minimum engine temperature.

However, current locomotive heating systems require power fed directly from a grid (i.e., shore power), and thus cannot function unless docked at a terminal. Additionally, current locomotive heating systems require manual operation, that is, a user must manually turn the system on or off based on the current state of the locomotive (i.e., running or off) and the temperature of the ambient air and/or the engine, etc.

Thus, there has been a long-felt need for a locomotive fluid heater control system that does not require shore power connection and automatically controls the various components of the system to maintain a minimum temperature of the locomotive engine and/or locomotive battery charge.

SUMMARY

According to aspects illustrated herein, there is provided a method of controlling a fluid heater control system for a locomotive, the fluid heater control system including a heater assembly including a water pump and a heating element, the method comprising determining if a fuel pump of the locomotive is on, if the fuel pump is off activating the heater assembly, running the water pump for a first predetermined period of time, determining if a temperature of the fluid is greater than a first predetermined threshold, and if the temperature of the fluid is greater than the first predetermined threshold, deactivating the water pump for a second predetermined time period.

In some embodiments, the method further comprises, if the temperature of the fluid is less than or equal to the first predetermined threshold, activating the heating element, running the water pump, determining if the temperature of the fluid is greater than a second predetermined threshold, and if the temperature of the fluid is greater than the second predetermined threshold, deactivating the heating element. In some embodiments, the method further comprises, after the step of deactivating the heating element, running the water pump for a third predetermined time period. In some embodiments, the method further comprises, after the step of running the water pump for the third predetermined time period, deactivating the heater assembly. In some embodiments, the method further comprises, if the temperature of the fluid is less than or equal to the first predetermined

threshold, activating the heating element, running the water pump, determining if the temperature of the fluid is greater than a second predetermined threshold, and if the temperature of the fluid is less than or equal to the second predetermined threshold, repeating the step of running the water pump. In some embodiments, the method further comprises determining if a battery of the locomotive is low, and if the battery is low, deactivating the heater assembly. In some embodiments, the method further comprises sending a signal to a remote location indicating that the battery is low. In some embodiments, the method further comprises determining if the locomotive is connected to a power source external to the grid, and if the locomotive is connected to the power source, activating a battery charger to charge the battery. In some embodiments, the second predetermined threshold is greater than the first predetermined threshold.

According to aspects illustrated herein, there is provided a system for controlling a fluid heater control system for a locomotive, comprising a heater assembly including a water pump and a heating element, one or more processors, one or more readable storage media, and program instructions stored on the readable storage media for execution by at least one of the one or more processors, the program instructions comprising program instructions to determine if a fuel pump of the locomotive is on, program instructions to, if the fuel pump is off run the water pump for a first predetermined period of time, program instructions to determine if a temperature of the fluid is greater than a first predetermined threshold, and program instructions to, if the temperature of the fluid is greater than the first predetermined threshold, deactivate the water pump for a second predetermined time period.

In some embodiments, the program instructions further comprise program instructions to, if the temperature of the fluid is less than or equal to the first predetermined threshold, activate the heating element, program instructions to run the water pump, program instructions to determine if the temperature of the fluid is greater than a second predetermined threshold, and program instructions to, if the temperature of the fluid is greater than the second predetermined threshold, deactivate the heating element. In some embodiments, the program instructions further comprise program instructions to, after the program instructions to deactivate the heating element, run the water pump for a third predetermined time period. In some embodiments, the program instructions further comprise program instructions to, before the program instructions to run the water pump for a first predetermined period of time, activate the heater assembly. In some embodiments, the program instructions further comprise program instructions to, after the program instructions to run the water pump for the third predetermined time period, deactivate the heater assembly. In some embodiments, the program instructions further comprise program instructions to, if the temperature of the fluid is less than or equal to the first predetermined threshold, activate the heating element, program instructions to run the water pump, program instructions to determine if the temperature of the fluid is greater than a second predetermined threshold, and program instructions to, if the temperature of the fluid is less than or equal to the second predetermined threshold, repeat the step of running the water pump. In some embodiments, the program instructions further comprise program instructions to determine if a battery of the locomotive is low, and program instructions to, if the battery is low, deactivate the heater assembly. In some embodiments, the program instructions further comprise program instructions to send a signal to a remote location indicating that the battery is low. In some embodiments, the program instructions further comprise program instructions to determine if the locomotive is connected to a power source external to the grid, and program instructions to, if the locomotive is connected to the power source, activate the battery charger to charge the battery. In some embodiments, the second predetermined threshold is greater than the first predetermined threshold.

According to aspects illustrated herein, there is provided a method of controlling a fluid heater control system for a locomotive, the fluid heater control system including a heater assembly including a water pump and a heating element, the method comprising determining if a fuel pump of the locomotive is on, if the fuel pump is off, running the water pump for a first predetermined period of time, determining if a temperature of the fluid is greater than a first predetermined threshold, if the temperature of the fluid is less than or equal to the first predetermined threshold, activating the heating element, running the water pump, determining if the temperature of the fluid is greater than a second predetermined threshold, if the temperature of the fluid is greater than the second predetermined threshold, deactivating the heating element, and running the water pump for a third predetermined time period.

These and other objects, features, and advantages of the present disclosure will become readily apparent upon a review of the following detailed description of the disclosure, in view of the drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments are disclosed, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, in which:

FIG. **1** is a functional block diagram illustrating a locomotive fluid heater control system;

FIG. **2**A is perspective view of a controller;

FIG. **2**B is a front elevational view of the controller shown in FIG. **3**A;

FIG. **3** is a perspective view of a heater assembly;

FIG. **4**A is a perspective view of an inlet box;

FIG. **4**B is a front perspective view of the inlet box shown in FIG. **4**A; and,

FIG. **5** is a flow chart depicting operational steps for controlling a locomotive fluid heating system.

DETAILED DESCRIPTION

At the outset, it should be appreciated that like drawing numbers on different drawing views identify identical, or functionally similar, structural elements. It is to be understood that the claims are not limited to the disclosed aspects.

Furthermore, it is understood that this disclosure is not limited to the particular methodology, materials and modifications described and as such may, of course, vary. It is also understood that the terminology used herein is for the purpose of describing particular aspects only, and is not intended to limit the scope of the claims.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this disclosure pertains. It should be understood that any methods, devices or materials similar or equivalent to those described herein can be used in the practice or testing of the example embodiments. The assembly of the present disclosure could be driven by hydraulics, electronics, pneumatics, and/or springs.

It should be appreciated that the term "substantially" is synonymous with terms such as "nearly," "very nearly," "about," "approximately," "around," "bordering on," "close to," "essentially," "in the neighborhood of," "in the vicinity of," etc., and such terms may be used interchangeably as appearing in the specification and claims. It should be appreciated that the term "proximate" is synonymous with terms such as "nearby," "close," "adjacent," "neighboring," "immediate," "adjoining," etc., and such terms may be used interchangeably as appearing in the specification and claims. The term "approximately" is intended to mean values within ten percent of the specified value.

It should be understood that use of "or" in the present application is with respect to a "non-exclusive" arrangement, unless stated otherwise. For example, when saying that "item x is A or B," it is understood that this can mean one of the following: (1) item x is only one or the other of A and B; (2) item x is both A and B. Alternately stated, the word "or" is not used to define an "exclusive or" arrangement. For example, an "exclusive or" arrangement for the statement "item x is A or B" would require that x can be only one of A and B. Furthermore, as used herein, "and/or" is intended to mean a grammatical conjunction used to indicate that one or more of the elements or conditions recited may be included or occur. For example, a device comprising a first element, a second element and/or a third element, is intended to be construed as any one of the following structural arrangements: a device comprising a first element; a device comprising a second element; a device comprising a third element; a device comprising a first element and a second element; a device comprising a first element and a third element; a device comprising a first element, a second element and a third element; or, a device comprising a second element and a third element.

Moreover, as used herein, the phrases "comprises at least one of" and "comprising at least one of" in combination with a system or element is intended to mean that the system or element includes one or more of the elements listed after the phrase. For example, a device comprising at least one of: a first element; a second element; and, a third element, is intended to be construed as any one of the following structural arrangements: a device comprising a first element; a device comprising a second element; a device comprising a third element; a device comprising a first element and a second element; a device comprising a first element and a third element; a device comprising a first element, a second element and a third element; or, a device comprising a second element and a third element. A similar interpretation is intended when the phrase "used in at least one of:" is used herein. Furthermore, as used herein, "and/or" is intended to mean a grammatical conjunction used to indicate that one or more of the elements or conditions recited may be included or occur. For example, a device comprising a first element, a second element and/or a third element, is intended to be construed as any one of the following structural arrangements: a device comprising a first element; a device comprising a second element; a device comprising a third element; a device comprising a first element and a second element; a device comprising a first element and a third element; a device comprising a first element, a second element and a third element; or, a device comprising a second element and a third element.

Adverting now to the figures, FIG. **1** is a functional block diagram illustrating locomotive fluid heater control system **10**. FIG. **1** provides only an illustration of one implementation, and does not imply any limitations with regard to the environments in which different embodiments may be implemented. Many modifications to the depicted environment may be made by those skilled in the art without departing from the scope of the disclosure as recited by the claims. In some embodiments, locomotive fluid heater control system, or control system **10**, comprises controller **20** and heater assembly **20** and is operatively arranged to implemented on locomotive **120**. In some embodiments, control system **10** further comprises inlet box **100** operatively arranged to connect to shore power or building power (power source) **14**. As is known in the art, shore power is the provision of electrical power to a locomotive while its main and auxiliary engines are shut down. For example, when a locomotive is stopped at a terminal, the term "shore power" denotes the ability of the locomotive to plug into grid power when parked for idle reduction. In some embodiments, control system **10** further comprises network **12** and/or a computing device. In some embodiments, control system **10** further comprises a processor or microprocessor (i.e., a chip that resides in computers and other electronic devices to receive input and provide the appropriate output, as is known to those skilled in the art).

Network **12** can be, for example, a local area network (LAN), a wide area network (WAN) such as the Internet, or a combination of the two, and can include wired, wireless, or fiber optic connections. Network **12** may, for example, interact with gateway **34** (see FIG. **2**B). Gateway **34** is operatively arranged to send and receive communications to a remote location. For example, gateway **34** is capable if sending communications to a remote location indicating that battery **122** is low, an error has occurred in control system **10**, a status of shore power (e.g., shore power is connected and whether the source is 120 V or 240V), etc. Network **12** may also interact with gateway **34** and/or circuit boards **24** to program controller **20**.

Locomotive **120** generally comprises battery **122**, fuel pump **124**, fuel supply **126**, and fluid system **128**.

Battery or batteries **122** are utilized by locomotive **120** as an auxiliary power source. For example, battery **122** may be used to start or help start up the locomotive, to power the locomotive lights, for power outlets within the train, etc. In some embodiments, battery-powered locomotives may be used to operate the train. Both controller **20** and heater assembly **60** are connected to battery **122**, as will be described in greater detail below.

Fuel pump **124** provide fuel to the engine of locomotive. Fuel pump **124** is operatively arranged to communicate with controller **20**. Specifically, when locomotive **120** is started, fuel pump **124** is activated. Controller **20** receives a signal from fuel pump **124** indicating that fuel pump **124**, and thus locomotive **120**, is on. This triggers controller **20** to shut down heater assembly **60**, as will be described in greater detail below. In some embodiments, the signal from fuel pump **124** is continuous as long as fuel pump **124** is on. When fuel pump **124** is shut off (i.e., when locomotive **120** is turned off), the signal ceases and controller **20** turns on heater assembly **60**.

Fuel supply **126** supplies fuel to locomotive **120** via a fuel pump **124**. Fuel supply **126** also supplies fuel to heater assembly **60**, via a fuel pump in heating unit **68**, specifically, heating element **76**. As such, heater assembly **60**, specifically, heating unit **68**, is connected to fuel supply **126** and/or fuel pump **124**, as will be described in greater detail below.

Fluid system **128** comprises water or coolant and is arranged to run fluid (e.g., water or coolant) through locomotive **120** in order to maintain a temperature throughout the engine and other components. During times of low temperature (e.g., winter), it is important to maintain the engine at a certain temperature (e.g., 100° F.). Similarly, it is important to prevent locomotive **120** getting too hot. Fluid system **128** circulates water or coolant through the locomotive engine block and cooling system to maintain a temperature throughout. Fluid system **128** is connected to heater assembly **60**, as will be described in greater detail below.

FIG. **2**A is perspective view of controller **20**. FIG. **2**B is a front elevational view of controller **20**. Controller **20** comprises control panel **22** and battery charger **40**. Controller **20** (i.e., control panel **22**) is a hardware device that controls control system **10** and is capable of automatically maintaining the temperature of fluid system **128** and/or the charge of battery **122** using heater control program **50**. Control panel **22** is operatively arranged to control heater assembly **60**, battery charger **40**, and fluid system **128**. In some embodiments, controller **20** may include a computer or computing device. In some embodiments, controller **20** further comprises a processor or microprocessor. In some embodiments, control program **50** is implemented on a web server, which ay be a management server, or web server, or any other electronic device or computing system capable of receiving and sending data. The web server can represent a computing system utilizing clustered computers and components to act as a single pool of seamless resources when accessed through a network.

Control panel **22** generally comprises one or more circuits or circuit boards **24**, terminal **26**, direct current (DC) to DC power supply **32**, and gateway **34**. In some embodiments, heater control program **50** is programmed into circuit boards **24** (i.e., circuit boards **24** are programmable circuit boards). Control panel **22** further comprises one or more circuit breakers **28** and switch **30**. A power source (e.g., shore power through inlet box **100** or battery power from battery **122**) is connected to terminal **26**. DC to DC power supply **32** regulates the power from inlet box **100** and/or battery **122** by reducing the input voltage down to a voltage suitable for use by circuit boards **24**, heating element **76**, gateway **34**, and/or battery charger **40**. For example, in some embodiments, DC to DC power supply **32** steps the voltage from locomotive battery **122** down to 24 VDC. In some embodiments, element **32** is a voltage or power regulator. Circuit breakers **28** and switch **30** are connected to terminal **26**. Circuit boards **24** are connected to circuit breakers **28** and switch **30**. Circuit boards **24** may comprise one or more processors (e.g., microcontrollers). It should be appreciated that controller **20** may comprise a computing device including memory and storage. Switch **30** is the main disconnect switch for both alternating current (AC) shore power **14** and power from locomotive battery **122**.

In some embodiments, controller **20** comprises one or more ports, for example, ports **36**A-C, port **37**, and ports **38**A-C. In some embodiments, ports **36**A-C are conduit connections for shore power **14** (for example through inlet box **100**), locomotive battery **122**, and signal from locomotive fuel pump **124**. In some embodiments, port **37** is a connector for an external indicator light. The external indicator light can be mounted on locomotive **20** (e.g., to the exterior of locomotive **20**) and shows the system status. For example, the external indicator light may have green, red, and yellow indicator colors indicating various statuses of controller **20**, heater assembly **60**, fuel pump **124**, inlet box **100** (i.e., the presence of shore power **14**), etc. In some embodiments, and as shown, port **38**A connects battery charger **40** to control panel **22**. In some embodiments, port **38**B is a connector for an optional air compressor module. In some embodiments, port **38**C is a connector for heater assembly **60**.

Heater control program **50** receives communicates with fuel pump **124** indicating whether locomotive **120** is running and is capable of activating and deactivating the components of heater assembly **60** (e.g., water pump **62**, heating unit **68**, heating element **76**) depending thereon. In this regard, heater control program **50** is capable of automatically controlling fluid system **128** and the temperature thereof according to predetermined criteria, as will be described in greater detail below with respect to FIG. **5**. Heater control program **50** is capable of detecting a current charge in battery **122** and communicating such status with a remote location (i.e., sending a communication indicating that the charge battery **122** is low). Heater control program **50** is capable of detecting connection to shore power **14** and activating battery charger **40** to charge battery **122**. Heater control program **50** can generally include any software capable of communicating with heater assembly **60**, locomotive **120**, inlet box **100**, and network **12** to maintain a temperature of locomotive **120**, maintain a charge in battery **122**, activate and deactivating various components of control system **10** based on a current status of the respective component, and send signals to remote locations.

Battery charger **40** is connected to control panel **22** and battery **122**. Battery charger **40** is operatively arranged to charge battery **122** when locomotive **120** is connected to shore power **14**. Battery charger **40** receives power from inlet box **100** (from grid) via control panel **22**, and uses that power to charge battery **122** (e.g., trickle charge). When locomotive **120** is not connected to shore power **14**, battery charger **40** does not charge battery **122**. In some embodiments, battery charger **40** comprises cooling fan **42** and a plurality of fins in order to dissipate heat from charger **40** and maintain a suitable temperature.

FIG. **3** is a perspective view of heater assembly **60**. Heater assembly **60** comprises water pump **62**, heating unit **68**, and fuel filter **82**. In some embodiments, heater assembly **60** is electrically connected to battery **122** through controller **20**.

Water pump **62** comprises inlet **64** connected to fluid system **128** and outlet **66** connected to heating unit **68** at inlet **70**. Water pump **62** pumps fluid (e.g., water, coolant, etc.) from fluid system **128** to/through heating unit **68** and back to fluid system **128**. In some embodiments, water pump **62** comprises a MP Pumps **27667**, Series 60 Standard End Suction Centrifugal Pump. In some embodiments, water pump **62** comprises a 3/4 HP Leeson 2500 RPM 56C TEFC 90 VDC MOTOR 098009.00. Water pump **62** is electrically connected to controller **20**. Specifically, controller **20** is arranged to activate and deactivate water pump **62**.

Heating unit **68** comprises inlet **70** connected to outlet **66** of water pump, outlet **72** connected to fluid system **128**, and heating element **76**. Fluid is pumped through heating unit **68** via water pump **62**. Heating element **76** comprises inlet **78** and is operatively arranged to heat the fluid passing through heating unit **68**. Fuel is pumped (e.g., via fuel pump **124** or an additional fuel pump) from fuel supply **126** through fuel filter **82** to inlet **78** of heating element **76**. Heating element **76** burns the fuel to heat the fluid. In some embodiments, heating unit **68** further comprises exhaust **74** and combustion air inlet **80**. Heater assembly **60** is electrically connected to controller **20**. Specifically, controller **20** is arranged to activate and deactivate heating unit **68** (i.e., heating element **76**). Heater assembly **60**, namely, heating unit **68** further comprises a temperature sensor that is operatively arranged to detect the temperature of the fluid passing through heating unit **68**. Controller **20** communicates with the temperature sensor to detect the temperature of the fluid.

FIG. **4**A is a perspective view of inlet box **100**. FIG. **4**B is a front perspective view of inlet box **60**. Inlet box **100** generally comprises terminal **102**, switch **104**, socket **106**, socket **108**, indicator light **110**, and one or more ports, for example, port **112**. Inlet box **100** is arranged to be electrically connected to controller **20**. For example, a cable or wire(s) may be, at a first end, fed through port **112** and connected to terminal **102** and, at a second end, fed through port **36**A and connected to terminal **26**. Sockets **106** and **108** are connected to switch **104** and terminal **102**. In some embodiments, one of sockets **106** and **108** is a 120 V socket and the other of sockets **106** and **108** is a 240 V socket. Switch **104** is operatively arranged to direct power from one of sockets **106** and **108** to terminal **102**, or prevent power to terminal **102** from sockets **106** and **108**. For example, in a first position, as shown in FIG. **4**A, switch **104** prevents any power to terminal **102** from both of sockets **106** and **108** (i.e., in an off state). If switch **104** is turned in a first circumferential direction from the off state, power is allowed to flow from socket **106** to terminal **102**, and thus controller **20**. If switch **104** is turned in a second circumferential direction from the off state, opposite the first circumferential direction, power is allowed to flow from socket **108** to terminal **102**, and thus controller **20**. For example, if the shore power **14** comprises a 240 V connection, the shore power **14** connector is connected to socket **108** and switch **104** is turned in the second circumferential direction, thus allowing shore power to controller **12**. If shore power **14** comprises a 120 V connection, the shore power **14** connector is connected to socket **106** and switch **104** is turned in the first circumferential direction, thus allowing shore power to controller **12**. Furthermore, when switch **104** is turned to an on state (i.e., when rotated either in the first circumferential direction or the second circumferential direction to allow power to terminal **102** and thus controller **20**), indicator light **110** activates. When switch is turned to the off state, indicator light **110** deactivates.

When inlet box **100** is connected to shore power **14** and switch **104** is in an on state, or more specifically, when controller **20** receives power from inlet box **100**, controller **20** activates battery charger **40** to charge battery **122**. When shore power **14** is disconnected from shore power or switch **104** is in an off state, controller **20** deactivates battery charger **40**.

FIG. **5** illustrates flow chart **200** depicting operational steps for controlling a locomotive fluid heating system.

In step **202**, heater control program **50** determines if locomotive fuel pump **124** and/or locomotive **120** is running. As previously described, in some embodiments, fuel pump **124** sends a continuous signal to controller **20** when it is on, indicating that locomotive is on. It should be appreciated that when locomotive **120** fuel pump **124** is activated as locomotive **120** requires fuel to operate. Thus, if fuel pump **124** is on, so is locomotive **120**. When locomotive **120** is turned off or deactivated, so is fuel pump **124** and the continuous signal ceases. In some embodiments, controller receives a single signal from fuel pump **124** when fuel pump **124** is turned on, and a single signal from fuel pump **124** when fuel pump **124** is turned off.

If, in step **202**, heater control program **50** determines that locomotive fuel pump **124** is on, then the program ends.

If, in step **202**, heater control program **50** determines that locomotive fuel pump **124** is off, then in step **204** heater control program **50** activates heater assembly **60**. By activate it is meant that power is provided to heater assembly **60** and/or heater assembly **60** is initiated or turned on.

In step **206**, heater control program **50** determines if locomotive battery **122** is low. Heater control program **50** is capable of measuring the current charge in battery **122**. In this step, heater control program **50** determines whether the current charge in battery **122** is less than a predetermined threshold, which would indicate that it is low.

If, in step **206**, heater control program **50** determines that locomotive battery **122** is low, then in step **208** heater control program **50** sends a signal to a remote location, for example via gateway **34**, indicating a low charge in batter **122**. Then, in step **226**, heater control program **50** deactivates heater assembly **60**.

If, in step **206**, heater control program **50** determines that locomotive battery **122** is not low (i.e., the current charge is greater than or equal to the predetermined threshold), then in step **210** heater control program **50** runs water pump **62** for a first predetermined period of time. By run it is meant that water pump **62** pumps fluid from fluid system **128**, through heating unit **68**, and back to fluid system **128**. In some embodiments, the first predetermined period of time is two minutes.

In step **212**, heater control program **50** determines if the temperature of the fluid is greater than a first predetermined threshold. Controller **20** communicates with the temperature sensor of heating unit **68** to detect the temperature of the fluid flowing therethrough. In some embodiments, the first predetermined threshold is 90° F.

If, in step **212**, heater control program **50** determines that the temperature of the fluid is greater than the first predetermined threshold, then in step **214** heater control program **50** deactivates water pump **62** for a second predetermined period of time. Then the process restarts at step **210**. In some embodiments, the second predetermined time period is fifteen minutes.

If, in step **212**, heater control program **50** determines that the temperature of the fluid is less than or equal to the first predetermined threshold, then in step **216** heater control program **50** activates heating element **76**. Controller **20** activates heating element **76** in order to increase the temperature of the fluid flowing through heating unit **68**.

In step **218**, heater control program **50** runs water pump **62**. In some embodiments, in step **218**, water pump **62** may be run indefinitely until a temperature of the fluid is reached or water pump **62** may be run for a predetermined period of time.

In step **220**, heater control program **50** determines if the temperature of the fluid is greater than a second predetermined threshold. Controller **20** communicates with the temperature sensor of heating unit **68** to detect the temperature of the fluid flowing therethrough, all the while heating element **76** is activated. In some embodiments, the second predetermined threshold is different than the first predetermined threshold. For example, the second predetermined threshold may be greater than the first predetermined threshold. In some embodiments, the second predetermined threshold is 110° F.

If, in step **220**, heater control program **50** determines that the temperature of the fluid is less than or equal to the second predetermined threshold, then the process repeats at step **218** (i.e., water pump **62** runs indefinitely until heater control program **50** determines that the temperature of the fluid is greater than the second predetermined threshold).

If, in step **220**, heater control program **50** determines that the temperature of the fluid is greater than the second predetermined threshold, then in step **222** heater control program **50** deactivates heating element **76**. By deactivate it is meant that heating element **76** is turned off such that the temperature of the fluid is no longer increased by heating unit **68** and fuel is no longer being utilized by heating unit **68**.

In step **224**, heater control program **50** runs water pump **62** for a third predetermined period of time. After heating element **76** is deactivated in step **222**, it is desired to remove some of the heat from the heat exchanger (i.e., heating unit **68**). This is accomplished by pumping fluid through heating unit **68** with heating element **76** disabled. In some embodiments, the third predetermined period of time is three minutes.

In step **226**, heater control program **50** deactivates heater assembly **60**. It should be appreciated that instead of deactivating heater assembly **60** in step **226**, heater control program **50** may proceed back to step **214**, and deactivate water pump **62** for the second predetermined time period (e.g., fifteen minutes). Subsequently, in step **210**, heater control program **50** runs water pump **62** for the first predetermined time period (e.g., two minutes) and proceeds through flow chart **200** accordingly.

In some embodiments, in an additional step, heater control program **50** determines if inlet box **100** is connected to shore power **14** and/or if controller **20** is receiving power from inlet box **100**. If heater control program **50** determines that controller **20** is receiving power from inlet box **100**, then heater control program **50** activates battery charger **40** to charge battery **122**.

It should be appreciated that flowchart **200** may run continuously, over and over again, from step **202** through step **226**. Additionally, and as previously described, flowchart **200** may run continuously from step **210** through step **224**. In some embodiments, steps **204** and **226** of flowchart **200** are removed.

It will be appreciated that various aspects of the disclosure above and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

LIST OF REFERENCE NUMERALS

10 Locomotive fluid heater control system
12 Network
14 Shore or grid or building power (power source)
20 Controller
22 Control panel
24 Circuit boards
26 Terminal
28 Circuit breakers
30 Switch
32 Direct current to direct current power supply (voltage/power regulator)
34 Gateway
36A Port
36B Port
36C Port
37 Port
38A Port
38B Port
38C Port
40 Battery charger
42 Fan
50 Heater control program
60 Heater assembly

62 Water pump
64 Inlet
66 Outlet
68 Heating unit
70 Inlet
72 Outlet
74 Exhaust
76 Heating element
78 Inlet
80 Exhaust
82 Fuel filter
84 Inlet
86 Outlet
100 Inlet box
102 Terminal
104 Switch
106 Socket
108 Socket
110 Indicator light
112 Port
200 Flow chart
202 Step
204 Step
206 Step
208 Step
210 Step
212 Step
214 Step
216 Step
218 Step
220 Step
222 Step
224 Step
226 Step

What is claimed is:

1. A method of controlling a fluid heater control system for a locomotive, the fluid heater control system including a heater assembly including a water pump and a heating element, the method comprising:

determining if a fuel pump of the locomotive is on;

if the fuel pump is off, activating the heater assembly;

running the water pump for a first predetermined period of time;

determining if a temperature of the fluid is greater than a first predetermined threshold; and,

if the temperature of the fluid is greater than the first predetermined threshold, deactivating the water pump for a second predetermined time period.

2. The method as recited in claim **1**, further comprising:

if the temperature of the fluid is less than or equal to the first predetermined threshold, activating the heating element;

running the water pump;

determining if the temperature of the fluid is greater than a second predetermined threshold; and,

if the temperature of the fluid is greater than the second predetermined threshold, deactivating the heating element.

3. The method as recited in claim **2**, further comprising:

after the step of deactivating the heating element, running the water pump for a third predetermined time period.

4. The method as recited in claim **3**, further comprising:

after the step of running the water pump for the third predetermined time period, deactivating the heater assembly.

5. The method as recited in claim **2**, further comprising:

if the temperature of the fluid is less than or equal to the first predetermined threshold, activating the heating element;

running the water pump;

determining if the temperature of the fluid is greater than a second predetermined threshold; and,

if the temperature of the fluid is less than or equal to the second predetermined threshold, repeating the step of running the water pump.

6. The method as recited in claim **1**, further comprising:

determining if a battery of the locomotive is low; and,

if the battery is low, deactivating the heater assembly.

7. The method as recited in claim **6**, further comprising:

sending a signal to a remote location indicating that the battery is low.

8. The method as recited in claim **6**, further comprising:

determining if the locomotive is connected to a power source external to the grid; and,

if the locomotive is connected to the power source, activating a battery charger to charge the battery.

9. The method as recited in claim **2**, wherein the second predetermined threshold is greater than the first predetermined threshold.

10. A system for controlling a fluid heater control system for a locomotive, comprising:

a heater assembly including a water pump and a heating element;

one or more processors;

one or more readable storage media; and,

program instructions stored on the readable storage media for execution by at least one of the one or more processors, the program instructions comprising:

program instructions to determine if a fuel pump of the locomotive is on;

program instructions to, if the fuel pump is off, run the water pump for a first predetermined period of time;

program instructions to determine if a temperature of a fluid is greater than a first predetermined threshold; and,

program instructions to, if the temperature of the fluid is greater than the first predetermined threshold, deactivate the water pump for a second predetermined time period.

11. The system as recited in claim **10**, wherein the program instructions further comprise:

program instructions to, if the temperature of the fluid is less than or equal to the first predetermined threshold, activate the heating element;

program instructions to run the water pump;

program instructions to determine if the temperature of the fluid is greater than a second predetermined threshold; and,

program instructions to, if the temperature of the fluid is greater than the second predetermined threshold, deactivate the heating element.

12. The system as recited in claim **11**, wherein the program instructions further comprise:

program instructions to, after the program instructions to deactivate the heating element, run the water pump for a third predetermined time period.

13. The system as recited in claim **12**, wherein the program instructions further comprise:

program instructions to, before the program instructions to run the water pump for a first predetermined period of time, activate the heater assembly.

14. The system as recited in claim **13**, wherein the program instructions further comprise:

program instructions to, after the program instructions to run the water pump for the third predetermined time period, deactivate the heater assembly.

15. The system as recited in claim **10**, wherein the program instructions further comprise:

program instructions to, if the temperature of the fluid is less than or equal to the first predetermined threshold, activate the heating element;

program instructions to run the water pump;

program instructions to determine if the temperature of the fluid is greater than a second predetermined threshold; and,

program instructions to, if the temperature of the fluid is less than or equal to the second predetermined threshold, repeat the step of running the water pump.

16. The system as recited in claim **10**, wherein the program instructions further comprise:

program instructions to determine if a battery of the locomotive is low; and,

program instructions to, if the battery is low, deactivate the heater assembly.

17. The system as recited in claim **16**, wherein the program instructions further comprise:

program instructions to send a signal to a remote location indicating that the battery is low.

18. The system as recited in claim **16**, further comprising a battery charger, wherein the program instructions further comprise:

program instructions to determine if the locomotive is connected to a power source external to the grid; and,

program instructions to, if the locomotive is connected to the power source, activate the battery charger to charge the battery.

19. The system as recited in claim **12**, wherein the second predetermined threshold is greater than the first predetermined threshold.

20. A method of controlling a fluid heater control system for a locomotive, the fluid heater control system including a heater assembly including a water pump and a heating element, the method comprising:

determining if a fuel pump of the locomotive is on;

if the fuel pump is off, running the water pump for a first predetermined period of time;

determining if a temperature of a fluid is greater than a first predetermined threshold;

if the temperature of the fluid is less than or equal to the first predetermined threshold, activating the heating element;

running the water pump;

determining if the temperature of the fluid is greater than a second predetermined threshold;

if the temperature of the fluid is greater than the second predetermined threshold, deactivating the heating element; and,

running the water pump for a second predetermined time period.

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