(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 August 2016 (25.08.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/134082 A1

(51) International Patent Classification: *B60H 1/32* (2006.01)

(21) International Application Number: PCT/US2016/018359

(22) International Filing Date: 17 February 2016 (17.02.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/176,307 18 February 2015 (18.02.2015) US

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) Title: VEHICULAR AIR CONDITIONING SYSTEM

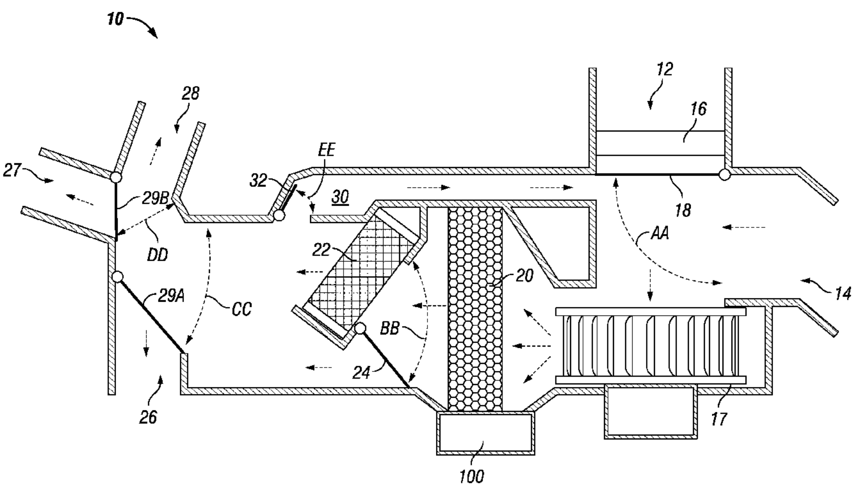

FIG. 2

(57) Abstract: The application is directed to a vehicular HVAC system operationally configured to heat air flowing through the system and route at least some of the heated air to a point in the system upstream of the system's A/C evaporator in a manner effective to increase the temperature of the air flowing over the system's A/C evaporator to promote condensate production of the HVAC system.

WO 2016/134082 A1

VEHICULAR AIR CONDITIONING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The application is entitled to the benefit of the filing date of the prior-filed U.S. Provisional Application Number 62/176,307, filed on February 18, 2015.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

FIELD OF THE APPLICATION

[0003] The application relates generally to vehicular HVAC systems, condensate production and usage.

BACKGROUND OF THE APPLICATION

[0004] Known vehicular heating, ventilation, and air conditioning ("HVAC") systems are designed to control the climate of a vehicle's interior. In general operation, air is directed from outside a vehicle through the HVAC system where the air may be warmed via a heater core or cooled via an air conditioning evaporator. A byproduct of air conditioning is condensate that collects on the air conditioning evaporator. In other words, as air passes over the air conditioning evaporator the water that is in the air condenses on the cool evaporator's surface and eventually drips out of a drain tube outside of the vehicle.

[0005] Techniques have been developed to capture and use condensate as opposed to allowing the condensate to simply being wasted by dripping out from a vehicle onto the ground. For example, techniques are known for capturing condensate and sending it to a window washer fluid reservoir or to a vehicle radiator. However, in low temperature conditions, e.g., below 0.0 degrees Celsius, it becomes difficult to produce condensate, not only because of the low ambient temperature realized, but also due to the lower amount of water that is present in air at such low ambient temperatures. The ability to promote air conditioning evaporator condensate production under such ambient conditions is desired.

SUMMARY OF THE APPLICATION

[0006] The present application is directed to a vehicular HVAC system including (1) a first outside air intake and a second recycled cabin air intake; (2) a blower fan in fluid communication with the first and second air intakes for blowing air out through one or more downstream system outlets; (3) an air conditioning assembly downstream of the blower fan for cooling blown air; (4) a heater assembly downstream of the air conditioning assembly for heating blown air; (5) an air channel defined by an inlet and an outlet, the air channel being operationally configured to route air heated by the heater assembly to a location within the system upstream of the blower fan; wherein the inlet includes an airflow control member effective to dictate air flow through the air channel according to one or more ambient environmental conditions; and (6) control circuitry operationally configured to measure one or more ambient environmental conditions and regulate the airflow control member between open and closed positions according to the one or more measured ambient environmental conditions.

[0007] The present application is also directed to a vehicular HVAC system including (1) one or more air inlets; (2) one or more air outlets in fluid communication with the one or more air inlets; (3) a blower fan in fluid communication with the one or more air inlets for blowing air through the system and out through the one or more air outlets; (4) an air conditioning assembly including an A/C evaporator for cooling air blown by the blower fan; (5) a heater assembly including a heater core for heating air blown by the blower fan; (6) an air channel having an inlet at a position downstream of the heater core and an outlet at a position upstream of the blower fan; (7) a plurality of airflow control members each being operable between open and closed positions for dictating directional air flow through the system including an airflow control member located at the inlet of the air channel operationally configured to dictate air flow through the air channel; and (8) control circuitry operationally configured to measure one or more ambient environmental conditions and set the airflow control members to open and closed positions according to the one or more measured ambient environmental conditions.

[0008] The present application is also directed to a method for optimizing temperature dew point of an A/C evaporator of a vehicular HVAC system, comprising (1) providing a vehicular HVAC system including an air channel operationally configured to route air heated by a system heater core to a location upstream of a system blower fan and downstream of one or more system air inlets, the air channel having an inlet including a airflow control member regulated by control circuitry to change between a normal closed position and one or more open positions for controlling the flow of heated air through the air channel according to a measured ambient temperature of the system in relation to a target ambient temperature of the system; and (2) when the measured ambient temperature of the system is below the target ambient temperature of the system, signaling the airflow control member to open from a closed position allowing a desired amount of air heated by the heater core to flow through the air channel to be blown by the blower fan over an A/C evaporator of the system.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0009] Figure 1 shows a simplified illustration of a prior art vehicular HVAC system.

[0010] Figure 2 shows a simplified illustration of a vehicular HVAC system of the present application.

[0011] Figure 3 shows an exemplary A/C condensate reclamation system of the vehicular HVAC system of the present application.

[0012] Figure 4 is a first segment of an exemplary schematic of representative control circuitry of an exemplary A/C condensate reclamation system of the vehicular HVAC system of the present application.

[0013] Figure 5 is a second segment of the control circuitry of Figure 4.

[0014] Figure 6 is a third logic circuit of the control circuitry of Figures 4 and 5.

[0015] Figure 7 is a fourth logic circuit of the vehicular HVAC system of the present application.

[0016] Figure 8 is an exemplary logic flow scenario of the vehicular HVAC system of the present application.

[0017] Figure 9 is another exemplary logic flow scenario of the vehicular HVAC system of the present application.

[0018] Figure 10 is another exemplary logic flow scenario of the vehicular HVAC system of the present application.

DETAILED DESCRIPTION

[0019] Before describing the invention in detail, it is to be understood that the present system and method are not limited to particular embodiments. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting. As used in this specification and the appended claims, the terms “Air Conditioner,” “A/C” and “AC” may be used interchangeably. As used in this specification and the appended claims, “vehicle,” “vehicular” and like terms refer to any motorized mode of conveyance capable of traveling across land, rail, water or air. The terms “vehicle cabin” and “cabin” may be used interchangeably.

[0020] In one aspect, the application provides a vehicular HVAC system for promoting A/C evaporator condensate production.

[0021] In another aspect, the application provides a vehicular HVAC system for promoting and using A/C evaporator produced condensate.

[0022] In another aspect, the application provides a vehicular HVAC system and method to increase the temperature of air flowing over an A/C evaporator of the system.

[0023] In another aspect, the application provides a vehicular HVAC system and method for dew point optimization in regard to A/C evaporator condensate production.

[0024] With attention to **FIG. 1**, a known HVAC system **900** used to control the climate of a vehicle's interior is provided. HVAC systems **900** on vehicles such as automobiles have various controls and settings for producing hot air, cold air as well as a defrost dry air setting. As understood by the skilled artisan, the mechanisms for producing hot air may be referred to as the "heater" or "heater assembly" and the mechanisms for producing cold air may be referred to as the "cooler" or "air conditioner." As also understood by the skilled artisan, HVAC systems are typically powered via the vehicle power source.

[0025] A typical HVAC system **900** includes an air conditioner assembly including a compressor, condenser, expansion valve and evaporator. A typical HVAC system **900** also includes a heater assembly including a heater core, which is a radiator like device in fluid communication with a vehicle's engine/radiator and operationally configured to circulate hot coolant received from the engine/radiator and gives off heat that may be directed to the cabin of a vehicle. In an embodiment where the HVAC system **900** is used with an automobile, the heater core is typically located under the dashboard of the automobile.

[0026] The first thing of note in the system **900** of **FIG. 1** is the airflow regulator or recirculation airflow control member that may be provided in the form of a valve, damper, pivotal door or flap **901** for dictating whether air entering the HVAC system **900** is received from outside the cabin **902** or is recirculated air from inside the cabin **903**. Outside air **902**, which is typically taken in from under a wiper cowl (not shown) of a vehicle, has to pass through a cabin air filter **904** before making its way into the rest of the HVAC system **900**. Air coming into the system **900** is directed through a blower fan or blower motor **905**, which determines how hard to blow air into the cabin of a vehicle.

[0027] The blown air typically first passes through an A/C evaporator **906** as shown (see the directional arrows of system **900**). As understood by the skilled artisan, the A/C evaporator **906** does not automatically absorb heat, in other words, the A/C evaporator **906** does not cool the blown air unless a compressor (not shown) is activated. Therefore, the evaporator **906** does not need to be bypassed when a vehicle's A/C is not in use. From the A/C evaporator **906** the air is directed to an airflow control member in the form of a blend valve, damper, pivotal door or flap **907**. The airflow control member **907** dictates how much air passes through the downstream heater core **908**. As understood by the skilled artisan, the heater core **908** has engine coolant passing through it, meaning that the heater core **908** is hot any time the engine is hot.

[0028] In operation, once the system **900** reaches a desired cabin air temperature the air is suitably directed to the cabin of the vehicle via one or more system outlets or vents, e.g., one or more main vents **909**, one or more defrost vents **910**, one or more floor vents **911**, according to operator settings controlling the various airflow control members of the system **900** as shown in **FIG. 1** via system control circuitry. As shown, the exemplary HVAC system **900** includes airflow control members provided as valves, dampers, pivotal doors or flaps **912** and **913**, and combinations thereof, for directing air toward one or more of the vents. As understood by persons of ordinary skill in the art, vehicular airflow control members include electric actuators in electrical communication with system control circuitry for moving and/or controlling the airflow control members.

[0029] A typical HVAC system also includes a condensate drain plug **914** for removing condensate from the system that is produced during operation of the system's air conditioner. As **FIG. 1** further illustrates, the air passing over the A/C evaporator **906** is limited to external ambient air **902** and/or recirculated air **903**. Thus, the highest temperature of air passing over the A/C evaporator **906** is limited to the ambient temperature of air external the vehicle, the temperature of the air inside the cabin of the vehicle used for recirculation, or a combination of the two. In extremely cold weather conditions, the external air and/or the cabin air may include a temperature at about 0.0 degrees Celsius or less – a temperature typically too low for adequate A/C evaporator condensate production.

[0030] With reference now to a simplified illustration of the present HVAC system as shown in **FIG. 2**, the present HVAC system **10** is suitably operationally configured to route a desired amount of air that is heated by the heater core back upstream of the blower motor. By routing an amount of heated air back through the blower motor, the temperature of the air passing over or through the A/C evaporator is higher than the temperature would otherwise be in a prior art system **900** as described in reference to **FIG. 1**. In other words, the temperature of the air passing over or through the A/C evaporator in the present system **10** can be raised to a temperature higher than the air passing over or through the A/C evaporator in a system **900** as described in reference to **FIG. 1**.

[0031] As **FIG. 2** illustrates, the system **10** includes a first air intake or air inlet port **12** for receiving outside ambient air and a second air intake or air inlet port **14** for receiving recycled air from the cabin of the vehicle. The source of air entering the system **10** is suitably regulated by an airflow control member **18**, depicted here as a pivotal flap, which is operationally configured to pivot about its attachment point to the system **10** (see Arrow **AA)** in a manner effective to (1) substantially seal off inlet port **12** limiting air flow into the system **10** via inlet port **14**, (2) substantially seal off inlet port **14** limiting air flow into the system **10** via inlet port **12**, or (3) be positioned in a manner effective to allow air to enter the system **10** via both inlet ports **12** and **14** simultaneously. In another embodiment, the airflow control member **18** may be provided in the form of a butterfly valve, damper or equivalent.

[0032] As understood by the skilled artisan, the various airflow control members of the system **10** may be controlled by an operator located in the cabin of the vehicle. As also understood by the skilled artisan, when the system **10** is set to defrost mode the system **10** may be operationally configured to receive only ambient outside air via inlet port **12** unless an operator manually requests recirculated air via inlet port **14**. Likewise, when the system **10** is set to maximum air-condition mode, the system **10** may use only recirculated air via inlet port **14** unless an operator manually requests ambient outside air via inlet port **12**.

[0033] Similar as described in reference to **FIG. 1**, outside ambient air entering the present system **10** via inlet port **12** may first pass through an air filter **16** before passing through a blower fan **17**. As understood by a skilled artisan, the flow rate of air through the system **10** may be adjusted by adjusting the speed of the blower fan **17** as is common to vehicle HVAC systems.

[0034] As shown, air passes from the blower fan **17** through an A/C evaporator **20** at a desired rate where the air is then directed through a heater core **22**, around the heater core **22** or both according to the orientation of airflow control member **24**. As shown, the airflow control member **24** may be provided in the form of a pivotal door or flap operationally configured to pivot about its attachment point to the system **10** (see Arrow **BB**) in a manner effective to (1) substantially seal off air flow to the heater core **22** thereby routing air flow around the heater core **22**, (2) direct substantially all air flow through the heater core **22** as shown in **FIG. 2**, or (3) be positioned in a manner effective to allow air to flow through the heater core **22** and around the heater core **22** simultaneously. For example, when a vehicle operator desires to send heated air to the cabin, the system **10** controls may be set as shown in

FIG. 2 forcing air through the heater core **22** thereby heating the air before the air is directed to the cabin by way of one or more floor vents **26**, one or more dash vents **27** or one or more defrost vents **28**, or combinations thereof. When a vehicle operator desires to send cooled air to the cabin, the airflow control member **24** may be directed to block air flow to the heater core **22** forcing air cooled by the A/C evaporator **20** to be routed around the heater core **22** to the cabin by way of one or more floor vents **26**, one or more dash vents **27** or one or more defrost vents **28**, or combinations thereof. Suitably, a series of airflow control members **29A** and **29B** are provided for directing air flow through the one or more vents **26**, **27**, **28** according to operator cabin settings (see Arrows **CC** and **DD**). Although the airflow control members **24**, **29A** and **29B** are shown as pivotal flaps, in another embodiment, one or more of the airflow control members **24**, **29A** and **29B** may be provided in the form of butterfly valves, dampers, or the like.

[0035] Still referring to **FIG. 2**, a novel feature of the present system **10** includes the air channel or passage **30** defining a sealed air pathway operationally configured as a heat boost of the system **10** for routing air that is heated by the heater core **22** back upstream of the blower fan **17** as shown. The air channel **30** is suitably defined by a fluid inlet located downstream of the heater core **22** and a fluid outlet located upstream of the blower fan **17**. The inlet of the air channel **30** suitably includes an airflow control member or closure member **32** operationally configured to regulate air flow through the air channel **30** according to system **10** programming or operator cabin settings. As shown, the closure member **32** may include a pivotal flap operationally configured to be directed between a closed and open position (see Arrow **EE**). In another embodiment, the closure member **32** may include a butterfly valve, damper or the like as understood by persons of ordinary skill in the art of vehicle HVAC systems.

[0036] In a fully closed position, the closure member **32** is operationally configured to substantially seal off the inlet of the air channel **30** blocking air flow there through. In a fully open position as shown in **FIG. 2**, the closure member **32** is operationally configured expose the inlet allowing a maximum amount of airflow into the air channel **30**. The closure member **32** may also be set to one or more partially open positions for allowing less than a maximum amount of air flow through the air channel **30** according to system **10** programming or operator cabin settings. The amount of air flowing into the air channel **30** may be determined according to the internal design of the system **10**, e.g., the design of the inner surface(s) or air flow paths of the system **10**, the location and orientation of the heater core **22**, the location and orientation of the inlet of the air channel **30** in relation to the heater core **22** and the position of the closure member **32** between a fully closed position and a fully open position. The rate of the blower fan **17** may also dictate the amount and/or rate of air flow through the air channel **30**.

[0037] As shown in **FIG. 2**, one suitable air channel **30** may be disposed along or near the perimeter of the system **10** adjacent the A/C evaporator **20** and heater core **22** in a manner effective for air flowing through the air channel **30** to blend with air entering the system **10** via inlet port **12** and/or inlet port **14** prior to being fed through the blower fan **17**. It should be noted that the configuration of the air channel **30**, including its length, inner dimensions and its volume may be altered according to one or more vehicle designs or as otherwise desired. In the example of **FIG. 2**, the air channel **30** may be part of a one piece system **10** construction. In another embodiment, the system **10** may include an assembly of component parts including a separate air channel **30** member attachable to the remaining system. In still another embodiment, the air channel **30** may include a conduit such as a tube, pipe, hose, or combination thereof, operationally configured to route heated air from a point in the system **10** downstream of the heater core **22** to a point in the system **10** upstream of the blower fan **17**. Without limiting the invention, for vehicular purposes a suitable air channel **30** may be operationally configured to route up to about 50.0 percent of the air flowing through the heater core **22** back upstream of the blower fan **17**. In another embodiment of the system **10** for vehicular purposes, an air channel **30** may be operationally configured to route from about 10.0 percent up to about 50.0 percent of the air flowing through the heater core **22** back upstream of the blower fan **17**.

[0038] Still referring to **FIG. 2**, the present system **10** may also include a vehicular A/C condensate reclamation system **100** operationally configured to capture and store condensate originating from the A/C evaporator and convey the condensate to one or more reservoirs for further use of the condensate, e.g., conveying captured condensate to refill a windshield wiper fluid reservoir of the vehicle. Suitable systems **100** include, but are not necessarily limited to those as described in United States Patent Number 8,865,002 B2 entitled "Processing Captured Vehicle Fluid" issued on October 21, 2014 and International Patent Application Number PCT/US 15/59758 filed on November 9, 2015 entitled "Processing Captured Vehicle Fluid," each of which is herein incorporated by reference in its entirety. The present system **10** may incorporate the power source and electrical system of the system **100** as described below.

[0039] One exemplary vehicular A/C condensate reclamation system **100** is provided in **FIG. 3**. The system **100** suitably includes an electrical system defined by control circuitry, fluid volume sensors and ambient temperature sensors, the control circuitry being in communication with (1) a system pump **114** operationally configured for the transfer or conveyance of captured condensate fluid, (2) fluid volume sensor systems of the various reservoirs of the system **100** and (3) reservoir valves for dictating condensate fluid flow in and out of the reservoirs of the system **100**.

[0040] The system **100** is suitably communicated with an A/C assembly including an A/C evaporator **20**, drip pan **112** and A/C drain plug **118** and includes a fluid reservoir assembly (or "control module **113**") for (a) receiving and storing condensate from the A/C evaporator **20**, (b) controlling condensate circulation through the system **100** and (c) controlling the chemical composition of condensate in the control module **113**. The system **100** also includes a power source **117**, either a vehicular power source, e.g., lead-acid battery, or a separate power source having a positive terminal and a ground, in electrical communication with the electrical system of the system **100**, e.g., the control circuitry (not shown) of the control module **113**. The system **100** also suitably includes a first post-treatment fluid reservoir assembly **124** in fluid communication (see Arrow **100A**) and in circuit communication with the control module **113**. In one exemplary embodiment, the first post-treatment fluid reservoir assembly **124** may operate as the windshield wiper fluid reservoir of a vehicle.

[0041] Still referring to **FIG. 3**, a suitable system **100** may also include a chemical reservoir assembly **125** with a fluid inlet **160**, the chemical reservoir assembly **125** being in fluid communication (Directional Arrow **100B**) and in circuit communication with the control module **113** and a temperature sensor (not shown) operationally configured to measure the ambient temperature of the system **10**. The chemical reservoir assembly **125** suitably houses one or more chemical based fluids operationally configured to be added to the control module **113** via activation of a valve member **126** to provide a fluid chemical additive to the condensate stored in the control module **113** when the chemical reservoir assembly **125** has fluid to give according to one or more fluid volume sensors **164**. The resulting chemical fluid mixture in the control module **113** may be conveyed downstream to one or more post-treatment fluid reservoirs including the first post-treatment fluid reservoir assembly **124**. In one embodiment, the chemical reservoir assembly **125** may deliver one or more chemical based fluids to the control module **113** via gravity. As shown in **FIG. 3**, in another embodiment the chemical reservoir assembly **125** may include a pump **162** at an outlet of the fluid storing reservoir of the assembly **125** for conveying one or more fluid chemicals to the control module **113** to provide a fluid mixture therein. In one embodiment, the chemical reservoir assembly **125** may be operationally configured to deliver one or more antifreeze chemicals to the control module **113** to mix with condensate to provide a fluid mixture operable at freezing and subfreezing temperatures.

[0042] The system **100** may also include a treatment member **127** in fluid communication with the control module **113** and the post-treatment reservoir **124** that is operationally configured to act on the captured condensate or fluid mixture being pumped out of the control module **113** to provide a fluid product in the one or more post-treatment reservoirs. Suitable treatment of the captured condensate or condensate mixture at the treatment member **127** may be accomplished according to one or more of the following techniques: (1) filtering the captured condensate or condensate mixture to remove undesired fluid(s), undesired impurities, particulates, and/or undesired organic matter; (2) altering the temperature of the captured condensate or condensate mixture; (3) altering the chemical constituency of the captured condensate or condensate mixture; (4) altering the pH of the captured condensate or condensate mixture; (5) separating fluid constituents of the captured condensate or condensate mixture into a plurality of fluid streams, e.g., fluids having different viscosities; (6) altering the color of the captured condensate or condensate mixture; and combinations thereof.

[0043] In an embodiment of the system **10** including a vehicular A/C condensate reclamation system **100** as described above, the control circuitry is suitably provided in the form of a printed circuit board ("PCB") housed in the control module **113**, the control circuitry being in electrical communication with the power source **117** of the vehicle, with the fluid reservoir assembly, the chemical reservoir assembly **125** and the one or more post-treatment reservoir assemblies such as the first post-treatment fluid reservoir assembly **124** described above. The control circuitry is also in electrical communication with sensors for measuring the ambient air temperature and/or relative humidity ("R/H") of the system **10** and in electrical communication with the various airflow control members of the system **10** (see **FIG. 2**), the control circuitry being operationally configured to direct the airflow control members between fully open and fully closed positions according to control circuitry programming based on the readings of one or more sensors of the system **10**. The various sensors may include one or more air temperature sensors and/or relative humidity sensors, or in the alternative, a combined air temperature and relative humidity sensor packaged in a like housing. As such, the control circuitry of the present system **10** is operationally configured to orient the various airflow control members in a manner effective to optimize the dew point of the system **10** to enable A/C evaporator **20** condensate production irrespective of the ambient environmental conditions of the system **10**, e.g., the air temperature and/or relative humidity of the system **10**. In another aspect, the control circuitry may be operationally configured to safeguard the A/C condensate reclamation system **100** against non-requested operation according to the volume of condensate, fluid mixtures and chemical fluids available in the several reservoirs of the system **100**.

[0044] In an embodiment of the system **10** not including a vehicular A/C condensate reclamation system **100** as described above, the electrical system provided suitably includes control circuitry in electrical communication with one or more ambient air temperature sensors and/or one or more relative humidity sensors, or in the alternative, a combined air temperature and relative humidity sensor packaged in a like housing. The control circuitry is also electrically communicated with the various airflow control members of the system **10** (see **FIG. 2**), the control circuitry being operationally configured to direct the airflow control members between fully open and fully closed positions based on the sensor readings regarding the ambient air temperature and/or relative humidity according to control circuitry programming in a manner effective to optimize the dew point of the system **10** to enable A/C evaporator **20** condensate production irrespective of one or more ambient environmental conditions.

[0045] As understood by the skilled artisan, the dew point or dew point temperature is the saturation temperature for water in air. For purposes of the present application, the dew point of the system **10** is the temperature at which condensate forms on the A/C evaporator **20**. As such, the system **10** is operationally configured to optimize condensate formation on the A/C evaporator **20** in order to ensure the presence of condensate for system **10** use.

[0046] The dew point of the system **10** may be subject to change according to one or more ambient conditions, including but not necessarily limited to the ambient temperature and relative humidity of the system **10**. In regard to a system **10** configured for an automobile, the temperature of the air entering the system **10** and the relative humidity of the system **10** are directly correlated to the amount of condensate produced during operation of the system's air conditioner assembly. Table 1 below provides exemplary condensate production of a typical automotive HVAC system continuously operating with recycled air. As Table 1 shows, condensate production typically drops at lower ambient temperatures and at a lower relative humidity. In other words, condensate production typically drops at lower A/C Evaporator **20** temperature dew points.

[0047] Table 1

Inside Cabin Temperature °C / °F	Relative Humidity %	A/C Evaporator **20** Temperature Dew Point °C / °F	Volume of Condensate Produced Per Hour liters / ounces
10 / 50	20	12.2 / 10	0 / 0

10 / 50	30	-6.7 / 20	0 / 0
10 / 50	40	-3.3 / 26	*0.12 / 4
10 / 50	50	0 / 32	0.4 / 15
10 / 50	60	2.8 / 37	0.89 / 30
15.6 / 60	20	-7.8 / 18	0 / 0
15.6 / 60	30	-2.7 / 27	* 0.18 / 6
15.6 / 60	40	1.7 / 35	0.4 / 15
15.6 / 60	50	4.4 / 40	0.89 / 30
15.6 / 60	60	7.2 / 45	1.2 / 40
21.1 / 70	20	-2.8 / 27	* 0.09 / 3
21.1 / 70	30	2.8 / 37	0.3 / 10
21.1 / 70	40	6.7 / 44	0.6 / 20
21.1 / 70	50	10 / 50	1.2 / 40
21.1 / 70	60	12.8 / 55	1.8 / 60
21.1 / 70	70	15.6 / 60	2.4 / 80
26.7 / 80	20	2.2 / 36	0.15 / 5
26.7 / 80	30	7.8 / 46	0.44 / 15
26.7 / 80	40	12.2 / 54	0.89 / 30
26.7 / 80	50	15.6 / 60	1.8 / 60
26.7 / 80	60	18.3 / 65	2.4 / 80
26.7 / 80	70	21.1 / 70	2.96 / 100
26.7 / 80	80	23.3 / 74	3.55 / 120
32.2 / 90	20	6.1 / 43	0.3 / 10
32.2 / 90	30	12.2 / 54	0.6 / 20

32.2 / 90	40	16.7 / 62	1.2 / 40
32.2 / 90	50	20.6 / 69	2.1 / 70
32.2 / 90	60	23.3 / 74	2.96 / 100
32.2 / 90	70	26.1 / 79	3.55 / 120
32.2 / 90	80	28.3 / 83	4.1 / 140
32.2 / 90	90	30 / 86	4.7 / 160
*When the A/C Evaporator **20** temperature is below 0.0 degrees Celsius condensate will collect onto the A/C Evaporator **20** in the form of frost and thereafter thaw into a liquid state as warmer air flows over the A/C Evaporator **20**.			

[0048] In view of the condensate production described in Table 1, in one embodiment the present system **10** is suitably operationally configured to maintain the A/C Evaporator **20** temperature dew point above about -6.7 degrees Celsius (20.0 degrees Fahrenheit) to ensure condensate production. In another embodiment, the present system **10** is suitably operationally configured to maintain the A/C Evaporator **20** temperature dew point at about 0.0 degrees Celsius (32.0 degrees Fahrenheit) or greater to ensure desired condensate production. As such, the control circuitry of the present system **10** is operationally configured to direct the closure member **32** to an open position or partially open position when a programmed target ambient temperature is realized, thus allowing heated air to flow through the air channel **30** thereby raising the temperature of air flowing over the A/C Evaporator **20** in a manner effective to promote condensate production upon the A/C Evaporator **20**.

[0049] **FIGS. 4 - 7** provide a schematic representation of control circuitry **115** of an embodiment of the system **10** including an A/C condensate reclamation system **100**. Provided via a PCB, the control circuitry **115** may include the above mentioned components, as well as one or more fuses, an optional power switch, an optional temperature switch, an optional timer relay to delay system pump **114** activation and/or determine the time for pump **114** operation once activated, flow switches and an optional operator signal, which in a particular embodiment may all lie in communication with a relay terminal. The fuses and switches include those known to persons skilled in electronic circuitry. With further reference to **FIGS. 4 - 7**, persons of ordinary skill in the art will appreciate that the various relays of the control circuitry **115** suitably open and close in a manner effective to accomplish various functions according to the established ambient temperature and/or relative humidity parameters of the system **10** including, but necessarily limited to: (1) setting the system pump **114** to an OFF position when both the control module **113** and post-treatment fluid reservoir **124** have sufficient fluid levels, (2) setting the system pump **114** to an ON position when the control module **113** has an adequate amount of fluid and the post-treatment fluid reservoir **124** has an insufficient fluid level thereby activating the pump **114**, (3) setting the system pump **114** to an OFF position when both the control module **113** and post-treatment fluid reservoir **124** are substantially empty or have low or insufficient fluid levels, (4) setting the pump **114** to an OFF position when the control module **113** has a low or insufficient fluid level (or empty) and the post-treatment fluid reservoir **124** has a sufficient fluid level, (5) setting the pump **114** to an OFF position when the ambient temperature of the system **10** drops to about freezing or below freezing and the chemical reservoir **125** is substantially empty, (6) setting the pump **162** (if present) to an ON position and the valve member **126** to an OPEN position to deliver fluid from the chemical reservoir assembly **125** to the control module **113** when the control module **113** is substantially empty according to temperature settings of the system **10**, (7) setting the closure member **32** to an OPEN position allowing air flow through the air channel **30** to promote condensate production when a set point, i.e., a preprogrammed ambient air temperature and/or relative humidity and/or A/C Evaporator **20** temperature dew point are realized and/or the control module **113** is substantially empty, (8) setting the closure member **32** to a CLOSED position preventing air flow through the air channel **30** during system **10** operation when a set point is not realized.

[0050] **FIG.** 7 provides an exemplary schematic representation of system **10** dew point optimization circuitry. Without limiting the invention, exemplary dew point optimization logic is provided in Table 2 below.

[0051] Table 2

D = A x B x C			
A	**B**	**C**	**D**
Temperature Below Set Point (0=NO)	Closure Member **32** (0 = CLOSED)	Heater/Defrost (0=OFF)	Output to Closure Member **32**
0	0	0	0
0	0	0	0
0	0	1	0
0	0	1	0
0	1	0	0
0	1	0	0
0	1	1	0
0	1	1	0
1	0	0	0
1	0	0	0
1	0	1	0
1	0	1	0
1	1	0	0

1	1	0	0
1	1	1	1

[0052] Without limiting the invention, for exemplary purposes, various scenarios of dew point optimization of the system **10** are described in **FIGS. 8 - 10**. **FIG. 8** provides a scenario including a vehicular system **10** with the heater or defrost set to an ON position but where the inlet air temperature of the system **10** is too low for adequate condensate production. In this scenario, the system **10** has a set point of 23.9 degrees Celsius (75.0 degrees Fahrenheit) and the control circuity **115** is programmed having a power supply circuit ("Circuit I") and a load circuit ("Circuit II") for the closure member **32** each set as "Normally Open" ("N/O") thereby setting the closure member **32**, via an actuator or motor, at a "Normally Closed" ("N/C") position. With the system **10** operating with either the heater or defrost set to an ON position and the inlet air temperature of the system **10** being at about 10.0 degrees Celsius (40.0 degrees Fahrenheit) and the relative humidity at about 40.0 percent or less, the control circuitry **115** is operationally configured to set Circuit I and Circuit II to a CLOSED position activating the actuator and setting the closure member **32** to an OPEN position allowing for air flow through the air channel **30**.

[0053] With attention to **FIG. 9**, in a scenario where a vehicular system **10** has a set point of 23.9 degrees Celsius (75.0 degrees Fahrenheit) and the control circuity **115** is programmed having a power supply circuit ("Circuit I") and a load circuit ("Circuit II") for the closure member **32** set as "Normally Open" ("N/O") thereby setting the closure member **32**, via an actuator or motor, at a "Normally Closed" ("N/C") position, with the system **10** operating with either the heater or defrost set to an ON position and the inlet air temperature of the system **10** is at about 25.6 degrees Celsius (78.0 degrees Fahrenheit) and the relative humidity is at about 20.0 percent or greater, the control circuitry **115** is operationally configured to set Circuit I to a CLOSED position and Circuit II to an OPEN position maintaining the closure member **32** in a CLOSED position preventing air flow through the air channel **30**.

[0054] With attention to **FIG. 10**, in a scenario where a vehicular system **10** has a set point of 23.9 degrees Celsius (75.0 degrees Fahrenheit) and the control circuity **115** is programmed having a power supply circuit ("Circuit I") and a load circuit ("Circuit II") for the closure member **32** set as "Normally Open" ("N/O") thereby setting the closure member **32**, via an actuator or motor, at a "Normally Closed" ("N/C") position, with the system **10** operating with either the heater or defrost set to an OFF position and the inlet air temperature of the system **10** is at about 10.0 degrees Celsius (40.0 degrees Fahrenheit) and the relative humidity is at about 40.0 percent or less, the control circuitry **115** is operationally configured to set Circuit I to an OPEN position and Circuit II to an CLOSED position maintaining the closure member **32** in a CLOSED position preventing air flow through the air channel **30**.

[0055] Suitably, the temperature sensor(s) employed as part of the system **10** may include ambient air temperature sensor(s) commonplace on modern vehicles such as automobiles. In one embodiment, the control circuitry **115** may be electrically communicated with the temperature sensor(s) of the vehicle for suitable system operation. In such embodiment, the ambient air temperature sensor may be electrically communicated with the control circuitry **115** inside the control module **113**, e.g., a suitable temperature sensor is provided in the form of a chip on a printed circuit board ("PCB") for measuring the ambient temperature during system **10** operation.

[0056] Suitably, the present system **10** is provided as an original equipment (hereafter "OE") system of a vehicle, but is also contemplated that an air channel **30** may be provided as an aftermarket type add-on to a pre-existing HVAC system of a vehicle depending on the availability of usable free space about the HVAC system for the possible addition of an air channel **30**. In addition, the system **10** may include an OE control module **113** provided as a one piece mold construction incorporated as part of a vehicle's drip pan **112** assembly. In another embodiment, a control module **113** may be provided as a separate after-market add-on type component for use with a pre-existing A/C assembly. For each type of system **10** employed, one or more of the component parts may vary in size and shape and proximity to one another according to the design features of a particular vehicle. In addition, one or more separate component parts of the system **10** may be provided as releasable members for replacement as desired or otherwise required. Also, two or more component parts may be provided as a one piece mold construction as desired.

[0057] Without limiting the system **10** to any particular materials of construction, a suitable system **10** is constructed from one or more materials including, but not necessarily limited to those materials resistant to chipping, cracking, excessive bending and reshaping as a result of ozone, weathering, heat, moisture, other outside mechanical and chemical influences, physical impacts, and combinations thereof. In one embodiment, the present system **10** may be constructed from like materials as known vehicle HVAC systems. Suitable materials may include, but are not necessarily limited to plastics, metals, composite materials, and combinations thereof. In one suitable example, the system **10** and/or its component parts may be constructed via plastic injection molding.

[0058] Persons of ordinary skill in the art will recognize that many modifications may be made to the present application without departing from the spirit and scope of the application. The embodiment(s) described herein are meant to be illustrative only and should not be taken as limiting the invention, which is defined in the claims.

I Claim:

1. A vehicular HVAC system including:

a first outside air intake and a second recycled cabin air intake;

a blower fan in fluid communication with the first and second air intakes for blowing air out through one or more downstream system outlets;

an air conditioning assembly downstream of the blower fan for cooling blown air;

a heater assembly downstream of the air conditioning assembly for heating blown air;

an air channel defined by an inlet and an outlet, the air channel being operationally configured to route air heated by the heater assembly to a location within the system upstream of the blower fan; wherein the inlet includes an airflow control member effective to dictate air flow through the air channel according to one or more ambient environmental conditions; and

control circuitry operationally configured to measure one or more ambient environmental conditions and regulate the airflow control member between open and closed positions according to the one or more measured ambient environmental conditions.

2. The vehicular HVAC system of claim 1 further including an A/C condensate reclamation system.

3. A vehicular HVAC system including:

one or more air inlets;

one or more air outlets in fluid communication with the one or more air inlets;

a blower fan in fluid communication with the one or more air inlets for blowing air through the system and out through the one or more air outlets;

an air conditioning assembly including an A/C evaporator for cooling air blown by the blower fan;

a heater assembly including a heater core for heating air blown by the blower fan;

an air channel having an inlet at a position downstream of the heater core and an outlet at a position upstream of the blower fan;

a plurality of airflow control members each being operable between open and closed positions for dictating directional air flow through the system including an airflow control member located at the inlet of the air channel operationally configured to dictate air flow through the air channel; and

control circuitry operationally configured to measure one or more ambient environmental conditions and set the airflow control members to open and closed positions according to the one or more measured ambient environmental conditions.

4. A method for optimizing temperature dew point of an A/C evaporator of a vehicular HVAC system, comprising:

providing a vehicular HVAC system including an air channel operationally configured to route air heated by a system heater core to a location upstream of a system blower fan and downstream of one or more system air inlets, the air channel having an inlet including an airflow control member regulated by control circuitry to change between a normal closed position and one or more open positions for controlling the flow of heated air through the air channel according to a measured ambient temperature of the system in relation to a target ambient temperature of the system; and

when the measured ambient temperature of the system is below the target ambient temperature of the system, signaling the airflow control member to open from a closed position allowing a desired amount of air heated by the heater core to flow through the air channel to be blown by the blower fan over an A/C evaporator of the system.

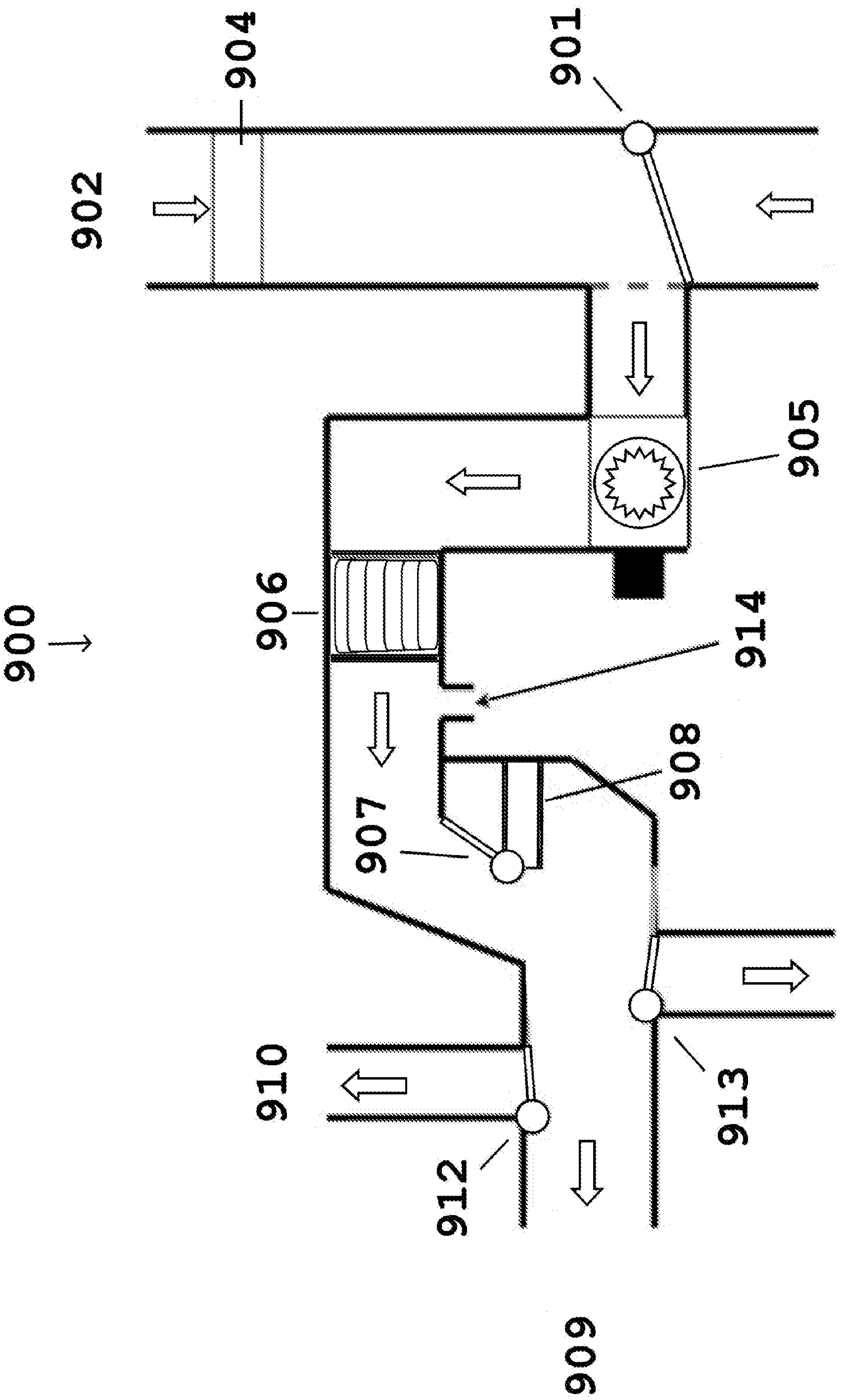

FIG. 1
Prior Art

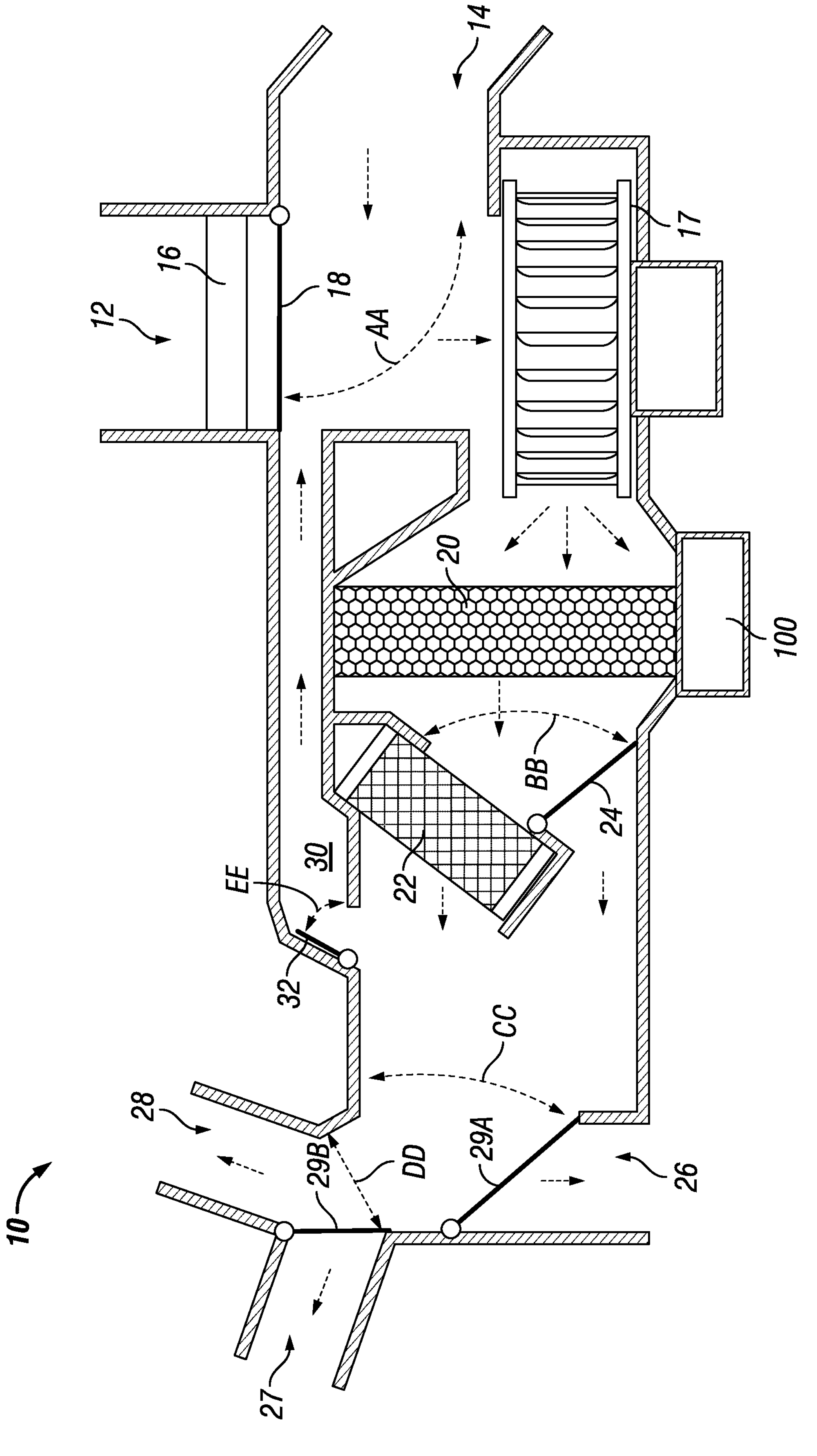

FIG. 2

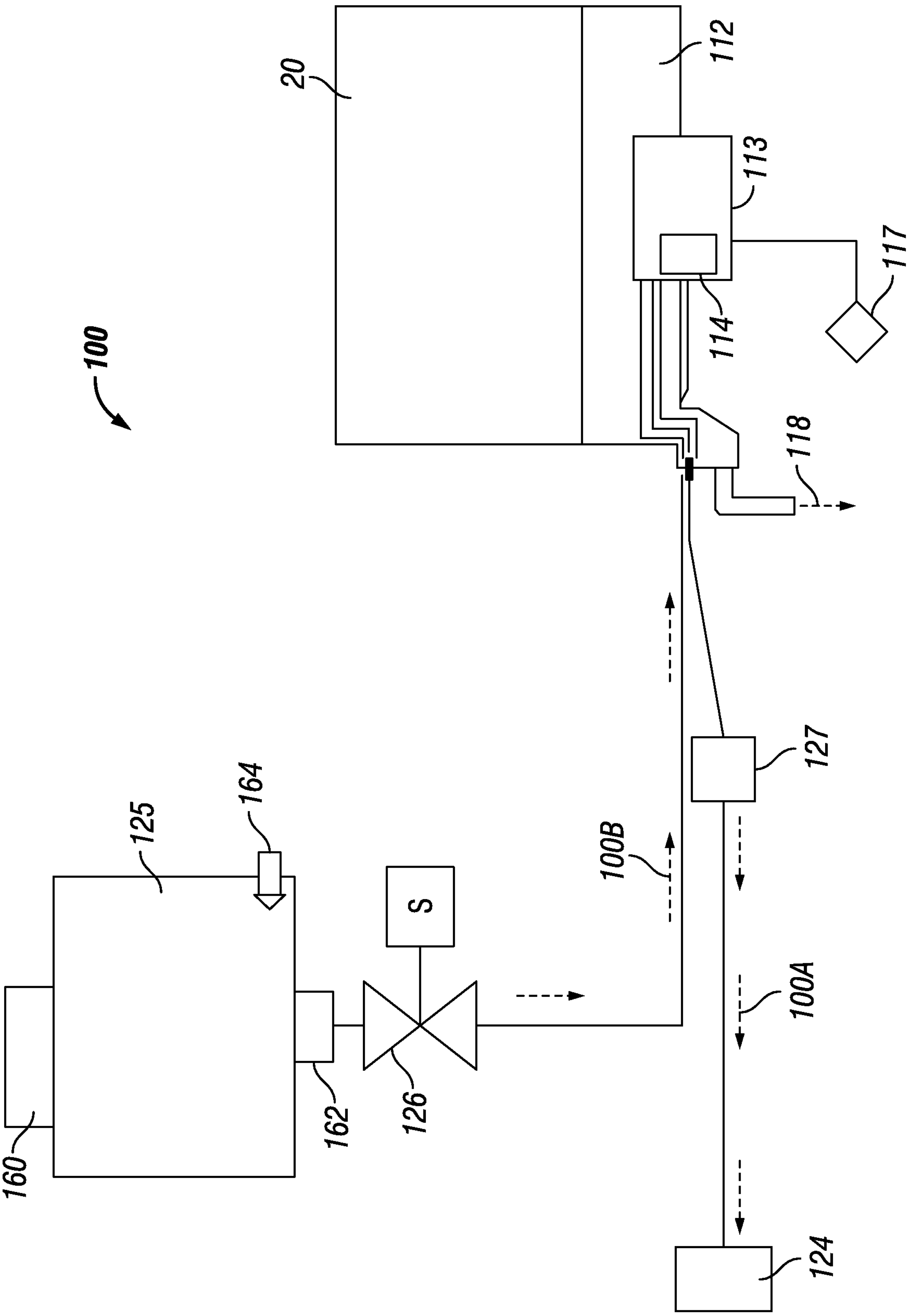
100
20
112
113
114
117
118
100B
127
164
125
S
100A
160
162
126
124

FIG. 3

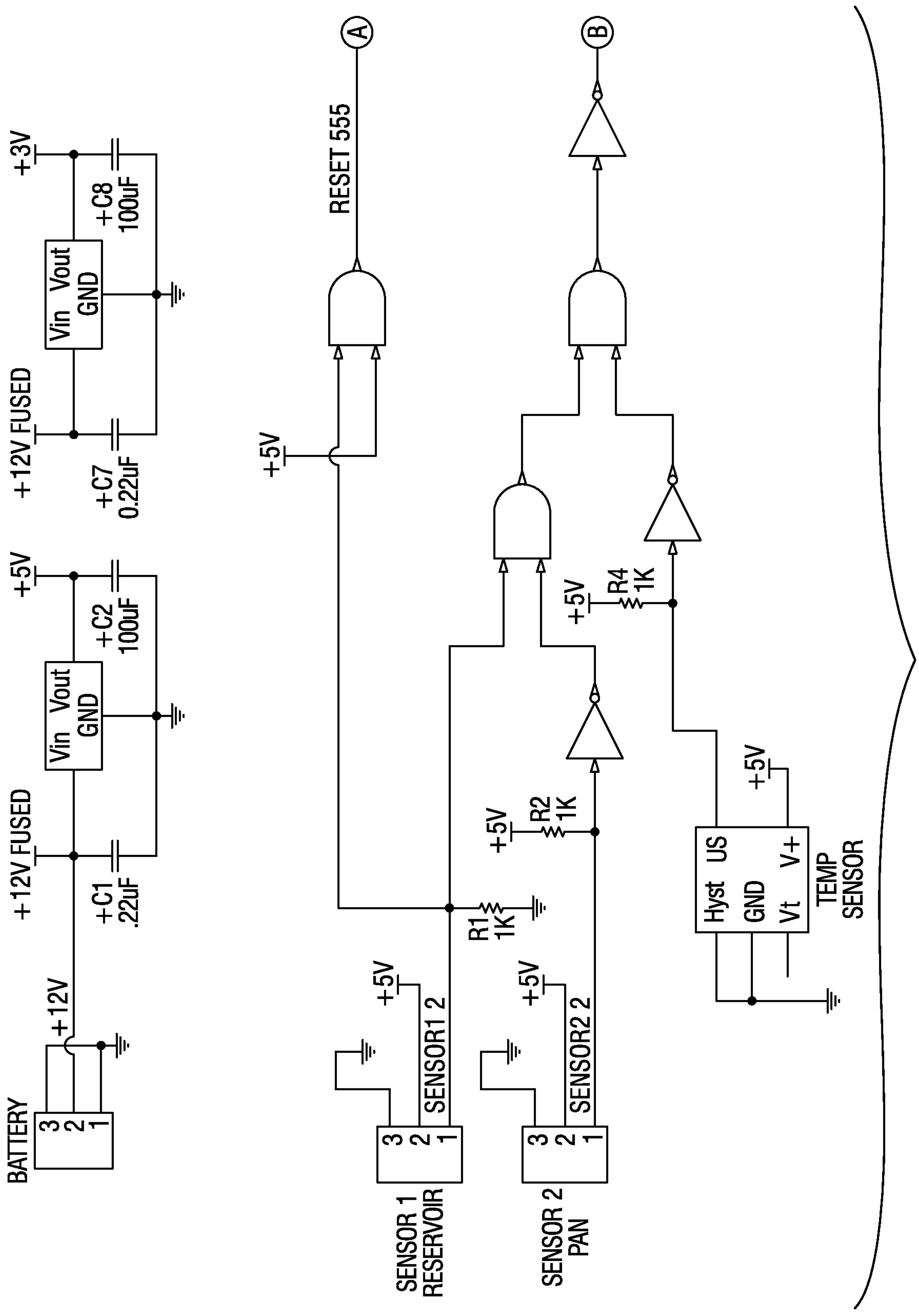
BATTERY
3
2
1
+12V
+12V FUSED
+C1
.22uF
Vin Vout
GND
+5V
+C2
100uF
+12V FUSED
+C7
0.22uF
Vin Vout
GND
+3V
+C8
100uF
SENSOR 1
RESERVOIR
SENSOR1 2
SENSOR 2
PAN
SENSOR2 2
R1
1K
R2
1K
R4
1K
+5V
RESET 555
A
B
Hyst US
GND
Vt V+
TEMP
SENSOR

FIG. 4

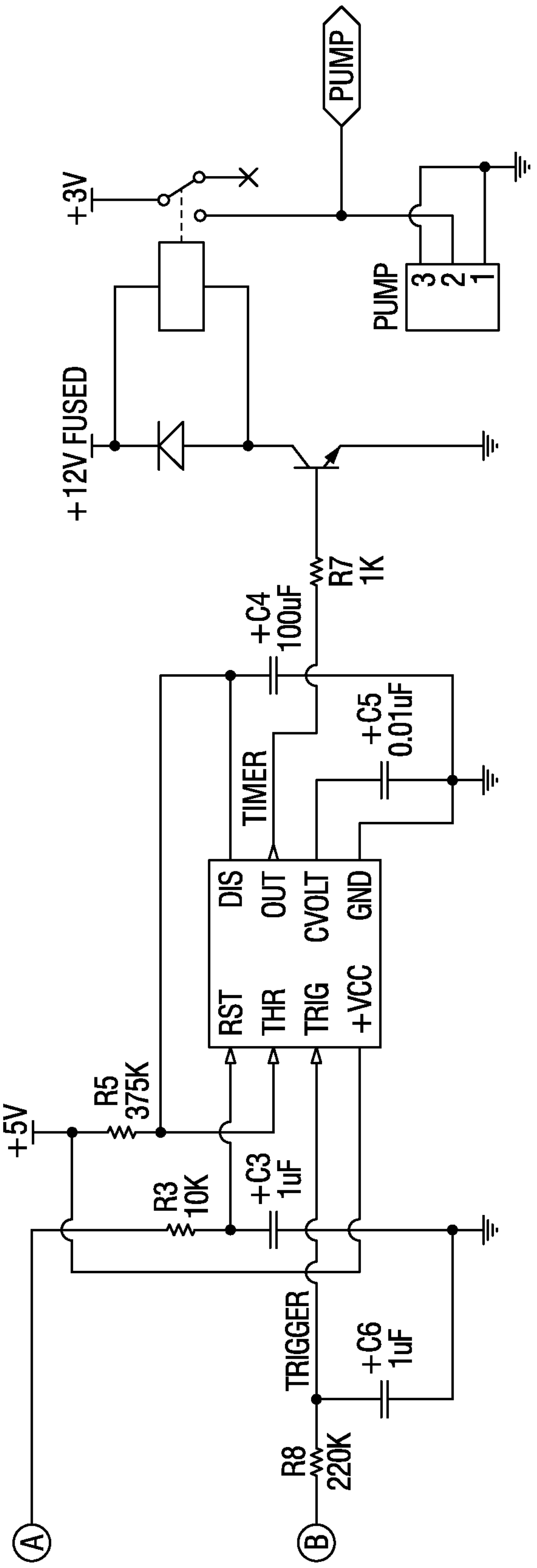
PUMP
+3V
+12V FUSED
PUMP
3
2
1
R7
1K
+C4
100uF
+C5
0.01uF
TIMER
DIS
OUT
CVOLT
GND
RST
THR
TRIG
+VCC
+5V
R5
375K
R3
10K
+C3
1uF
TRIGGER
+C6
1uF
R8
220K
A
B

FIG. 5

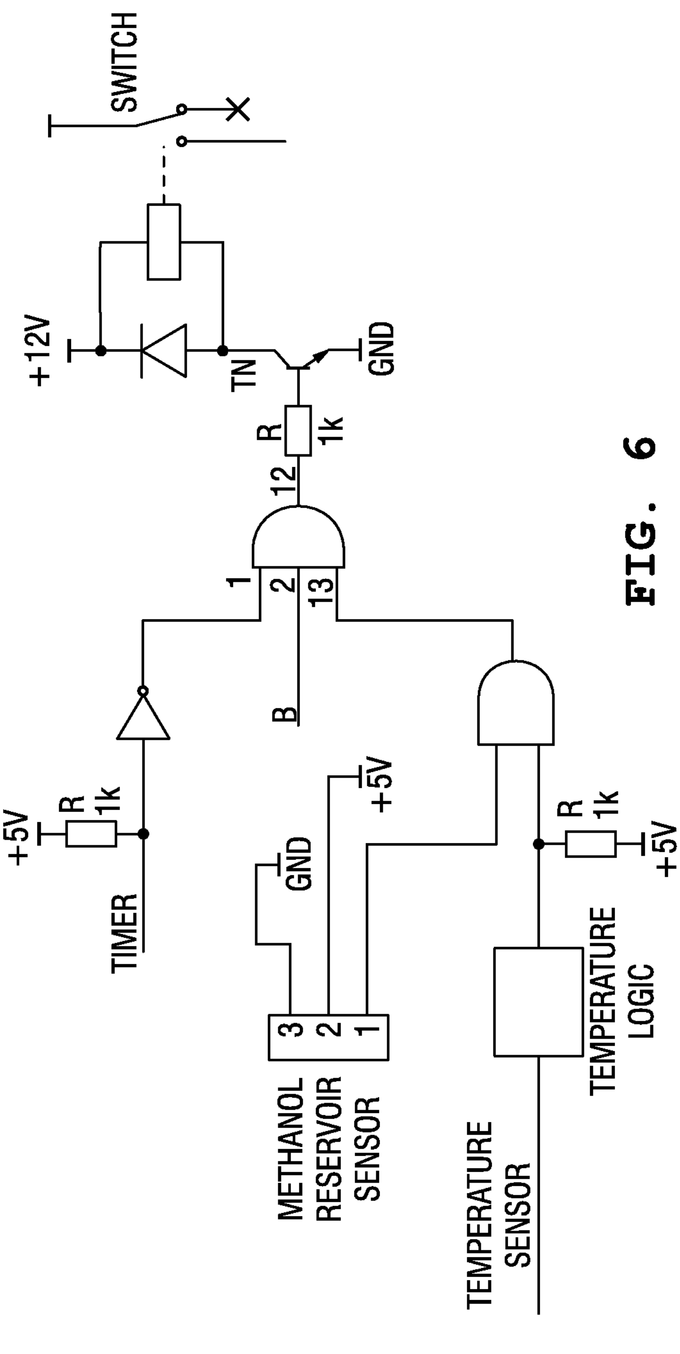
SWITCH
+12V
TN
GND
R
1k
12
1
2
13
B
+5V
R
1k
TIMER
GND
+5V
3
2
1
METHANOL
RESERVOIR
SENSOR
R
1k
+5V
TEMPERATURE
LOGIC
TEMPERATURE
SENSOR

FIG. 6

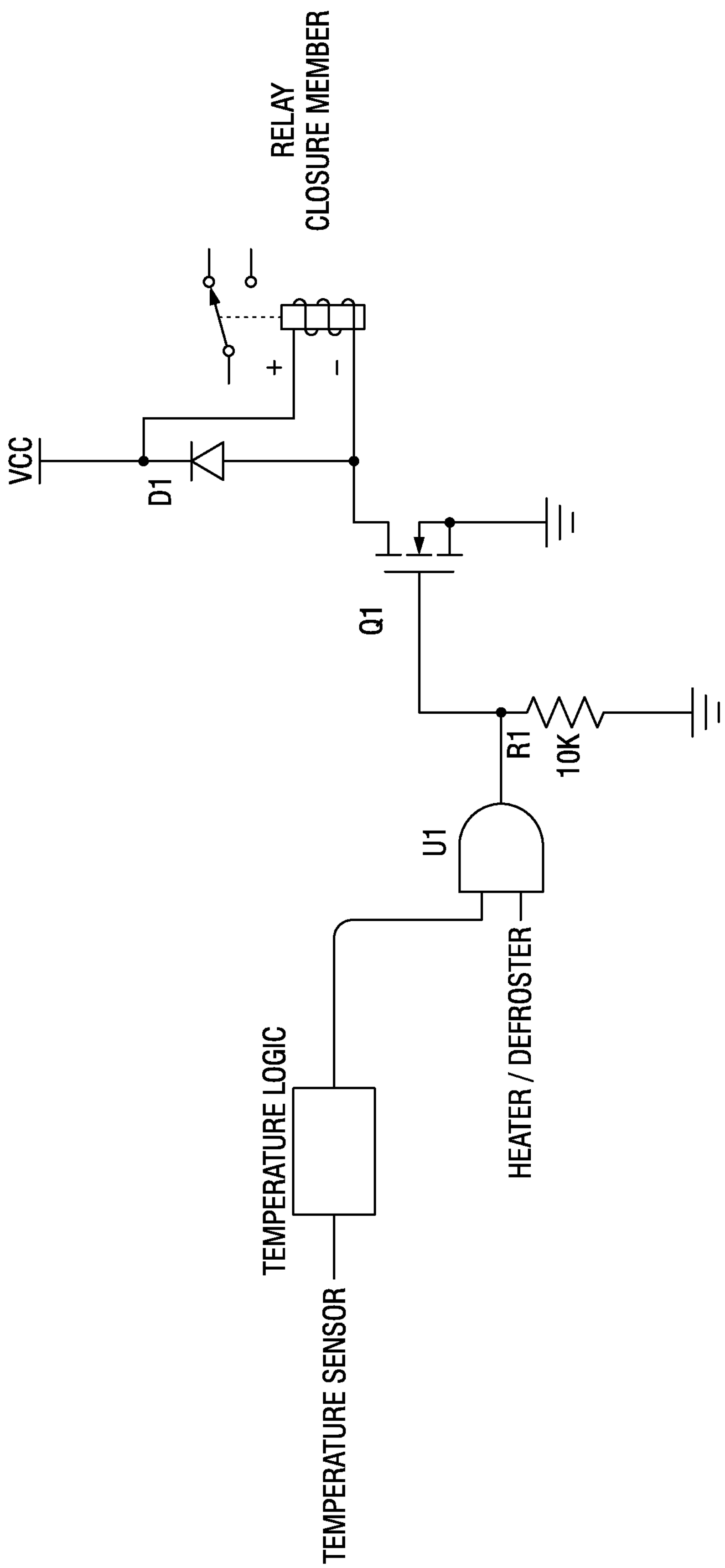
RELAY
CLOSURE MEMBER
+
–
VCC
D1
Q1
R1
10K
U1
TEMPERATURE LOGIC
TEMPERATURE SENSOR
HEATER / DEFROSTER

FIG. 7

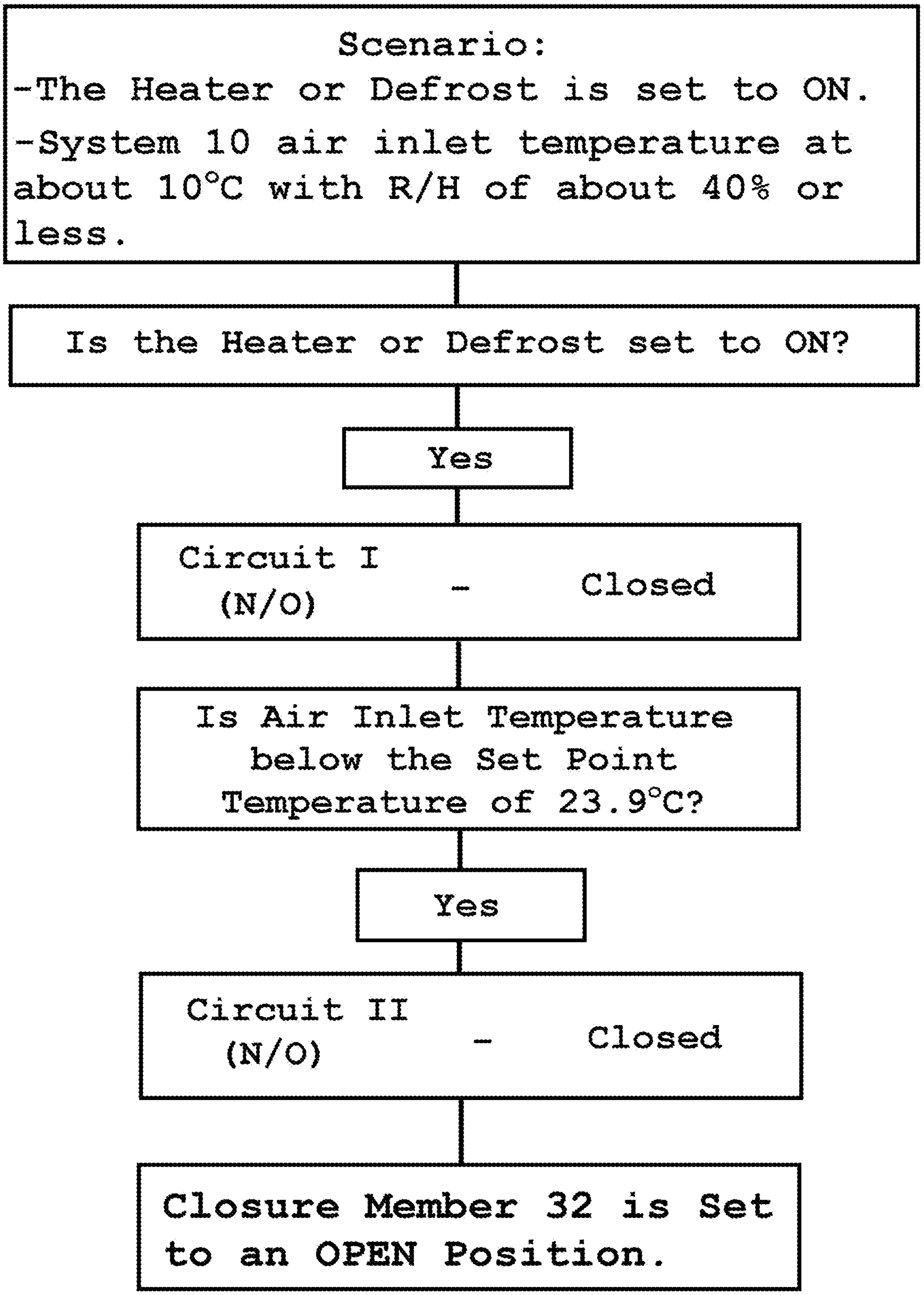
Scenario:
-The Heater or Defrost is set to ON.
-System 10 air inlet temperature at about 10°C with R/H of about 40% or less.
Is the Heater or Defrost set to ON?
Yes
Circuit I (N/O) - Closed
Is Air Inlet Temperature below the Set Point Temperature of 23.9°C?
Yes
Circuit II (N/O) - Closed
Closure Member 32 is Set to an OPEN Position.

FIG. 8

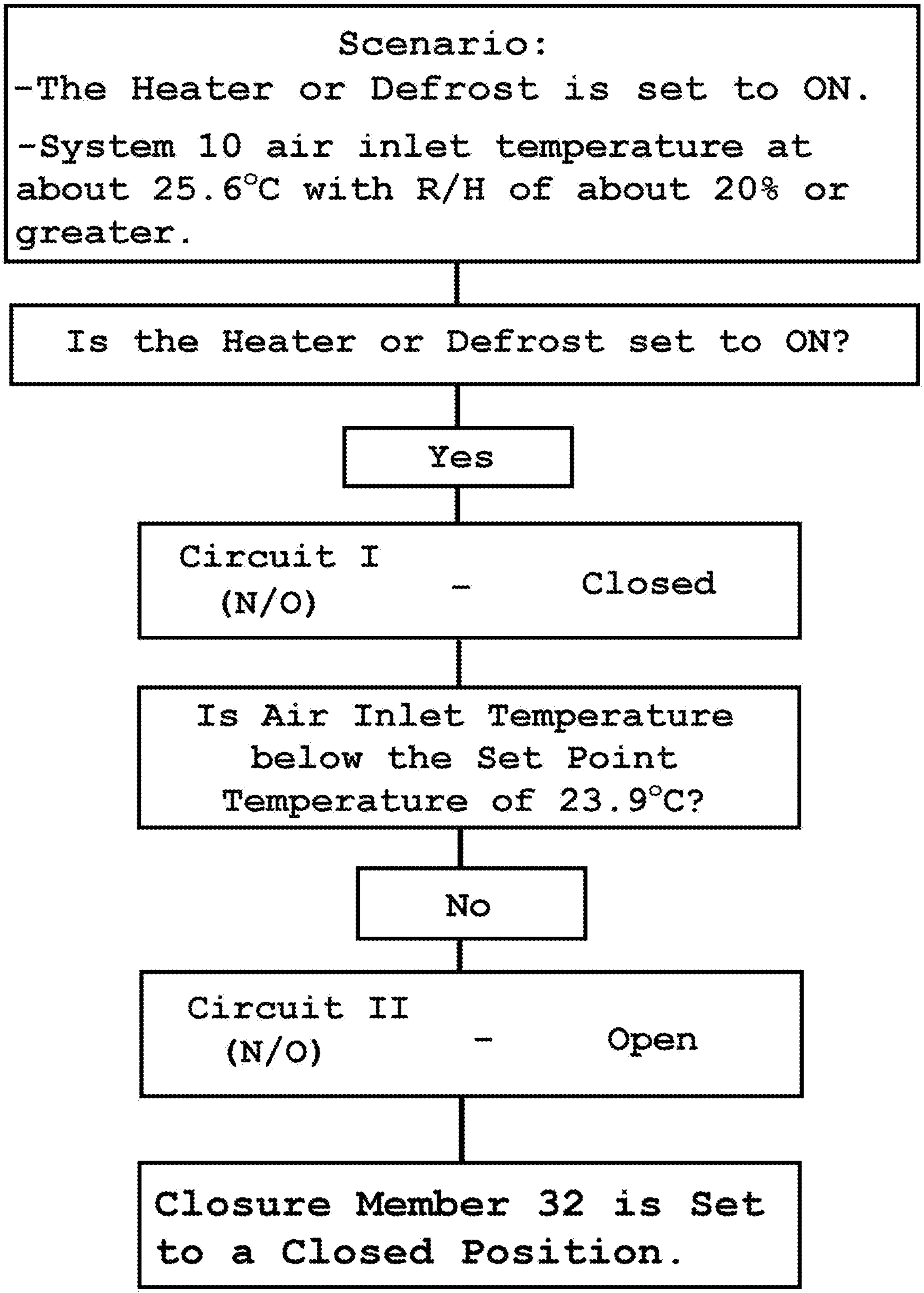
Scenario:
-The Heater or Defrost is set to ON.
-System 10 air inlet temperature at about 25.6°C with R/H of about 20% or greater.
Is the Heater or Defrost set to ON?
Yes
Circuit I (N/O) - Closed
Is Air Inlet Temperature below the Set Point Temperature of 23.9°C?
No
Circuit II (N/O) - Open
Closure Member 32 is Set to a Closed Position.

FIG. 9

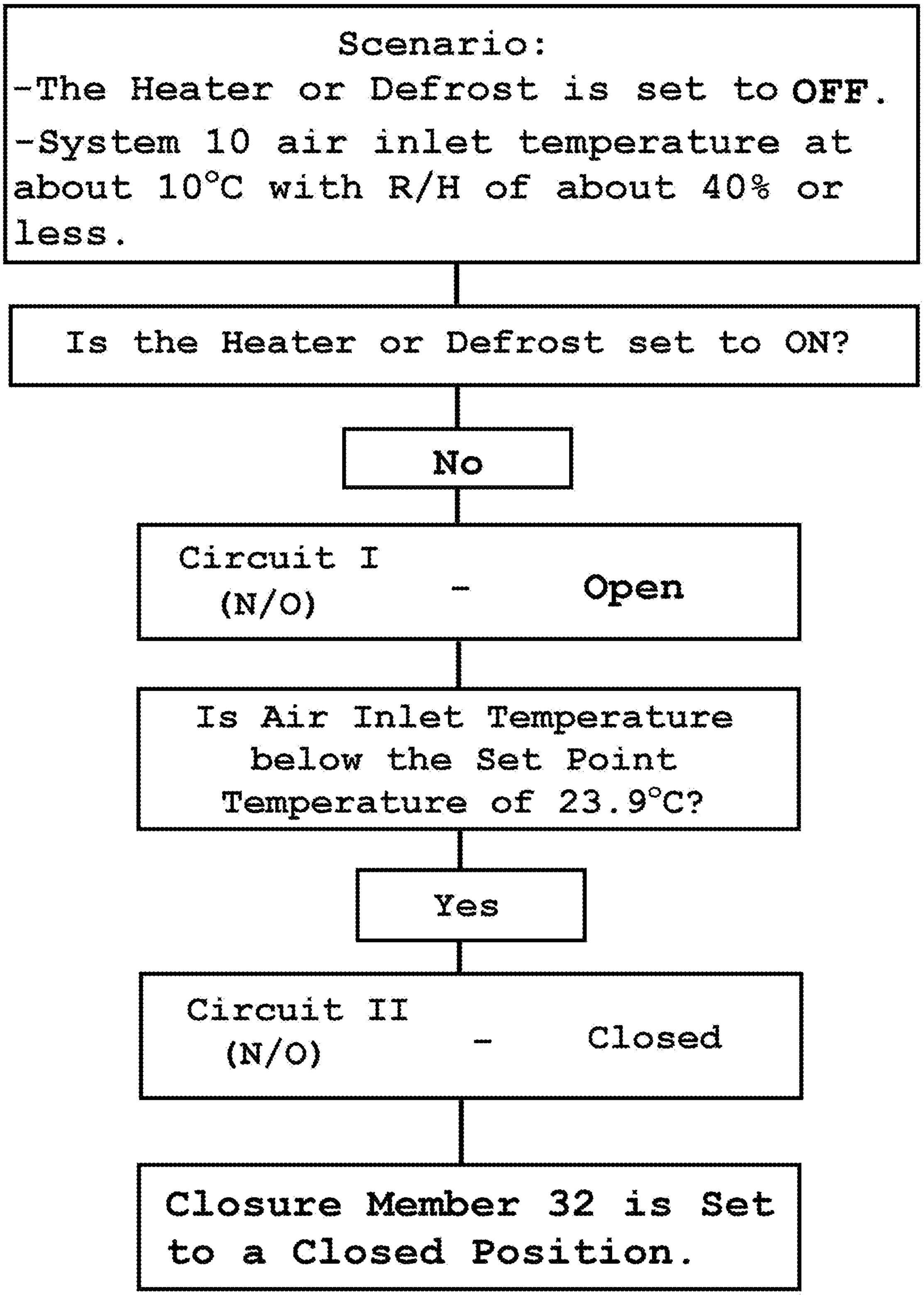
Scenario:
-The Heater or Defrost is set to OFF.
-System 10 air inlet temperature at about 10°C with R/H of about 40% or less.
Is the Heater or Defrost set to ON?
No
Circuit I (N/O) - Open
Is Air Inlet Temperature below the Set Point Temperature of 23.9°C?
Yes
Circuit II (N/O) - Closed
Closure Member 32 is Set to a Closed Position.

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 16/18359

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B60H 1/32 (2016.01)
CPC - B60H 1/0005
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)
IPC(8) - B60H 1/32 (2016.01)
CPC - B60H 1/0005

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase; GOOGLE (PATENTS, SCHOLAR) Search Terms Used: vehicle, HVAC, AC, air conditioning, evaporator, condensation, collect, heat, warm, air, heater, fan, blower, dew point, saturation, temperature, dehumidifying

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2013-91367 A (KEIHIN THERMAL TECHNOLOGY CORP) 16 May 2013 (16.05.2013) entire document	1-4
Y	WO 2008/108740 A1 (SIRIUS WATER TECHNOLOGIES PTE LTD) 12 September 2008 (12.09.2008) entire document	1-4
A	US 2011/0048039 A1 (KOHAVI et al) 03 March 2011 (03.03.2011) entire document	1-4
A	US 2010/0025311 A1 (JONES et al) 04 February 2010 (04.02.2010) entire document	1-4
A	FR 2,780,144 A (VALEO CLIMATISATION) 24 December 1999 (24.12.1999) entire document	1-4

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 April 2016	03 MAY 2016

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PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 16/18359

Continuation of: B. FIELDS SEARCHED
IPC(8) - B01D 5/00; B60H 1/32; E03B 3/28; F24F 3/14; F25D 21/14 (2016.01)
CPC - B60H 1/00021, 1/0005, 2001/00114, 2001/00142, 2001/0015, 1/00271, 2001/003, 1/00557, 1/00564, 1/00814, 1/00821, 1/00835, 1/3207, 1/3233, 3/024; F24F 3/1405, 2003/144