US009273888B2

(12) **United States Patent**
McMasters

(10) **Patent No.: US 9,273,888 B2**
(45) **Date of Patent: Mar. 1, 2016**

(54) **REFRIGERANT RECOVERY DEVICE AND METHOD**

(71) Applicant: **Service Solutions U.S. LLC**, Warren, MI (US)

(72) Inventor: **Mark McMasters**, Owatonna, MN (US)

(73) Assignee: **Bosh Automotive Service Solutions Inc.**, Warren, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 288 days.

(21) Appl. No.: **13/795,803**

(22) Filed: **Mar. 12, 2013**

(65) **Prior Publication Data**

US 2014/0260350 A1 Sep. 18, 2014

(51) **Int. Cl.**
F25B 45/00 (2006.01)
F25D 17/04 (2006.01)

(52) **U.S. Cl.**
CPC ***F25B 45/00*** (2013.01); *F25B 2345/001* (2013.01); *F25B 2345/002* (2013.01); *F25B 2345/005* (2013.01)

(58) **Field of Classification Search**
CPC F25B 45/00
USPC 62/77, 149, 186, 292
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,146,761	A *	9/1992	Cavanaugh et al.	....	62/149
5,875,638	A *	3/1999	Tinsler	....	62/149
6,247,325	B1 *	6/2001	Muston et al.	....	62/292
6,978,636	B2 *	12/2005	Motush et al.	....	62/292
8,752,396	B2 *	6/2014	Chaudhry	....	62/149
8,887,516	B2 *	11/2014	Govekar et al.	....	62/77
2006/0130510	A1	6/2006	Murray et al.		
2008/0276634	A1	11/2008	Brown et al.		
2012/0186280	A1	7/2012	Brown et al.		

OTHER PUBLICATIONS

International Search Report mailed Jul. 9, 2014 for PCT/US2014/024556 filed Mar. 12, 2014.

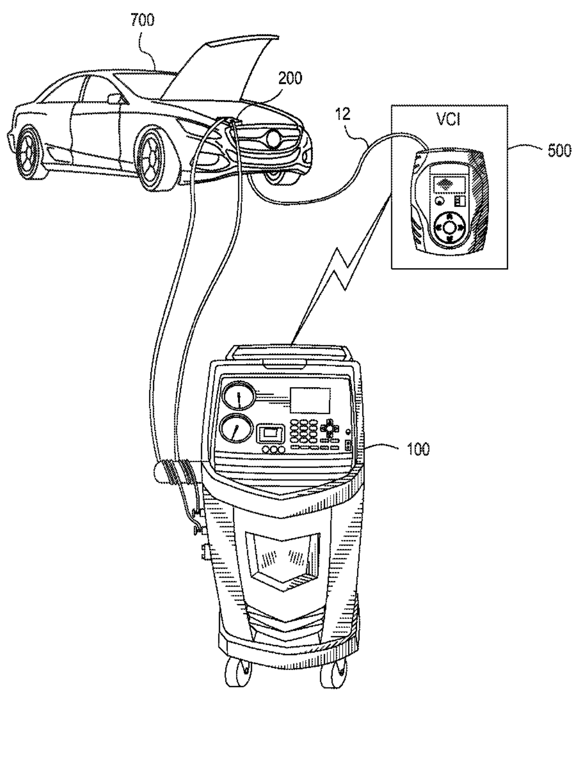
* cited by examiner

Primary Examiner — Allen Flanigan
Assistant Examiner — Filip Zec
(74) *Attorney, Agent, or Firm* — Baker & Hostetler LLP

(57) **ABSTRACT**

A refrigerant recovery unit includes a refrigerant storage unit, a refrigerant circuit, a processor, and a memory. The refrigerant storage unit is configured to store a refrigerant. The refrigerant circuit is in fluid connection with refrigeration system. The refrigerant circuit is configured to recover refrigerant from the refrigeration system and recharge the refrigeration system with the refrigerant. The processor is configured to control the refrigerant recovery unit and the processor is configured to control a fan. The fan is configured to provide a flow of air to the refrigeration system. The memory is to store diagnostic software and operating software to operate the refrigerant recovery unit.

20 Claims, 7 Drawing Sheets



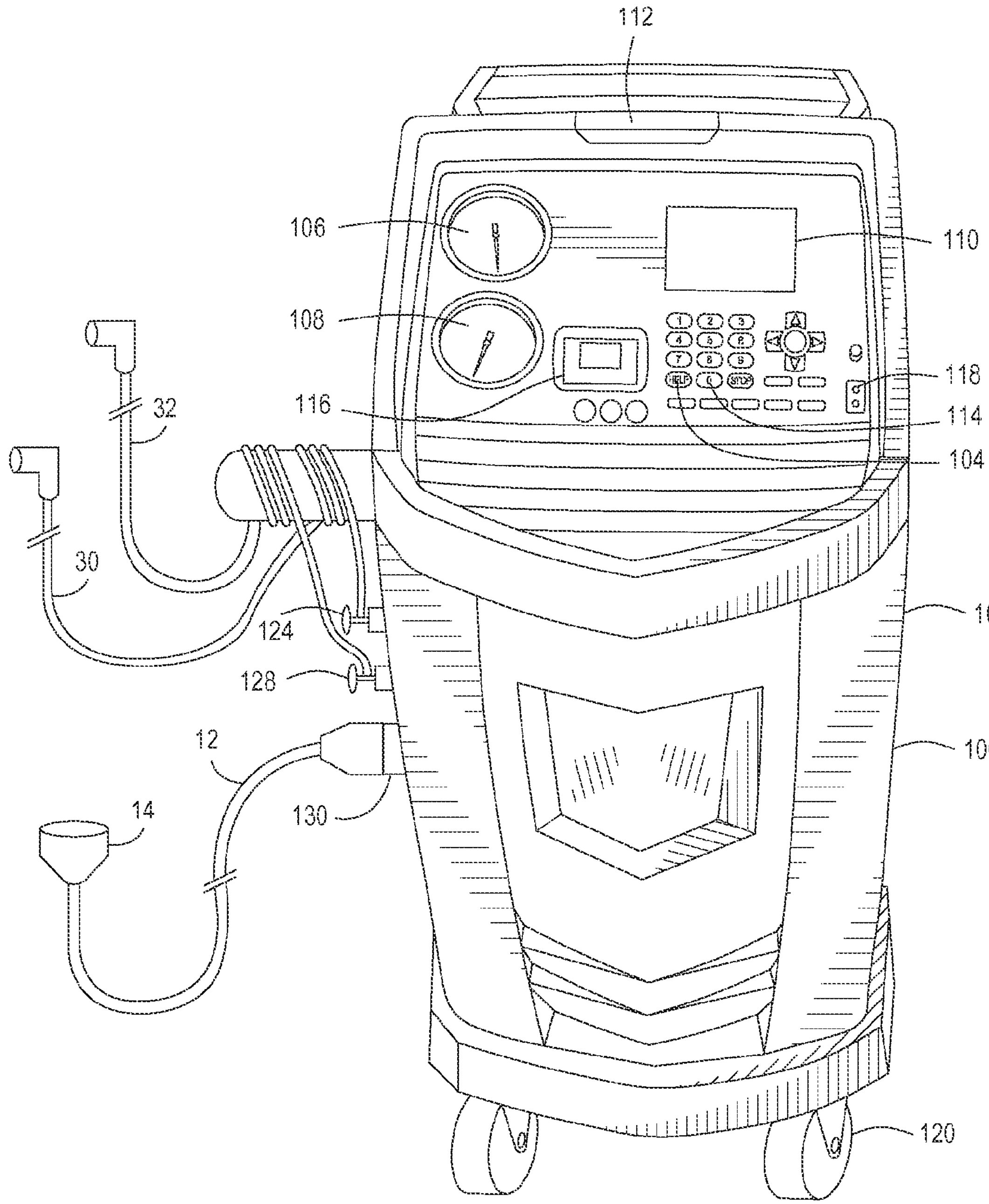
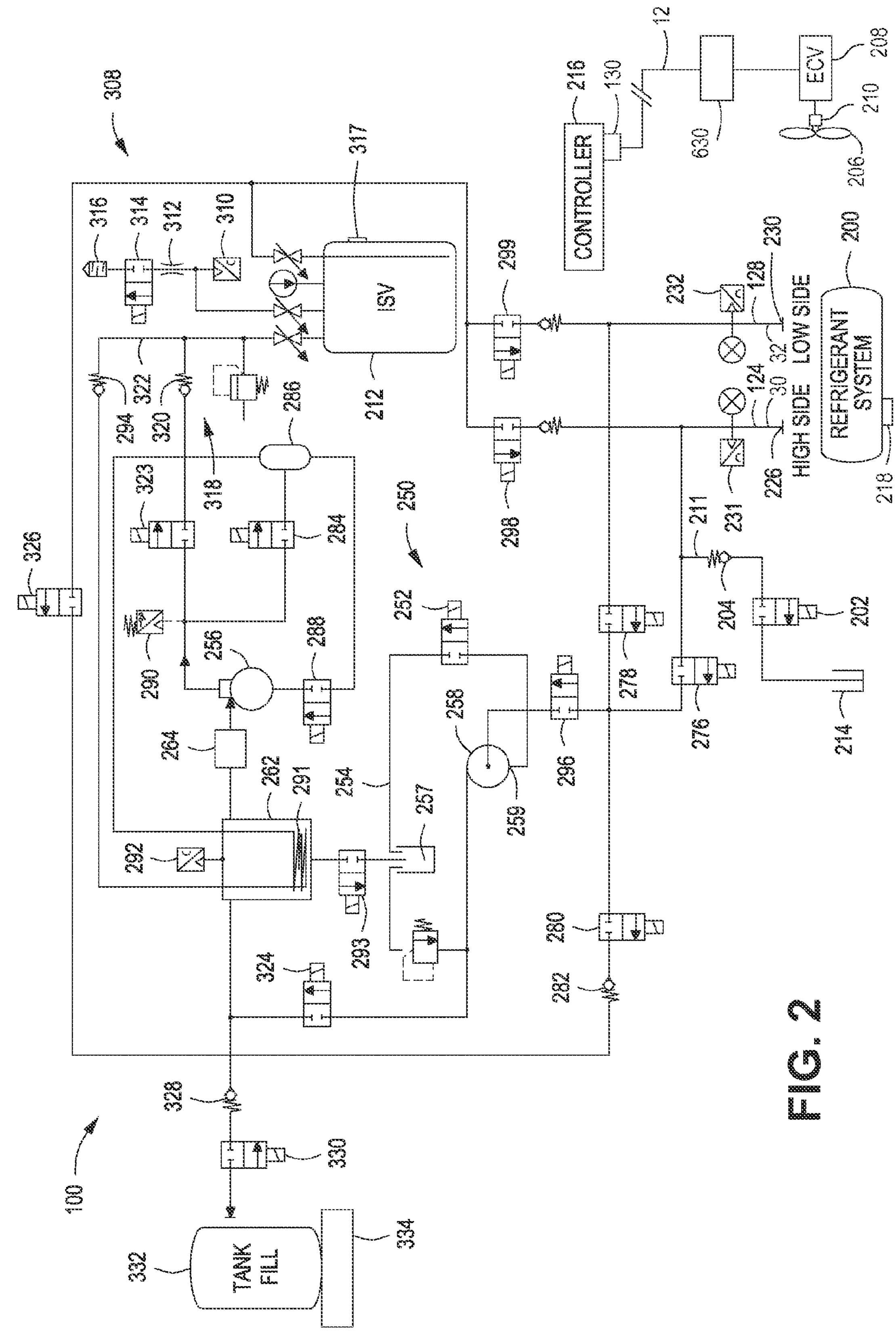

112
106
110
108
32
118
116
114
104
30
102
124
128
12
100
14
130
120

FIG. 1



CONTROLLER
ECV
ISV
HIGH SIDE
LOW SIDE
REFRIGERANT SYSTEM
TANK FILL
12
130
216
630
208
210
206
308
317
316
314
312
310
299
298
232
230
128
124
30
32
226
231
200
218
212
286
294
322
320
318
323
284
250
211
204
202
252
290
256
288
278
276
214
258
296
264
262
291
254
257
259
292
293
324
280
282
326
328
330
100
332
334

FIG. 2

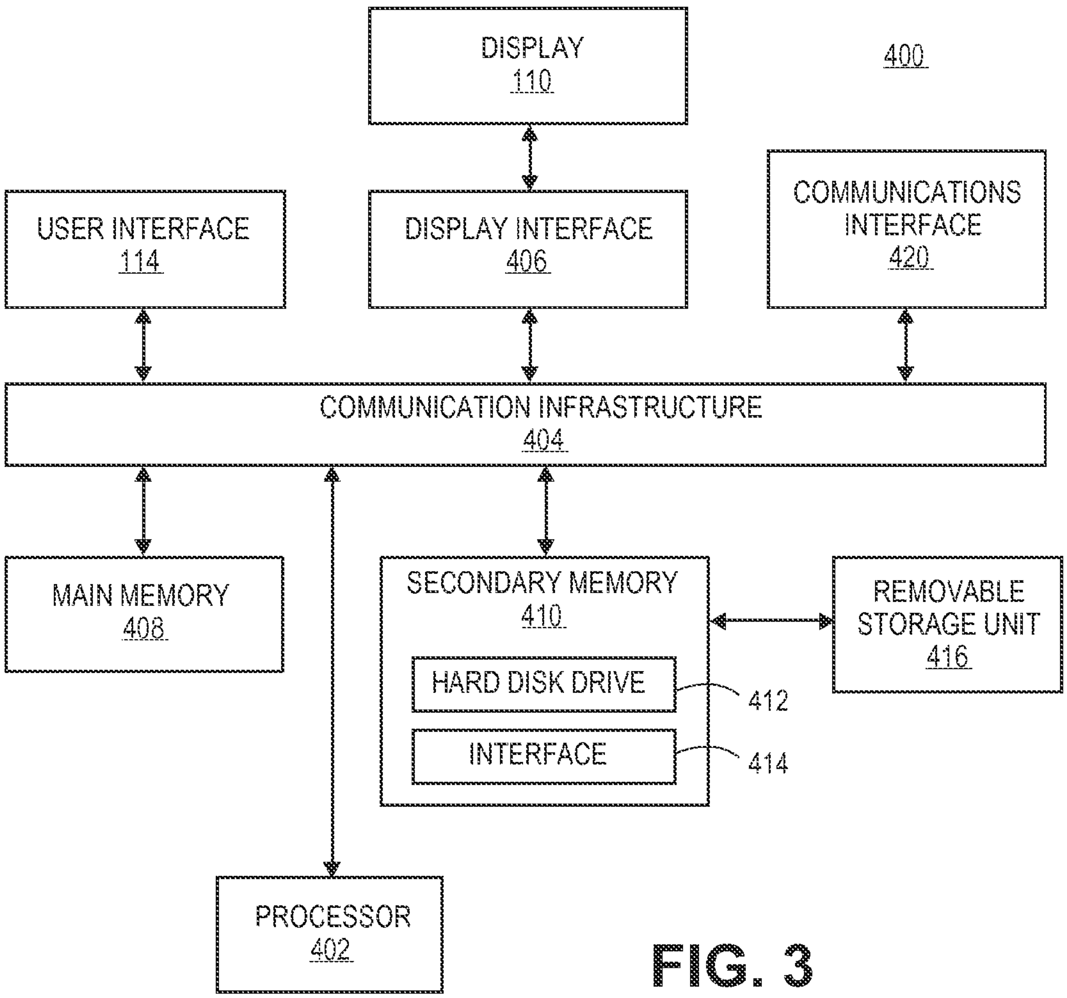

DISPLAY
110
400
USER INTERFACE
114
DISPLAY INTERFACE
406
COMMUNICATIONS
INTERFACE
420
COMMUNICATION INFRASTRUCTURE
404
MAIN MEMORY
408
SECONDARY MEMORY
410
HARD DISK DRIVE
412
INTERFACE
414
REMOVABLE
STORAGE UNIT
416
PROCESSOR
402

FIG. 3

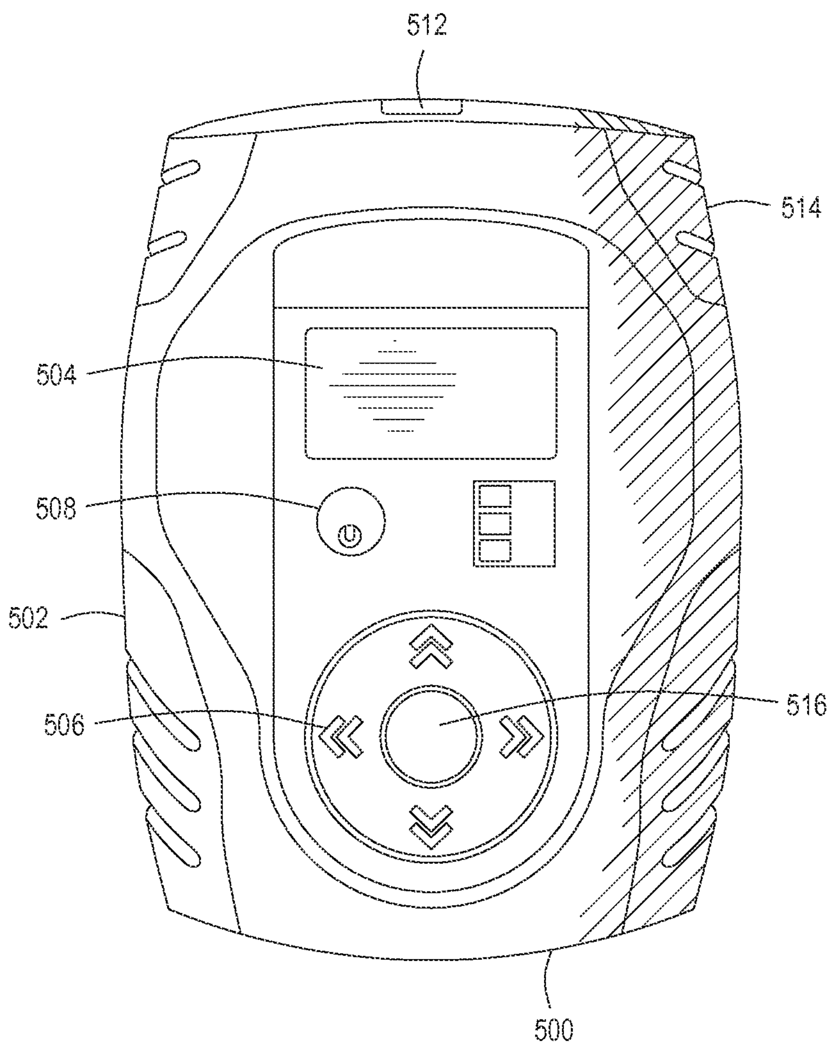


FIG. 4

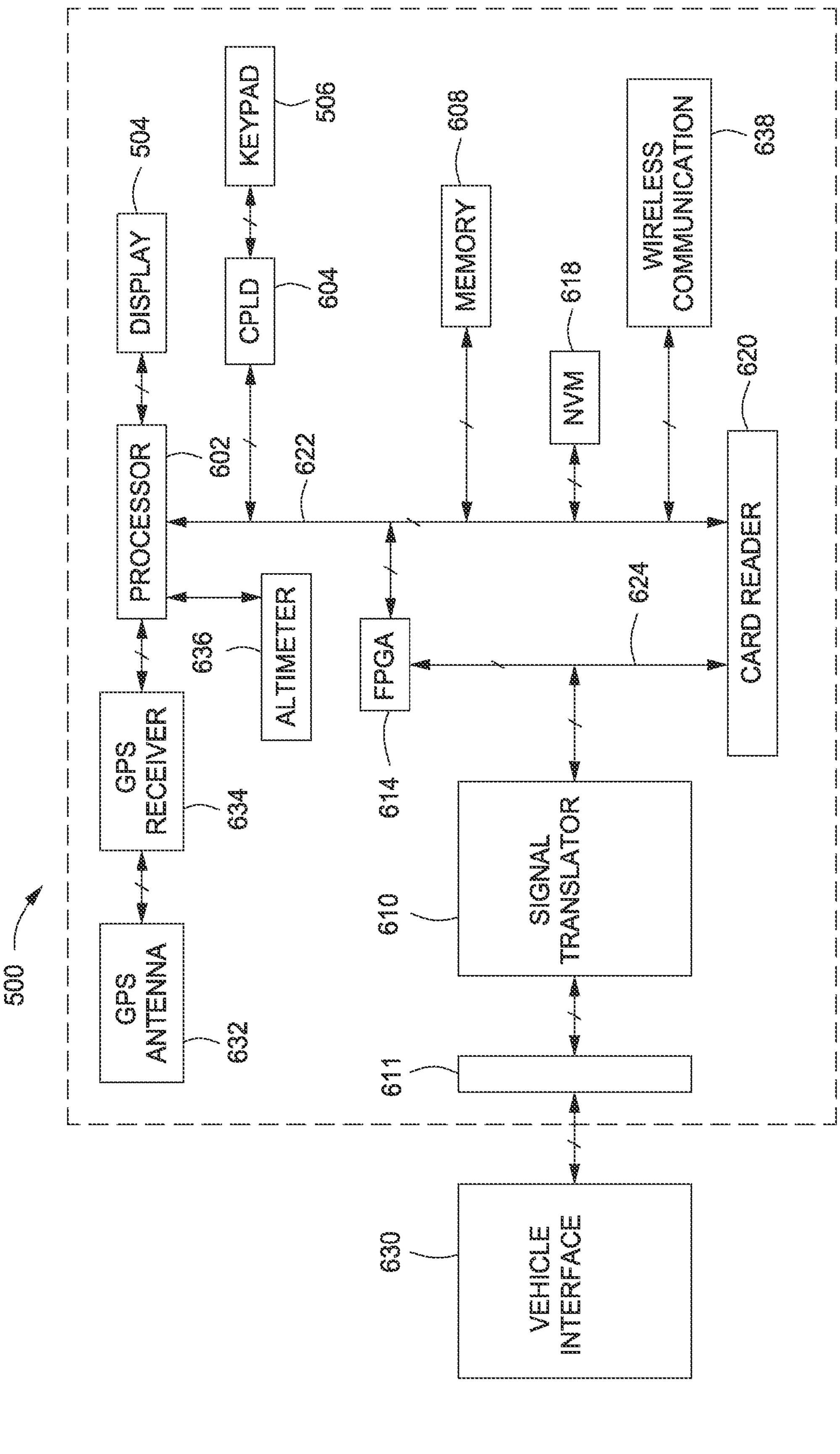

500
DISPLAY
504
KEYPAD
506
CPLD
604
MEMORY
608
WIRELESS COMMUNICATION
638
NVM
618
620
PROCESSOR
602
622
ALTIMETER
636
FPGA
614
624
CARD READER
GPS RECEIVER
634
GPS ANTENNA
632
SIGNAL TRANSLATOR
610
611
VEHICLE INTERFACE
630

FIG. 5

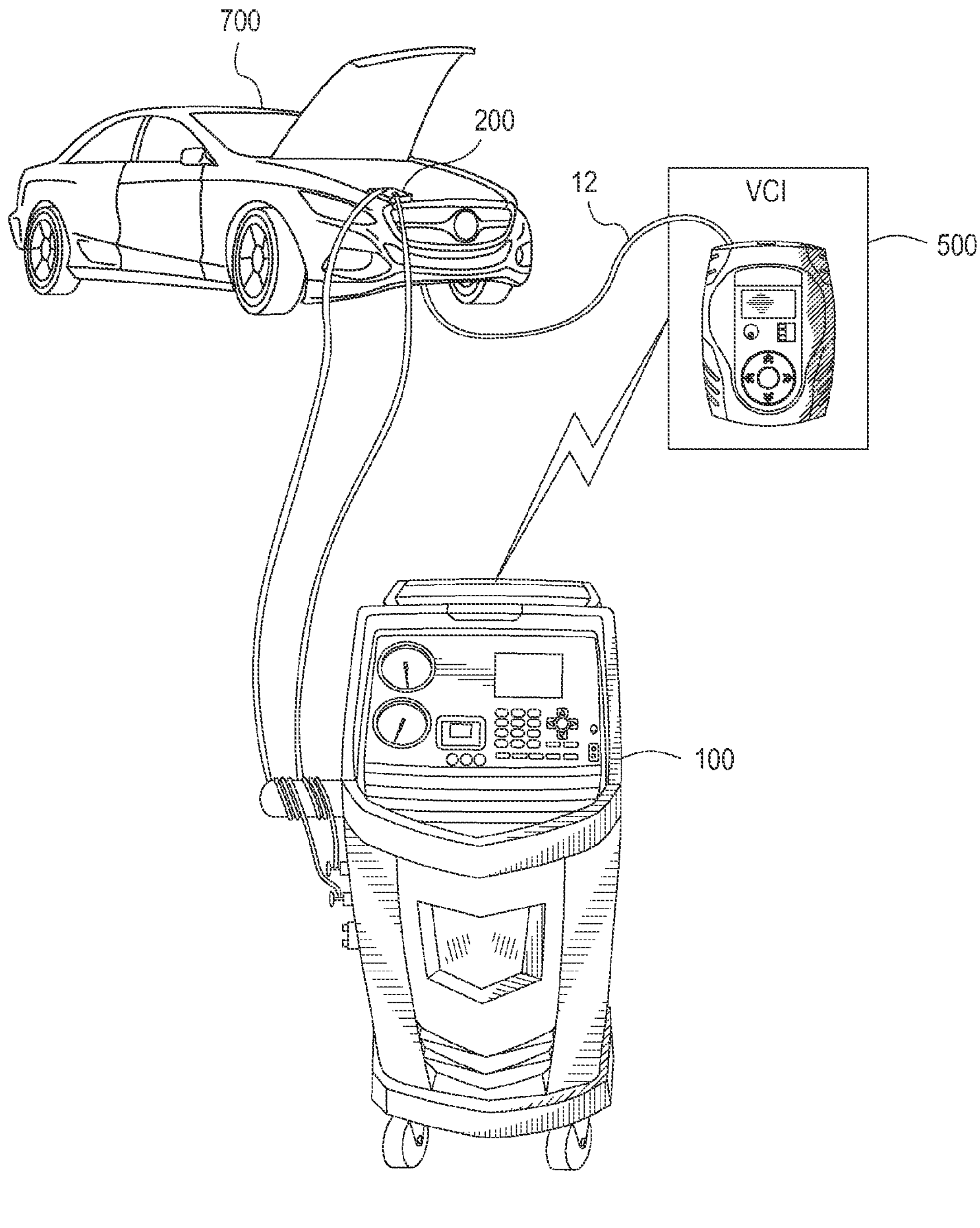


FIG. 6

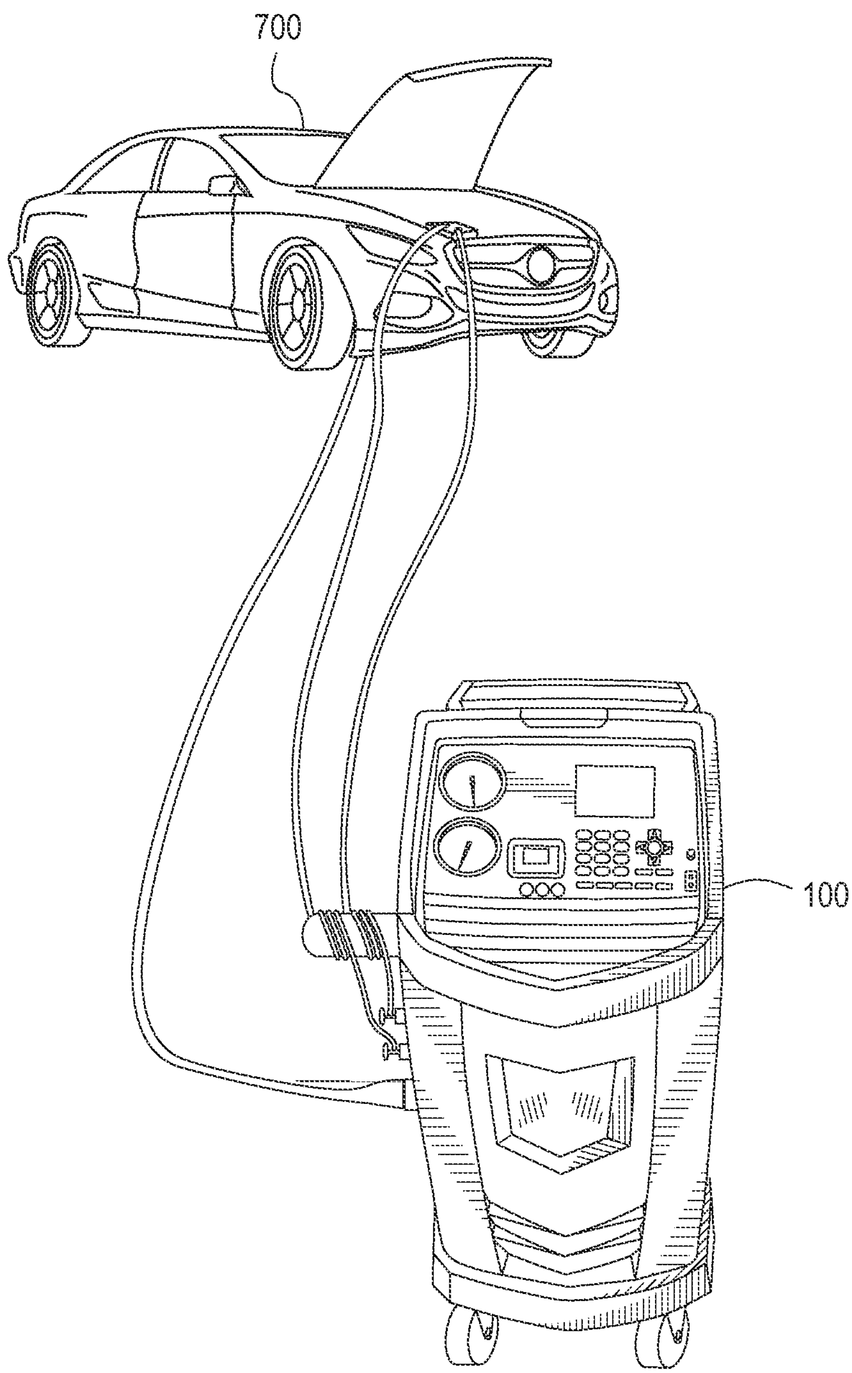


FIG. 7

REFRIGERANT RECOVERY DEVICE AND METHOD

FIELD OF THE INVENTION

The disclosure generally relates to a refrigerant recovery unit. More particularly to an improved refrigerant recovery unit that collects a higher percentage of refrigerant from a cooling system than conventional refrigerant recovery units.

BACKGROUND OF THE INVENTION

Portable refrigerant recovery units or carts are used in connection with the service and maintenance of refrigeration systems, such as a vehicle's air conditioning system. The refrigerant recovery unit connects to the air conditioning system of the vehicle to recover refrigerant out of the system, separate out oil and contaminants from the refrigerant in order to recycle the refrigerant, and recharge the system with additional refrigerant.

Due to the phase changing nature of refrigerant, as refrigerant is removed from the vehicle's air conditioning system or other such refrigeration systems, the pressure decreases which causes the refrigerant to vaporize. As this refrigerant vapor is removed, the heat of vaporization is removed from the air conditioning system causing the air conditioning system to become colder. As the temperature of the air conditioning system decreases, the refrigerant remaining therein may be chilled below its boiling point, which makes the liquid refrigerant difficult to completely remove.

Accordingly, it is desirable to provide a method and apparatus capable of overcoming the disadvantages described herein at least to some extent.

SUMMARY OF THE INVENTION

The foregoing needs are met, to a great extent, by the present invention, wherein in one respect an improved refrigerant recovery unit is provided.

An embodiment of the present invention pertains to a refrigerant recovery unit. The refrigerant recovery unit includes a refrigerant storage unit, a refrigerant circuit, a processor, and a memory. The refrigerant storage unit is configured to store a refrigerant. The refrigerant circuit is in fluid connection with refrigeration system. The refrigerant circuit is configured to recover refrigerant from the refrigeration system and recharge the refrigeration system with the refrigerant. The processor is configured to control the refrigerant recovery unit and the processor is configured to control a fan. The fan is configured to provide a flow of air to the refrigeration system. The memory is to store diagnostic software and operating software to operate the refrigerant recovery unit.

Another embodiment of the present invention relates to a refrigerant recovery system. The refrigerant recovery system includes a refrigerant recovery unit, a pair of hoses, a temperature sensor, and a communication cable. The refrigerant recovery unit includes a refrigerant storage unit, refrigerant circuit, a processor, and a memory. The refrigerant storage unit is configured to store a refrigerant. The refrigerant circuit is in fluid connection with refrigeration system and the refrigerant circuit is configured to recover refrigerant from the refrigeration system and recharge the refrigeration system with the refrigerant. The processor is configured to control the refrigerant recovery unit and the processor is configured to control a fan. The fan is configured to provide a flow of air to the refrigeration system. The memory is to store diagnostic software and operating software to operate the refrigerant recovery unit. The pair of hoses are to fluidly connect the refrigeration system to the refrigerant recovery unit. The temperature sensor is configured to sense a temperature of the refrigeration system. The communication cable is to convey signals from the temperature sensor to the processor. The processor is configured to receive the sensed temperature and control the fan to activate in response to the sensed temperature being outside a predetermined temperature range.

Yet another embodiment of the present invention pertains to a method of improving recovery of refrigerant from a refrigeration system. In this method, a refrigerant recovery unit is fluidly connected to the refrigeration system, a fan is controlled with a processor in the refrigerant recovery unit to provide a flow of air across the refrigeration system, and the refrigerant that enters the refrigerant recovery unit is collected.

There has thus been outlined, rather broadly, certain embodiments of the invention in order that the detailed description thereof herein may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional embodiments of the invention that will be described below and which will form the subject matter of the claims appended hereto.

In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of embodiments in addition to those described and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein, as well as the abstract, are for the purpose of description and should not be regarded as limiting.

As such, those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a refrigerant recovery unit in accordance with an embodiment.

FIG. **2** is a schematic diagram illustrating components of the refrigerant recovery unit shown in FIG. **1**.

FIG. **3** is a block diagram illustrating aspects of a control system for the refrigerant recovery unit of FIG. **1**.

FIG. **4** is a front view of a vehicle communication interface suitable for communication with the refrigerant recovery unit of FIG. **1**.

FIG. **5** is a block diagram illustrating components of the vehicle communication interface according to FIG. **4**.

FIG. **6** is a diagram illustrating the vehicle communication interface coupled to a suitable vehicle and communicating with the refrigerant recovery unit of FIG. **1**.

FIG. **7** is a diagram illustrating the refrigerant recovery unit of FIG. **1** directly coupled to and communicating with the vehicle.

DETAILED DESCRIPTION

According to various embodiments described herein, a refrigerant recovery unit is provided that facilitates the servicing of a refrigeration system. As used herein, the term, "servicing" refers to any suitable procedure performed on a refrigeration or air conditioning system such as, for example, recovering refrigerant, recharging refrigerant into the refrigeration system, testing refrigerant, leak testing the refrigeration system, recovering the lubricant, replacing the lubricant, and the like. An embodiment of the refrigerant recovery unit disclosed herein may be used to improve the servicing of an air conditioning system or other refrigeration system. In this or other embodiments, the refrigerant recovery unit described herein may facilitate improved servicing by controlling a fan associated with the air conditioning system to urge a flow of air over the air conditioning system. In this regard, air conditioning systems generally include fans configured to activate during operation of the air conditioning system. However, these fans are typically de-activated when the air conditioning system is not operating. During servicing, the air conditioning system is deactivated to prevent damage to the compressor from running without refrigerant and lubricant.

In a particular example, the temperature of the engine compartment of a vehicle may vary widely from one vehicle to the next due to operating conditions just prior to servicing, ambient conditions, and the like. If the temperature of the air conditioning system is cooler than expected, it may take longer to recover refrigerant from the air conditioning system. Also, because vehicle air conditioning systems are refilled according to pressure, the air conditioning system may be overcharged because the cooler temperature results in a lower pressure than expected. Conversely, a vehicle that is warmer than expected may cause the air conditioning system to be under charged. Furthermore, recovering and recharging the air conditioning system cause the temperature of the air conditioning system to fall and rise in ways that are not always predictable and are generally non-conducive to servicing. Activating a fan that blows across the air conditioning system brings the temperature of the air conditioning system to ambient temperature quickly and efficiently. By controlling the fan to activate during servicing, the refrigerant recovery unit of the present disclosure provides one or more of the following benefits: improves the efficiency of refrigerant recovery; reduces the refrigerant recovery time; improves the accuracy of recharging the air conditioning system; reduces the recharging time.

As shown in FIG. **1**, a refrigerant recovery system **100** includes a refrigerant recovery unit **100** and a communication cable **12** with a connector **14**. The connector **14** is configured to conform to any suitable communication standards or protocols. Examples of suitable communication standards include on-board diagnostics (OBD) and OBDII, J1850 (variable pulse width (VPW) and pulse-width modulation (PWM)), international organization for standards (ISO) 9141-2 signal, communication collision detection (CCD) (e.g., Chrysler collision detection), data communication links (DCL), serial communication interface (SCI), Controller Area Network (CAN), Keyword 2000 (ISO 14230-4), OBD II or other communication protocols. According to various embodiments, the connector **14** is configured to convey any suitable data/command control information. Examples of suitable data include commands to modulate a fan, temperature sensor measurements, status indicators, and the like.

Also shown in FIG. **1**, the refrigerant recovery system **100** optionally includes a pair of hoses **30** and **32** to connect the refrigerant recovery unit **100** to a refrigeration system (shown in FIG. **2**). In various embodiments, the refrigeration system may be a standalone unit and/or disposed within a vehicle, device, appliance, structure, or the like. A vehicle can be any suitable vehicle, such as an automobile, train, airplane, boat, ship and the like. Suitable devices or appliances may include, for example, an air conditioning unit, dehumidifier, ice maker, refrigerator/freezer, beverage dispenser, ice cream maker, and the like.

The refrigerant recovery unit **100** can be the AC1234™ from ROBINAIR® based in Owatonna, Minn. (Service Solutions U.S., LLC). The refrigerant recovery unit **100** includes a cabinet **102** to house components of the system (See FIG. **2**). The cabinet **102** may be made of any suitable material such as thermoplastic, steel and the like.

The cabinet **102** includes a control panel **104** that allows the user to operate the refrigerant recovery unit **100**. The control panel **104** may be part of the cabinet as shown in FIG. **1** or separated. The control panel **104** includes high and low gauges **106**, **108**, respectively. For the purposes of this disclosure, the terms, "high" and "low" generally refer to the high and low pressure sides of a refrigeration system, respectively. The gauges may be analog or digital. The control panel **104** has a display **110** to provide information to a user. The information may include, for example, operating status of the refrigerant recovery unit **100** or provide messages or menus to the user. The control panel **104** may include indicators **112** to indicate to the user the operational status of the refrigerant recovery unit **100**, fan activation, and the like. If included, the indicators **112** may include light emitting diodes (LEDs) or the like, that when activated, may indicate that the refrigerant recovery unit **100** is in the recovery, recycling or recharging mode or indicate that the filter needs to be changed or that there is a malfunction.

According to an embodiment, the control panel **104** includes a user interface **114** to provide the user with an interface to interact and operate the refrigerant recovery unit **100**. The user interface **114** may include any suitable interface such as, for example, an alphanumeric keypad, directional arrows, function keys, pressure or touch sensitive display, and the like. Optionally, a printer **116** is provided to print out information, such as test results.

The cabinet **102** further includes a pair of service couplers **124**, **128** that connect the hoses **30**, **32**, respectively, to the refrigerant recovery unit **100**. Also shown in FIG. **1**, a vehicle connector interface **130** is provided so that the communication cable **12** can be connected from the vehicle connector interface **130** to a data link connector in a vehicle (not shown in FIG. **1**). This allows the refrigerant recovery unit **100** to communicate with the vehicle and access various controllers in the vehicle (such as fan motor speed controllers) and/or diagnose any issues with the vehicle and its subsystems. In order for the refrigerant recovery unit **100** to be mobile, one or more wheels **120** are provided at a bottom portion of the cabinet **102**.

During servicing of a refrigeration system **200** (shown in FIG. **2**), the hoses **30** and **32** are typically connected to the refrigeration system **200** and the connector **14** is typically connected to a controller associated with the refrigeration system **200**. In operation, the refrigerant recovery system **100** is utilized to collect refrigerant from the refrigeration system **200**. For example, one or both of the hoses **30** and **32** may be connected to the refrigeration system **200** and the refrigerant recovery system **100** is configured to receive or draw out the refrigerant from the refrigeration system **200** and then condense the refrigerant being recovered from the refrigeration system **200**. Once the refrigerant has been recovered from the refrigeration system, the refrigeration system **200** may be recharged. For example, one or both of the hoses **30** and **32** may be utilized to deliver a suitable amount of a suitable refrigerant from the refrigerant recovery system **100** to the refrigeration system **200**.

However, as refrigerant is drawn from the refrigeration system **200**, the pressure within the refrigeration system **200** drops which causes refrigerant to vaporize which, in turn, removes the heat of vaporization from the refrigeration system **200**. Depending on conditions, this cooling of the refrigeration system **200** may become so extreme that refrigerant no longer vaporizes. This cooling may therefore slow the recovery (by requiring a wait time for the refrigeration system **200** to warm up via natural convection of heat) and/or cause some refrigerant to remain in the refrigeration system **200** (which can lead to refrigerant contamination and/or refrigerant overcharging during recharging). As described herein, the refrigerant recovery system **100** is configured to control a fan (shown in FIG. **2**) to operate and warm the refrigeration unit to ambient temperature.

FIG. **2** illustrates components of the refrigerant recovery system **100** of FIG. **1** according to an embodiment of the present disclosure. In general, the refrigerant recovery system **100** is configured to facilitate testing, removing, and recharging refrigerant and/or lubricant in a refrigeration system **200**. In addition, the refrigerant recovery system **100** may be configured to purify some types of contaminants from refrigerant recovered from the refrigeration system **200**. Furthermore, the refrigerant recovery system **100** is configured to control a fan **206**. The fan **206** may include any fan suitable to direct a flow of fluid such as air at ambient temperature towards the refrigeration system **200**. Examples of suitable fans include shrouded fans generally disposed in motor vehicles to provide cooling to the engine and various other components of the motor vehicle. By controlling the fan **206** to operate during recovery and/or refilling, the refrigerant recovery system **100** is configured to improve the speed of refrigerant recovery and/or refilling and/or improve the accuracy or reproducibility of refilling.

In this or other embodiments, operation of the fan **206** is configured to provide a flow of air to the refrigeration system **200** or components in thermal contact with the refrigeration system **200**. In this manner, the operation of the fan **206** is configured to urge the temperature of the refrigeration system **200** towards or near the temperature of the air (e.g., ambient temperature) more quickly than natural convection would provide. During refrigerant recovery operations when the temperature of the refrigeration system **200** may tend to fall due to the vaporization of refrigerant therein, the fan **206** may be controlled to operate to raise the temperature of the refrigeration system **200**. During refrigerant refilling operations when the temperature of the refrigeration system **200** may tend to rise due to the compression of refrigerant therein, the fan **206** may be controlled to operate to lower the temperature of the refrigeration system **200**. In this manner, the control of the fan **206** may tend to maintain the temperature of the refrigeration system **200** at or near ambient temperature.

In the particular example shown, the controller **216** of the refrigerant recovery system **100** is coupled to the fan **206** via the following: the controller **216** is coupled to the vehicle connector interface **130**; the vehicle connector interface **130** is coupled to the communication cable **12**; the communication cable **12** is connected to a vehicle communication interface **630** described herein; the vehicle communication interface **630** is connected to an electronic control unit (ECU) **208** or other such motor speed controller of a vehicle (shown in FIGS. **6** and **7**); and the ECU **208** is configured to control or modulate a motor **210** or other such actuator configured to urge the fan **206** to rotate. However, in other embodiments, the refrigerant recovery system **100** may be directly connected to the ECU **208**.

In some embodiments, the fan **206** may be urged to rotate prior to recovering the refrigerant, during recovery, or in response to a sensed temperature being outside a predetermined temperature range. For example, the fan **206** may be controlled to turn on in preparation to initiate recovery. In this manner, the refrigeration system **200** may be brought to or near ambient temperature. In addition, this may facilitate bringing the thermal mass of other components in the engine compartment of the vehicle to or near ambient temperatures. In another example, the fan **206** may be controlled to turn on during recovery. In yet another example, the fan **206** may be controlled to turn on in response to a sensed temperature being outside a predetermined range. In this regard, the refrigerant recovery unit **100** and/or the vehicle (shown in FIGS. **6** and **7**) may optionally include a temperature sensor **218**. If included, the temperature sensor **218** may be configured to sense the ambient temperature, temperature in the engine compartment, temperature of the refrigeration system **200**, and/or the like. The temperature sensor **218** may be further configured to relay sensed temperatures to the controller **216** either directly, via the ECU **208**, via the vehicle communication interface **630**, and/or the like. In the particular example shown, the temperature sensor **218** is configured to directly sense the temperature of the refrigeration system **200** and relay the sensed temperature to the controller **216** via the ECU **208**.

Prior to recovering refrigerant from the refrigerant system **200**, the service hoses **30** and **32** are coupled to the refrigeration system **200** of the vehicle, via couplers **226** (high side) and **230** (low side), respectively. The couplers are designed to be closed until they are coupled to the refrigerant system **200**. In an embodiment, the fan **206** is controlled to turn on in response to initiating the recovery cycle.

The recovery cycle is initiated by the opening of high pressure and low-pressure solenoids **276**, **278**, respectively. This allows the refrigerant within the vehicle's refrigeration system **200** to flow through a recovery valve **280** and a check valve **282**. The refrigerant flows from the check valve **282** into a system oil separator **262**, where it travels through a filter/dryer **264**, to an input of a compressor **256**. Refrigerant is drawn through the compressor **256** through a normal discharge solenoid **284** and through a compressor oil separator **286**, which circulates oil back to the compressor **256** through an oil return valve **288**. The refrigerant recovery unit **100** may include a high-pressure switch **290** in communication with a controller **216**, which is programmed to determine an upper pressure limit, for example, 435 psi, to optionally shut down the compressor **256** to protect the compressor **256** from excessive pressure. The controller **216** can also be, for example, a microprocessor, a field programmable gate array (FPGA) or application-specific integrated circuit (ASIC). The controller **216** via a wired or wireless connection (not shown) controls the various valves and other components (e.g. vacuum, compressor) of the refrigerant recovery unit **100**. In some embodiments of the present disclosure, any or all of the electronic solenoid or electrically activated valves may be connected and controlled by the controller **216**.

In addition, the controller **216** may be configured to control the fan **206** via the ECU **208**, receive sensed temperature reading from the temperature sensor **218**, compare the sensed temperature to a predetermined temperature range, store the predetermined temperature range, and/or the like. In particular, the controller **216** may be configured to compare the sensed temperature to the predetermined temperature range, turn the fan **206** on in response to the temperature being outside the predetermined temperature range, and turning the fan **206** off in response to the temperature being within the predetermined temperature range. The predetermined temperature range may include any suitable temperature range. In general, suitable temperature ranges include temperatures that are above a boiling point of the refrigerant at atmospheric pressure and below a liquid temperature of the refrigerant at standard low-side pressures. More particularly, the predetermined temperature range may be between about 40° F. (4° C.) and about 120° F. (49° C.) or other ranges known to those skilled in the art. It is to be noted that in this or other embodiments, the control of the fan **206** may be performed manually (e.g., User control or override) or automatically.

A high-side clear solenoid **323** may optionally be coupled to the output of the compressor **256** to release the recovered refrigerant transferred from compressor **256** directly into a storage tank **212**, instead of through a path through the normal discharge solenoid **284**.

The heated compressed refrigerant exits the oil separator **286** and then travels through a loop of conduit or heat exchanger **291** for cooling or condensing. As the heated refrigerant flows through the heat exchanger **291**, the heated refrigerant gives off heat to the cold refrigerant in the system oil separator **262**, and assists in maintaining the temperature in the system oil separator **262** within a working range. Coupled to the system oil separator **262** is a switch or transducer **292**, such as a low pressure switch or pressure transducer, for example, that senses pressure information, and provides an output signal to the controller **216** through a suitable interface circuit programmed to detect when the pressure of the recovered refrigerant is down to 13 inches of mercury, for example. An oil separator drain valve **293** drains the recovered oil into a container **257**. Finally, the recovered refrigerant flows through a normal discharge check valve **294** and into the storage tank **212**.

The evacuation cycle begins by the opening of high pressure and low-pressure solenoids **276** and **278** and valve **296**, leading to the input of a vacuum pump **258**. Prior to opening valve **296**, an air intake valve (not shown) is opened, allowing the vacuum pump **258** to start exhausting air. The vehicle's refrigerant system **200** is then evacuated by the closing of the air intake valve and opening the valve **296**, allowing the vacuum pump **258** to exhaust any trace gases remaining until the pressure is approximately 29 inches of mercury, for example. When this occurs, as detected by pressure transducers **231** and **232**, optionally, coupled to the high side **226** and low side **230** of the vehicle's refrigeration system **200** and to the controller **216**, the controller **216** turns off valve **296** and this begins the recharging cycle.

Prior to the recharging cycle, the fan **206** may be controlled to turn on automatically and/or turn on in response to the sensed temperature being above or otherwise outside the predetermined temperature range. The recharging cycle begins by opening charge valve **298** to allow the refrigerant in storage tank **212**, which is at a pressure of approximately 70 psi or above, to flow through the high side of the vehicle's refrigeration system **200**. The flow is through charge valve **298** for a period of time programmed to provide a full charge of refrigerant to the vehicle. Optionally, charge valve **299** may be opened to charge the low side. The charge valve **299** may be opened alone or in conjunction with charge valve **298** to charge the vehicle's refrigerant system **200**. The storage tank **212** may be disposed on a scale (not shown) that measures the weight of the refrigerant in the storage tank.

Other components shown in FIG. **2** include an oil inject circuit having an oil inject valve **202** and an oil inject hose or line **211**. The oil inject hose **211** is one example of a fluid transportation means for transmitting oil for the refrigerant recovery unit **100**. The oil inject hose **211** may be one length of hose or multiple lengths of hose or tubing or any other suitable means for transporting fluid. The oil inject hose **211** connects on one end to an oil inject bottle **214** and on the other end couples to the refrigerant circuit in the refrigerant recovery unit **100**. Disposed along the length of the oil inject hose **211** are the oil inject valve **202** and an oil check valve **204**. The oil inject path follows from the oil inject bottle **214**, through the oil inject solenoid **202**, to the junction with the high side charge line, and to the vehicle's refrigerant system **200**.

FIG. **2** also illustrates a vacuum pump oil drain circuitry **250** that includes a vacuum pump oil drain valve **252** that is located along a vacuum pump oil drain conduit **254** connecting a vacuum pump oil drain outlet **259** to the container **257** for containing the drained vacuum pump oil. The vacuum pump oil drain valve **252** may be an electronically activated solenoid valve controlled by controller **216**. The connection may be a wireless or wired connection. In other embodiments the valve **252** may be a manually activated valve and manually actuated by a user. The conduit **254** may be a flexible hose or any other suitable conduit for provided fluid communication between the outlet **259** and the container **257**.

FIG. **2** also illustrates an air purging apparatus **308**. The air purging apparatus **308** allows the refrigerant recovery unit **100** to be purged of non-condensable, such as air. Air purged from the refrigerant recovery unit **100** may exit the storage tank **212**, through an orifice **312**, through a purging valve **314** and through an air diffuser **316**. In some embodiments, the orifice may be 0.028 of an inch. A pressure transducer **310** may measure the pressure contained within the storage tank **212** and purge apparatus **308**. The pressure transducer **310** may send the pressure information to the controller **216**. And when the pressure is too high, as calculated by the controller, purging is required. The valve **314** may be selectively actuated to permit or not permit the purging apparatus **308** to be open to the ambient conditions. A temperature sensor **317** may be coupled to the main tank to measure the refrigerant temperature therein. The placement of the temperature sensor **317** may be anywhere on the tank or alternatively, the temperature sensor may be placed within a refrigerant line **322**. The measured temperature and pressure may be used to calculate the ideal vapor pressure for the type of refrigerant used in the refrigerant recovery unit. The ideal vapor pressure can be used to determine when the non-condensable gases need to be purged and how much purging will be done in order for the refrigerant recovery unit to function properly.

High side clearing valves **318** may be used to clear out part of the high-pressure side of the system. The high side clearing valves **318** may include valve **323** and check valve **320**. Valve **323** may be a solenoid valve. When it is desired to clear part of the high side, valve **323** is opened. Operation of the compressor **256** will force refrigerant out of the high pressure side through valves **323** and **320** and into the storage tank **212**. During this procedure the normal discharge valve **284** may be closed.

A deep recovery valve **324** is provided to assist in the deep recovery of refrigerant. When the refrigerant from the refrigerant system **200** has, for the most part, entered into the refrigerant recovery unit **100**, the remaining refrigerant may be extracted from the refrigerant system **200** by opening the deep recovery valve **324** and turning on the vacuum pump **258**.

In another embodiment, in order to charge the refrigerant system **200**, the power charge valve **326** may be opened and a tank fill structure **332** may be used. Alternatively or in addition to, the tank fill structure **332** may also be used to fill the storage tank **212**. In order to obtain refrigerant from a refrigerant source, the refrigerant recovery unit **100** may include the tank fill structure **332**, and valves **328** and **330**. The tank fill structure **332** may be configured to attach to a refrigerant source. The valve **330** may be a solenoid valve and the valve **328** may be a check valve. In other embodiments, valve **330** may be a manually operated valve.

When it is desired to allow refrigerant from a refrigerant source to enter the refrigerant recovery unit **100**, the tank fill structure **332** is attached to the refrigerant source and the tank fill valve **330** is opened. The check valve **328** prevents refrigerant from the refrigerant recovery unit **100** from flowing out of the refrigerant recovery unit **100** through the tank fill structure **332**. When the tank fill structure **332** is not connected to a refrigerant source, the tank fill valve **330** is kept closed. The tank fill valve **330** may be connected to and controlled by the controller **216**.

The tank fill structure **332** may be configured to be seated on the scale **334** configured to weigh the tank fill structure **332** in order to determine an amount of refrigerant stored in the tank fill structure **332**. The scale **334** may be operatively coupled to the controller **216** and provide a measurement of a weight of the tank fill structure **332** to the controller **216**. The controller **216** may cause a display of the weight of the tank fill structure **332** on the display **110**.

Aspects of the refrigerant recovery unit **100** may be implemented via control system **400** using software or a combination of software and hardware. In one variation, aspects of the present invention may be directed toward a control system **400** capable of carrying out the functionality described herein. An example of such a control system **400** is shown in FIG. **3**.

FIG. **3** is a block diagram illustrating aspects of the control system **400** for the refrigerant recovery system **100** of FIG. **1**. The control system **400** may be integrated with the controller **216** to permit, for example, automation of the recovery, evacuation, and recharging processes and/or manual control over one or more of each of the processes individually. In one embodiment, the control system **400** allows the refrigerant recovery unit to direct communicate and diagnose the vehicle under service. In another embodiment, the control system **400** allows for communication with a diagnostic tool, such as a vehicle communication interface (VCI), that is coupled to the vehicle under service. It should be understood that the VCI does not have to be coupled to a vehicle in order for the vehicle to communicate with the refrigerant recovery unit **100**. This allows the refrigerant recovery unit **100** to receive information from the vehicle such as VIN (vehicle identification number), manufacturer, make, model, and odometer information, and vehicle sensor data that pertains to the heating, ventilation, and air conditioning sensors and systems on the vehicle. Data could include A/C and HVAC system sensor readings, A/C and HVAC related diagnostic trouble codes, system pressures, and interactive tests, like actuating of various components, such as a fan control. All of this data and information would be displayed on the display **110** of the refrigerant recovery unit **100**. Menu selections, diagnostic trouble codes, and interactive tests may be displayed and certain diagnostic may be performed using the refrigerant recovery unit.

The control system **400** may also provide access to a configurable database of vehicle information so the specifications pertaining to a particular vehicle, for example, may be used to provide exacting control and maintenance of the functions described herein. The control system **400** may include a processor **402** connected to a communication infrastructure **404** (e.g., a communications bus, cross-over bar, or network). The various software and hardware features described herein are described in terms of an exemplary control system. A person skilled in the relevant art(s) will realize that other computer related systems and/or architectures may be used to implement the aspects of the disclosed invention.

The control system **400** may include a display interface **406** that forwards graphics, text, and other data from memory and/or the user interface **114**, for example, via the communication infrastructure **404** for display on the display **110**. The communication infrastructure **404** may include, for example, wires for the transfer of electrical, acoustic and/or optical signals between various components of the control system and/or other well-known means for providing communication between the various components of the control system, including wireless means. The control system **400** may include a main memory **408**, random access memory (RAM), and may also include a secondary memory **410**. The secondary memory **410** may include a hard disk drive **412** or other devices for allowing computer programs including diagnostic database (DTC information and repair and diagnostic information) or other instructions and/or data to be loaded into and/or transferred from the control system **400**. Such other devices may include an interface **414** and a removable storage unit **416**, including, for example, a Universal Serial Bus (USB) port and USB storage device, a program cartridge and cartridge interface (such as that found in video game devices), a removable memory chip (such as an erasable programmable read only memory (EPROM), or programmable read only memory (PROM)) and associated socket, and other removable storage units **416**.

The control system **400** may also include a communications interface **420** for allowing software and data to be transferred between the control system **400** and external devices. Examples of a communication interfaces include a modem, a network interface (such as an Ethernet card), a communications port, wireless transmitter and receiver, BLUETOOTH®, near field communication (NFC), Wi-Fi, infrared, cellular, satellite, a Personal Computer Memory Card International Association (PCMCIA) slot and card, etc.

The control system **400** also includes transceivers and signal translators necessary to communicate with the vehicle electronic control units in various communication protocols, such as J1850 (VPM and PWM), ISO 9141-2 signal, communication collision detection (CCD) (e.g., Chrysler collision detection), data communication links (DCL), serial communication interface (SCI), Controller Area Network (CAN), Keyword 2000 (ISO 14230-4), OBD II or other communication protocols that are implemented in a vehicle. This allows the refrigerant recovery unit to communicate directly with the vehicle without the VCI (e.g., directly connected to the vehicle) or while the VCI is simply acting as a pass through.

A software program (also referred to as computer control logic) may be stored in main memory **408** and/or secondary memory **410**. Software programs may also be received through communications interface **420**. Such software programs, when executed, enable the control system **400** to perform the features of the present invention, as discussed herein. In particular, the software programs, when executed, enable the processor **402** to perform the features of the present invention. Accordingly, such software programs may represent controllers of the control system **400**.

In variations where the invention is implemented using software, the software may be stored in a computer program product and loaded into control system **400** using hard drive **412**, removable storage drive **416**, and/or the communications interface **420**. The control logic (software), when executed by the processor **402**, causes the controller **216**, for example, to perform the functions of the invention as described herein. In another variation, aspects of the present invention can be implemented primarily in hardware using, for example, hardware components, such as application specific integrated circuits (ASICs), field programmable gate array (FPGA). Implementation of the hardware state machine so as to perform the functions described herein will be apparent to persons skilled in the relevant art(s).

FIG. **4** is a plan view illustrating a diagnostic tool **500** according to an embodiment of the invention. The diagnostic tool **500** can be any computing device, such as the Honda VCI from Service Solutions U.S. LLC in Warren, Mich. The diagnostic tool **500** includes a housing **502** to house the various components of the diagnostic tool, such as a display **504**, a user interface **506**, a power key **508**, a memory card reader (optional), a connector interface **512** and a connection **514**.

The display **504** can be any type of display, for example, a liquid crystal display (LCD), a video graphics array (VGA), a touch display (which can also be a user interface), etc. The display can turn OFF after a certain period of time that the tool is not being used. For example, when no buttons are pressed or no data being retrieved from the vehicle for ten minutes, five minutes, three minutes or 1 minute. However, any time period can be set for turning OFF the display so that the battery (internal) can be conserved.

The user interface **506** allows the user to interact with the diagnostic tool **500** in order to operate the diagnostic tool as desired. The user interface **506** can include scroll device, function keys, arrow keys or any other type of keys that can manipulate the diagnostic tool **500** in order to operate various menus that are presented on the display.

The keys can also include a "back" or "enter" or a "code connect" **516** key. Once activated, the code connect **516** can display additional information about a DTC or other diagnostic information as discussed herein. The input device **506** can also be a mouse or any other suitable input device, including a keypad, or a scanner. The user interface **506** can also include numbers or be alphanumeric.

The power key **508** allows the user to turn the diagnostic tool **500** ON and OFF, as required. The diagnostic tool **500** can automatically turn OFF after a user-selectable period of time of inactivity (e.g. no buttons pressed or data being collected from the vehicle). The power for the diagnostic tool **500** can be supplied from internal batteries of the tool or from the vehicle's battery when the tool is coupled to the DLC or from a connection to a computing device, such as through a USB connection. If the power source is the vehicle or through a connection (such as a computing device), then the tool can power on automatically once the tool is connected to the vehicle or computing device.

Memory card reader (optional) can be a single type card reader, such as a compact flash card, floppy disc, memory stick, secure digital memory, flash memory or other types of memory. The memory card reader can be a reader that reads more than one of the aforementioned memories such as a combination memory card reader. Additionally, the memory card reader can also read any other computer readable medium, such as CD, DVD, UMD, etc. In one embodiment, the memory card reader can be used to update the software or databases that are in the diagnostic tool **500**.

The connector interface **512** allows the diagnostic tool **100** to connect to an external device, such as an ECU of a vehicle, a computing device, an external communication device (such as a modem), a network, etc. through a wired or wireless connection (not shown). In addition, a connection **514** can also be included on the diagnostic tool **500** in order to connect to USB, FIREWIRE, modem, RS232, RS485, and other connections to communicate with external devices, such as a hard drive, USB drive, CD player, DVD player, UMD player, PC or other computer readable medium devices.

FIG. **5** is a block diagram of the components of the diagnostic tool **500**. In FIG. **5**, the diagnostic tool **500** according to an embodiment of the invention includes a processor **602**, a field programmable gate array (FPGA) **614**, a first system bus **624**, the display **504**, a complex programmable logic device (CPLD) **604**, the user interface in the form of a keypad **506**, a memory subsystem **608**, an internal non-volatile memory (NVM) **618**, a card reader **620** (optional), a second system bus **622**, a connector interface **611**, a selectable signal translator **610**, a GPS antenna **632**, a GPS receiver **634**, an optional altimeter **636** and wireless communication circuit **638**. A vehicle communication interface **630** is in communication with the diagnostic tool **500** through connector interface **611** via an external cable (not shown).

Selectable signal translator **610** communicates with the vehicle communication interface **630** through the connector interface **611**. Signal translator **610** conditions signals received from an ECU unit through the vehicle communication interface **630** to a conditioned signal compatible with diagnostic tool **500**. Signal translator **610** can communicate with, for example, the following communication protocols: J1850 (VPM and PWM), ISO 9141-2 signal, communication collision detection (CCD) (e.g., Chrysler collision detection), data communication links (DCL), serial communication interface (SCI), Controller Area Network (CAN), Keyword 2000 (ISO 14230-4), OBD II or other communication protocols that are implemented in a vehicle.

The circuitry to translate and send in a particular communication protocol can be selected by FPGA **614** (e.g., by tri-stating unused transceivers) or by providing a keying device that plugs into the connector interface **611** that is provided by diagnostic tool **500** to connect diagnostic tool **500** to the vehicle communication interface **630**. Signal translator **610** is also coupled to FPGA **614** and the card reader **620** via the first system bus **624**. FPGA **614** transmits to and receives signals (i.e., messages) from the ECU unit through signal translator **610**.

The FPGA **614** is coupled to the processor **602** through various address, data and control lines by the second system bus **622**. FPGA **614** is also coupled to the card reader **620** through the first system bus **624**. The processor **602** is also coupled to the display **504** in order to output the desired information to the user. The processor **602** communicates with the CPLD **604** through the second system bus **622**. Additionally, the processor **602** is programmed to receive input from the user through the user interface **506** via the CPLD **604**. The CPLD **604** provides logic for decoding various inputs from the user of the diagnostic tool **500** and also provides glue-logic for various other interfacing tasks.

Memory subsystem **608** and internal non-volatile memory **618** are coupled to the second system bus **622**, which allows for communication with the processor **602** and FPGA **614**. Memory subsystem **608** can include an application dependent amount of dynamic random access memory (DRAM), a hard drive, and/or read only memory (ROM). Software to run the diagnostic tool **500** can be stored in the memory subsystem **608**, including any database. The database can include diagnostic information and other information related to vehicles. In one embodiment, the database can include additional information such as possible fixes for a particular DTC retrieved from a vehicle.

The database can contain information about additional databases include the additional information but located at a remote location instead of being local on the diagnostic tool. The remote database can be accessed via a wireless or wired connection. The database can also be stored on an external memory, such as a compact flash card or other memories and accessed locally by the diagnostic tool.

Internal non-volatile memory **618** can be an electrically erasable programmable read-only memory (EEPROM), flash ROM, or other similar memory. Internal non-volatile memory **618** can provide, for example, storage for boot code, self-diagnostics, various drivers and space for FPGA images, if desired. If less than all of the modules are implemented in FPGA **614**, memory **618** can contain downloadable images so that FPGA **614** can be reconfigured for a different group of communication protocols.

The GPS antenna **632** and GPS receiver **634** may be mounted in or on the housing **502** or any combination thereof. The GPS antenna **632** electronically couples to the GPS receiver **634** and allows the GPS receiver to communicate (detects and decodes signals) with various satellites that orbit the Earth. In one embodiment, the GPS antenna and GPS receiver are one device instead of two. The GPS receiver **634** and GPS antenna **632** electronically couple to the processor **602**, which is coupled to memory **608**, NVM **618** or a memory card in the card reader **620**. The memory can be used to store cartographic data, such as electronic maps. The diagnostic tool can include all the maps for the U.S. (or country of use), North America or can have the region or state where the diagnostic tool is located. In alternative embodiments, the diagnostic tool can have all the maps of the world or any portion of the world desired by the user. This allows the diagnostic tool to be a GPS device so that a driver can drive from one location to another. The maps may be over lay or incorporated with traffic, local events, and location of other GPS devices (smart phones) and other information that can be useful to the technician. By being able to locate other diagnostic tools with GPS, then the technicians may be able to use the diagnostic tools to locate each other in order to conduct a meeting or have a social event.

The GPS receiver communicates with and "locks on" to a certain number of satellites in order to have a "fix" on its global location. Once the location is fixed, the GPS receiver, with the help of the processor, can determine the exact location including longitude, latitude, altitude, velocity of movement, and other navigational data of the diagnostic tool **500**.

Should GPS receiver be unable to lock onto the minimum number of satellites to determine the altitude or unable to determine the altitude for any reason, the altimeter **636** can be used to determine the altitude of the diagnostic tool **500**. The altimeter **636** is electronically coupled to the processor **602** and can provide the altitude or elevation of the diagnostic tool **500**. The altimeter can be coupled to a barometric pressure sensor (not shown) in order to calibrate the elevation measurements determined by the altimeter. The sensor can be positioned interior or exterior to the housing **502** of the diagnostic tool **500**. Minor atmospheric pressure changes can affect the accuracy of the altimeter, thus, diagnostic tool can correct for these changes by using the sensor in conjunction with the altimeter along with a correction factor known in the art.

Wireless communication circuit **638** communicates with the processor **602** via the second bus system **622**. The wireless communication circuit can be configured to communicate via RF (radio frequency), satellites, cellular phones (analog or digital), BLUETOOTH®, NFC, Wi-Fi, Infrared, Zigby, Local Area Networks (LAN), WLAN (Wireless Local Area Network), other wireless communication configurations and standards or a combination thereof. The wireless communication circuit allows the diagnostic tool to communicate with other devices wirelessly including the refrigeration recovery unit **100** in order to transmit wirelessly the vehicle diagnostic information retrieved by the diagnostic tool **500**. The wireless communication circuit includes an antenna built therein and being housed within the housing or can be externally located on the housing.

A diagnostic tool program is needed to operate the diagnostic tool to perform the various diagnostic tests. Different vehicle manufacturers (or even within the same manufacturer) require the diagnostic tool to operate using different programs and communication protocols. The vehicle information (make, model, year, etc.) may be inputted into the diagnostic tool through the user interface **506** in a manner such as, for example, scanning a bar coded VIN number located on the vehicle to be serviced or inputting information of the vehicle, such as year, make and model. In another embodiment, the diagnostic tool can automatically scan for the vehicle information, for example information from the ECUs of the vehicle, to determine the correct vehicle or communication protocol used by the vehicle.

Once the diagnostic tool program is operating and the diagnostic tool **500** is connected to the ECU **208**, the DLC, the DTCs and/or other such diagnostic devices from the vehicle. In one embodiment, the available vehicle diagnostic data can be automatically scan from the vehicle and displayed on the display. The display can include a list of data category (e.g., I/M monitors, DTCs, state OBD check, etc.) that can be available for that vehicle or a generic vehicle and a check mark or other indicators can be next to a category that has vehicle data that has been retrieved from the vehicle. This allows the technician to hone in on the information that he wants or be able to quickly determine what diagnostic data is available for the vehicle under test.

FIG. **6** illustrates the refrigerant recovery unit **100** communicating with the diagnostic tool **500** that is connected to the vehicle **700**. The diagnostic tool **500** is connected to the ECU **208** via the communication cable **12**. In operation, the diagnostic tool **500** can be used to collect vehicle information and diagnostic data for the vehicle under the test. In one embodiment, the diagnostic tool **500** can be used to collect vehicle information such as make, model and year, owner information, VIN, previous diagnosis performed, and location of the vehicle (indirectly from the GPS information of the diagnostic tool **500**). This type of vehicle information may be manually entered by the user or collected via a scanning system such as a bar code reader or RFID reader.

In another embodiment, the diagnostic tool **500** may be coupled to the ECU **208** or DLC of the vehicle in order to retrieve vehicle information including diagnostic information. The diagnostic information may include DTCs that are set in the vehicle, or vehicle operating parameters from various sensors such as the temperature sensor **218** (temperature, pressure, throttle, etc.). The vehicle information can be transmitted via a wired or wireless connection from the diagnostic tool **500** to the refrigerant recovery unit **100**.

In another embodiment, the diagnostic tool **500** can act as a pass through device that simply passes through the vehicle diagnostic data to the refrigerant recovery unit **100**. In this embodiment, the refrigerant recovery unit processes the diagnostic information and provides the fixes to the technician. The refrigerant recovery unit can include the communication protocols that are needed to communicate with the various computers or electronic control units of the vehicle. Additionally, the diagnostic software can be stored in the memory of the refrigerant recovery unit to diagnose the vehicle and clear the set DTCs. In a particular example, the diagnostic tool **500** may pass through temperature sensor data, signals to modulate the fan **206**, and the like.

The refrigerant recovery unit **100** can use the vehicle information including the DTCs and other diagnostic data to diagnose any issues with the vehicle. The refrigerant recovery unit can access diagnostic information including fixes that are stored in its memory as described herein. In the event that additional information is needed to diagnose or fix the vehicle, the refrigerant recovery unit or the diagnostic tool can retrieve it from remote computing device using the respective communication interface.

The communication between the refrigerant recovery unit and the diagnostic tool may be in any communication protocols, such as Wi-Fi, BLUETOOTH®, NFC, ZIGBEE® and other protocols described herein. The communication connection may be a wired or wireless connection.

FIG. **7** illustrates the refrigerant recovery unit of FIG. **1** directly coupled to and communicating with the vehicle according to an embodiment of the invention. A communication cable **702** is connected to the vehicle connector interface **130** of the refrigerant recover unit **100** and to the data link connector (not shown) in the vehicle **700**. In this embodiment, the diagnostic tool is not required to diagnose and retrieve vehicle information and data from the vehicle.

In operation, with the communication cable connecting the vehicle **700** with the refrigerant recovery unit, data including diagnostic information and vehicle information can be retrieved from the vehicle for processing. With the vehicle information retrieved from the vehicle via the communication cable (or by the manual entry), the refrigerant recovery unit can identify the appropriate diagnostic database to use to diagnose the vehicle under test. Vehicle diagnostic data can then be retrieved from the vehicle, such as DTCs for processing. Once the problems with the vehicle are identified, the appropriate fixes can be provided to the user. The fixes can be provided from a database stored in the refrigerant recovery unit or retrieved from an external source such as an external memory or a remote database on a remote computing device.

It is to be understood that any feature described in relation to any one aspect may be used alone, or in combination with other features described, and may also be used in combination with one or more features of any other of the disclosed aspects, or any combination of any other of the disclosed aspects.

The many features and advantages of the invention are apparent from the detailed specification, and thus, it is intended by the appended claims to cover all such features and advantages of the invention which fall within the true spirit and scope of the invention. Further, since numerous modifications and variations will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

What is claimed is:

1. A refrigerant recovery unit, comprising:

a refrigerant storage unit configured to store a refrigerant;

a refrigerant circuit in fluid connection with a refrigeration system of a vehicle, the refrigerant circuit configured to recover refrigerant from the refrigeration system and recharge the refrigeration system with the refrigerant;

a vehicle connector interface that communicates with an electronic control unit of the vehicle;

a processor configured to control the refrigerant recovery unit and the processor being configured to control a fan that is disposed in an engine compartment of the vehicle to provide a flow of air to components in the engine compartment including the refrigeration system; and

a memory to store diagnostic software and operating software to operate the refrigerant recovery unit.

2. The refrigerant recovery unit according to claim **1**, wherein the fan is a ducted fan.

3. The refrigerant recovery unit according to claim **1**, further comprising:

an input interface configured to receive an input from a user; and

a display configured to display information to the user.

4. The refrigerant recovery unit according to claim **1**, further comprising a communication interface to receive diagnostic information of the vehicle through a diagnostic tool, the diagnostic information including a sensed temperature from a temperature sensor.

5. The refrigerant recovery unit according to claim **4**, wherein the processor is configured to receive the sensed temperature and control the fan to activate in response to the sensed temperature being outside a predetermined temperature range.

6. The refrigerant recovery unit according to claim **4**, wherein the diagnostic information is passed through to the refrigerant recovery unit by the diagnostic tool without processing the diagnostic information.

7. The refrigerant recovery unit according to claim **1**, further comprising a communication interface that includes communication protocols to communicate directly with the vehicle electronic control unit.

8. The refrigerant recovery unit according to claim **1**, further comprising:

a pair of hoses to fluidly connect the refrigeration system to the refrigerant recovery unit.

9. A refrigerant recovery unit, comprising:

a refrigerant storage unit configured to store a refrigerant;

a refrigerant circuit in fluid connection with a refrigeration system of a vehicle, the refrigerant circuit configured to recover refrigerant from the refrigeration system and recharge the refrigeration system with the refrigerant;

a vehicle connector interface that communicates with an electronic control unit of the vehicle;

a processor configured to control the refrigerant recovery unit and the processor being configured to control a fan that is disposed in an engine compartment of the vehicle to provide a flow of air to components in the engine compartment including the refrigeration system;

a memory to store diagnostic software and operating software to operate the refrigerant recovery unit;

a pair of hoses to fluidly connect the refrigeration system to the refrigerant recovery unit;

a temperature sensor configured to sense a temperature of the refrigeration system; and

a communication cable to convey signals from the temperature sensor to the processor, wherein the processor is configured to receive the sensed temperature and control the fan to activate in response to the sensed temperature being outside a predetermined temperature range.

10. The refrigerant recovery unit according to claim **9**, wherein the fan is a ducted fan.

11. The refrigerant recovery unit according to claim **9**, further comprising:

an input interface configured to receive an input from a user; and

a display configured to display information to the user.

12. A method of improving recovery of refrigerant from a refrigeration system, the method comprising the steps of:

receiving a sensed temperature by a processor of a refrigerant recovery unit;

communicating via a vehicle connector interface of the refrigerant recovery unit to an electronic control unit of a vehicle;

controlling with the processor a fan disposed in an engine compartment of the vehicle in response to the sensed temperature being outside a predetermined range of temperatures; and

collecting the refrigerant that enters the refrigerant recovery unit.

13. The method according to claim **12**, further comprising the step of:

sensing a temperature of the refrigeration system.

14. The method according to claim **13**, further comprising the step of:

comparing the sensed temperature to the predetermined temperature range and controlling the fan to provide the flow of air in response to the sensed temperature being outside the predetermined temperature range.

15. The method according to claim **13**, further comprising the step of:

controlling the fan to provide the flow of air prior to collecting the refrigerant.

16. The method according to claim **13**, further comprising the step of:

recharging the refrigeration system comprising the step of:

supplying a recharging refrigerant to the refrigeration system with the refrigerant recovery unit.

17. The refrigerant recovery unit according to claim **1**, wherein the processor is further configured to control the fan to increase the temperature of the refrigeration system to at or near an ambient temperature.

18. The refrigerant recovery unit according to claim **1**, wherein the processor is further configured to control the fan to decrease the temperature of the refrigeration system to at or near an ambient temperature.

19. The refrigerant recovery unit according to claim **9**, wherein the processor is further configured to control the fan to increase the temperature of the refrigeration system to at or near an ambient temperature.

20. The refrigerant recovery unit according to claim **9**, wherein the processor is further configured to control the fan to decrease the temperature of the refrigeration system to at or near an ambient temperature.

* * * * *