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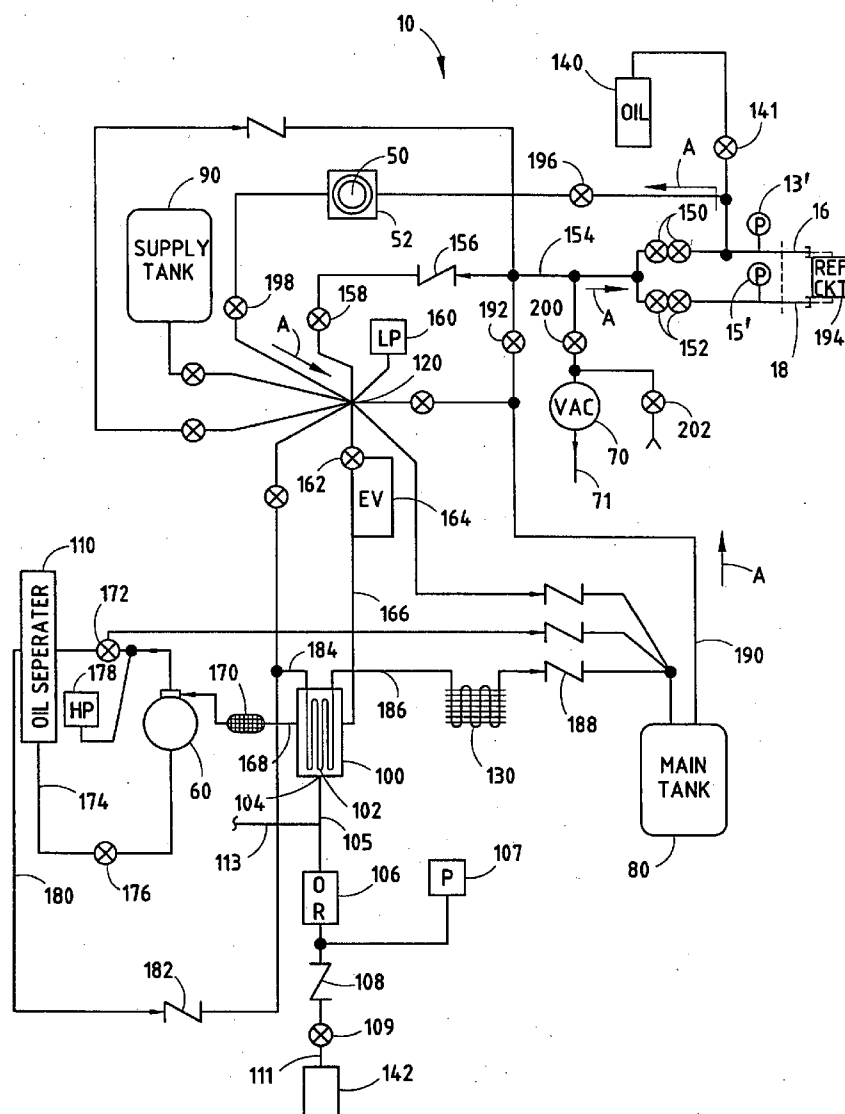
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(57) **ABSTRACT**

An apparatus and method for providing expandability to a refrigeration servicing unit which includes one or more integrated modules. The modules can communicate with the unit via a wired or wireless connection. The modules can add functionality such as an information module, a refrigerant identifier module, a communication module, a bar code module, and a diagnostic module.

(60) Provisional application No. 60/631,626, filed on Nov. 30, 2004.



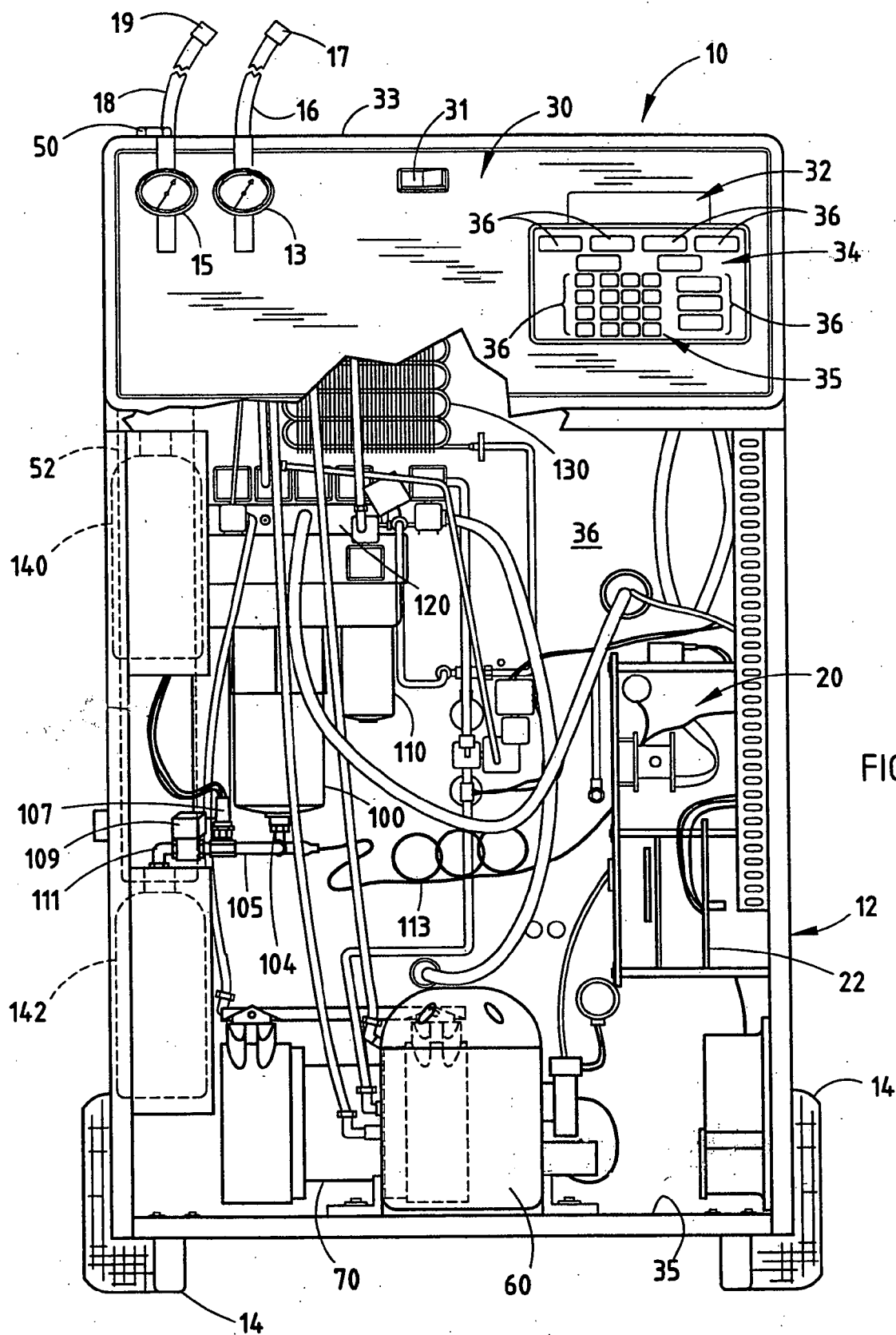
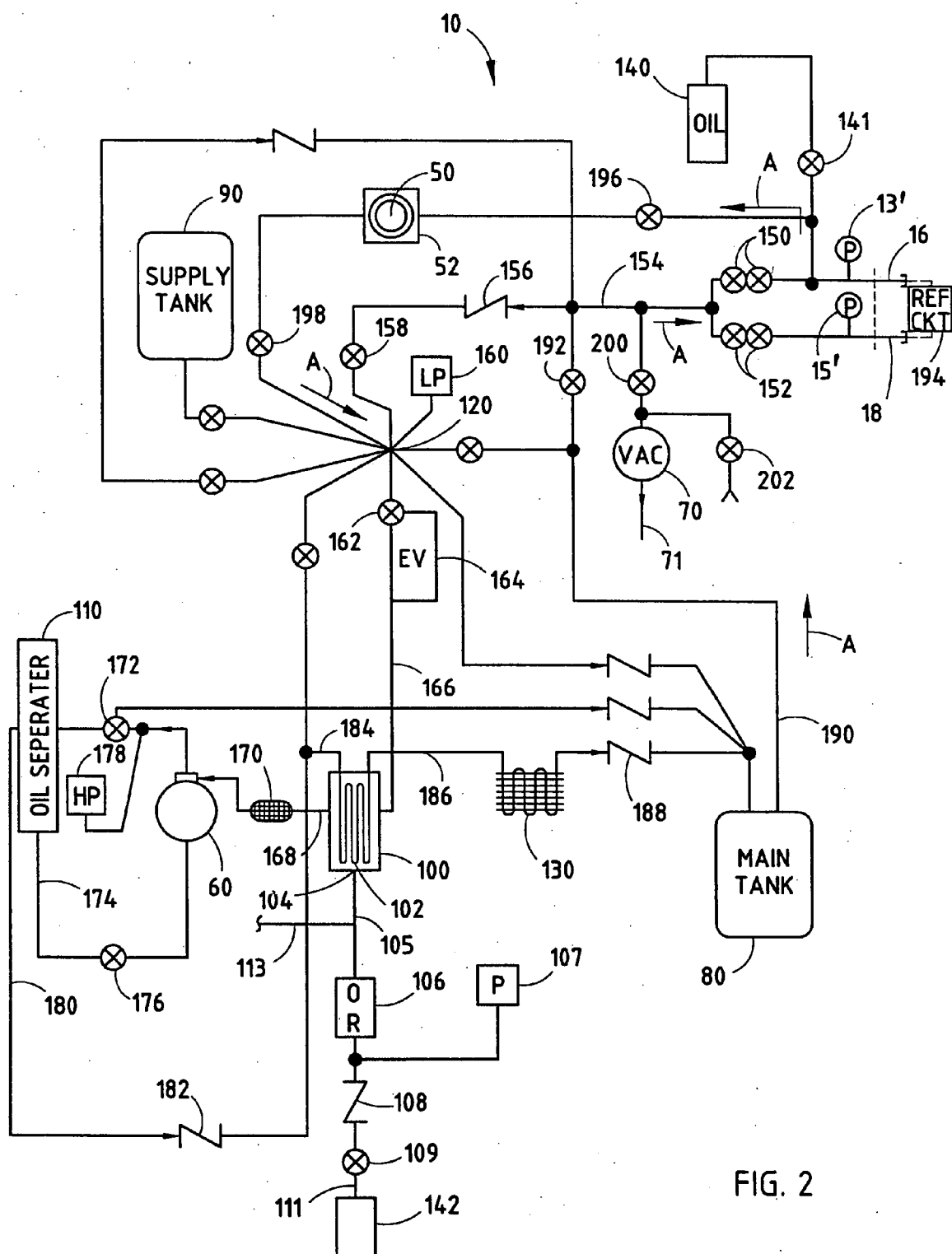


FIG. 1



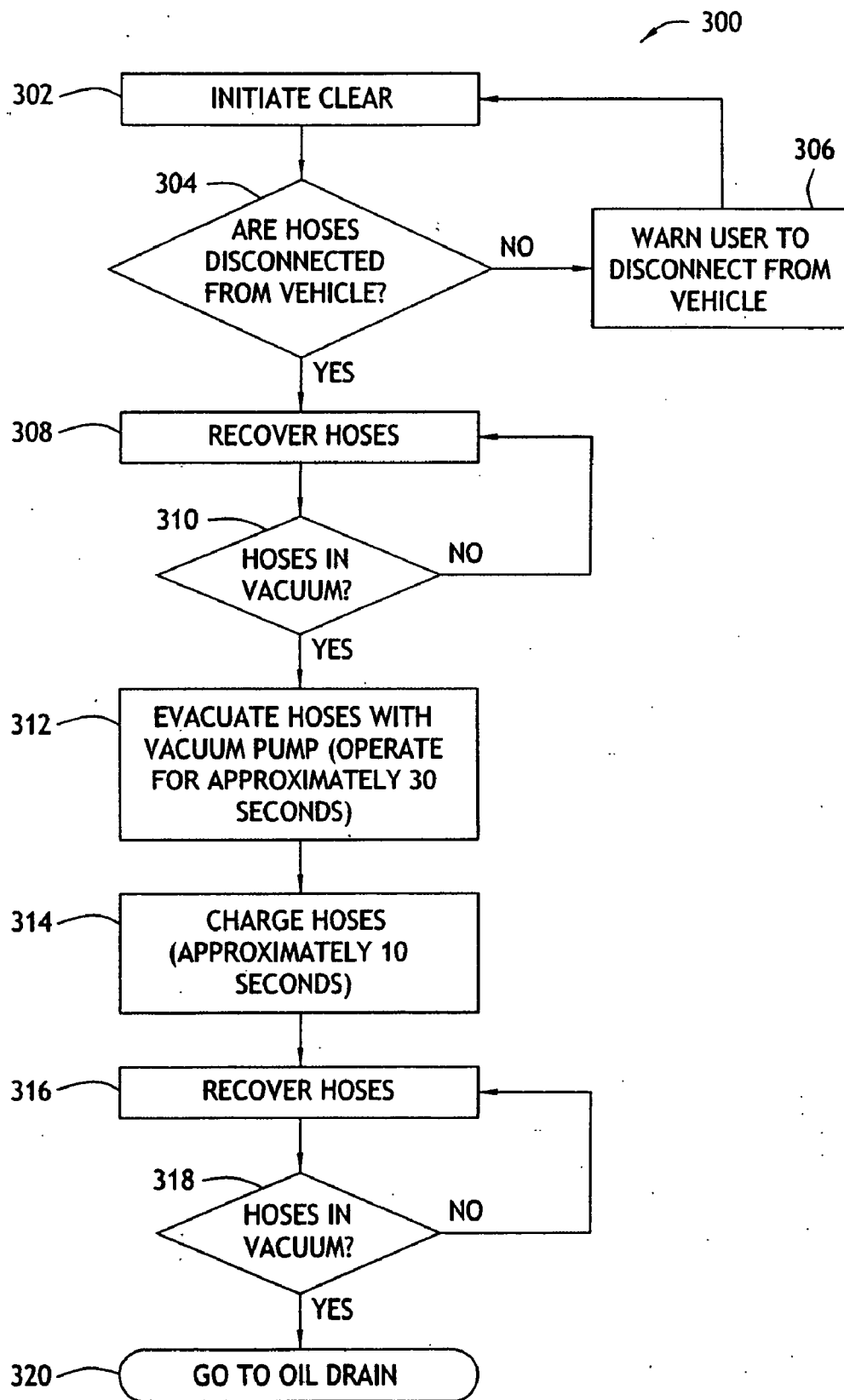


FIG. 3

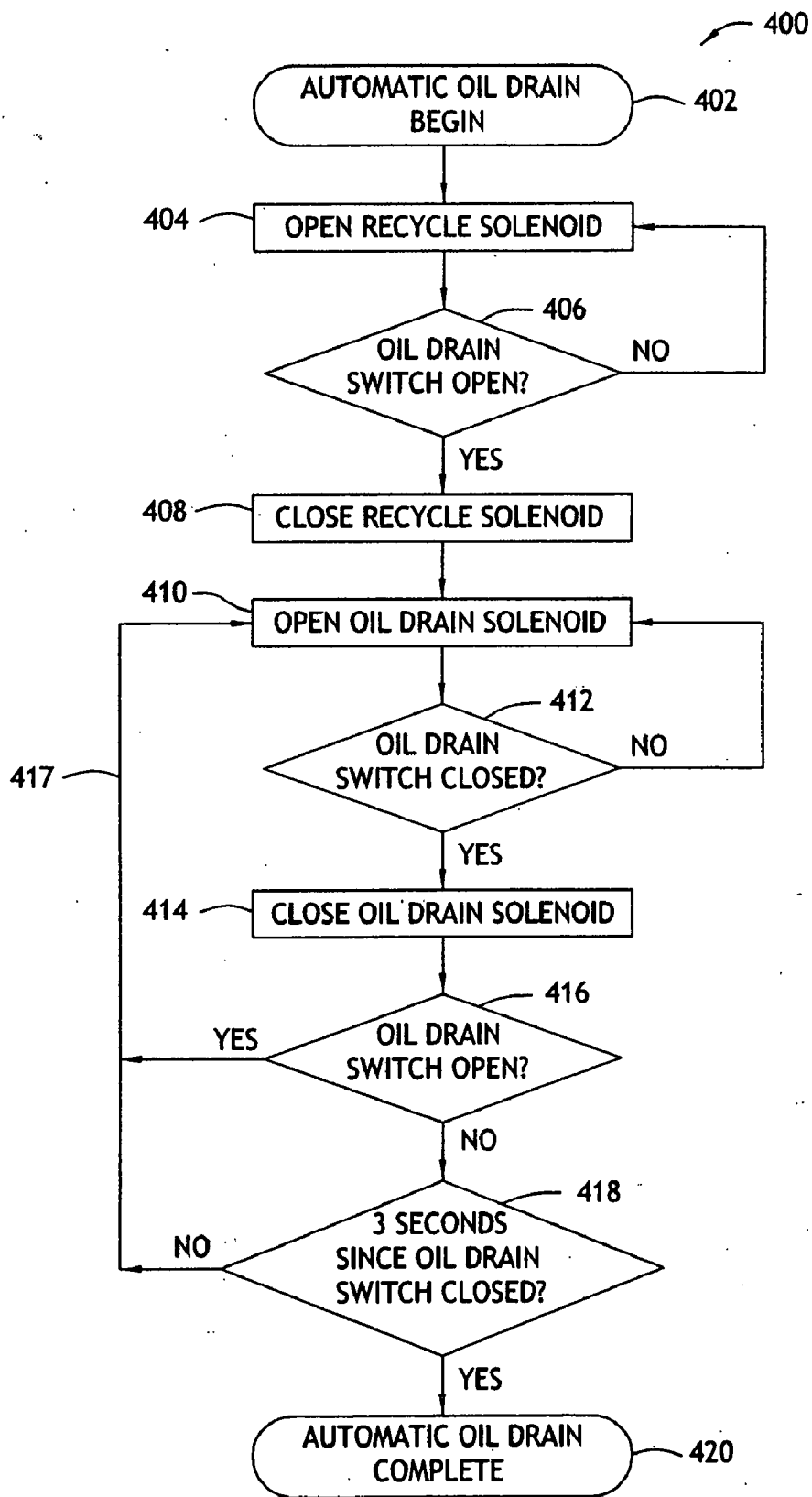


FIG. 4

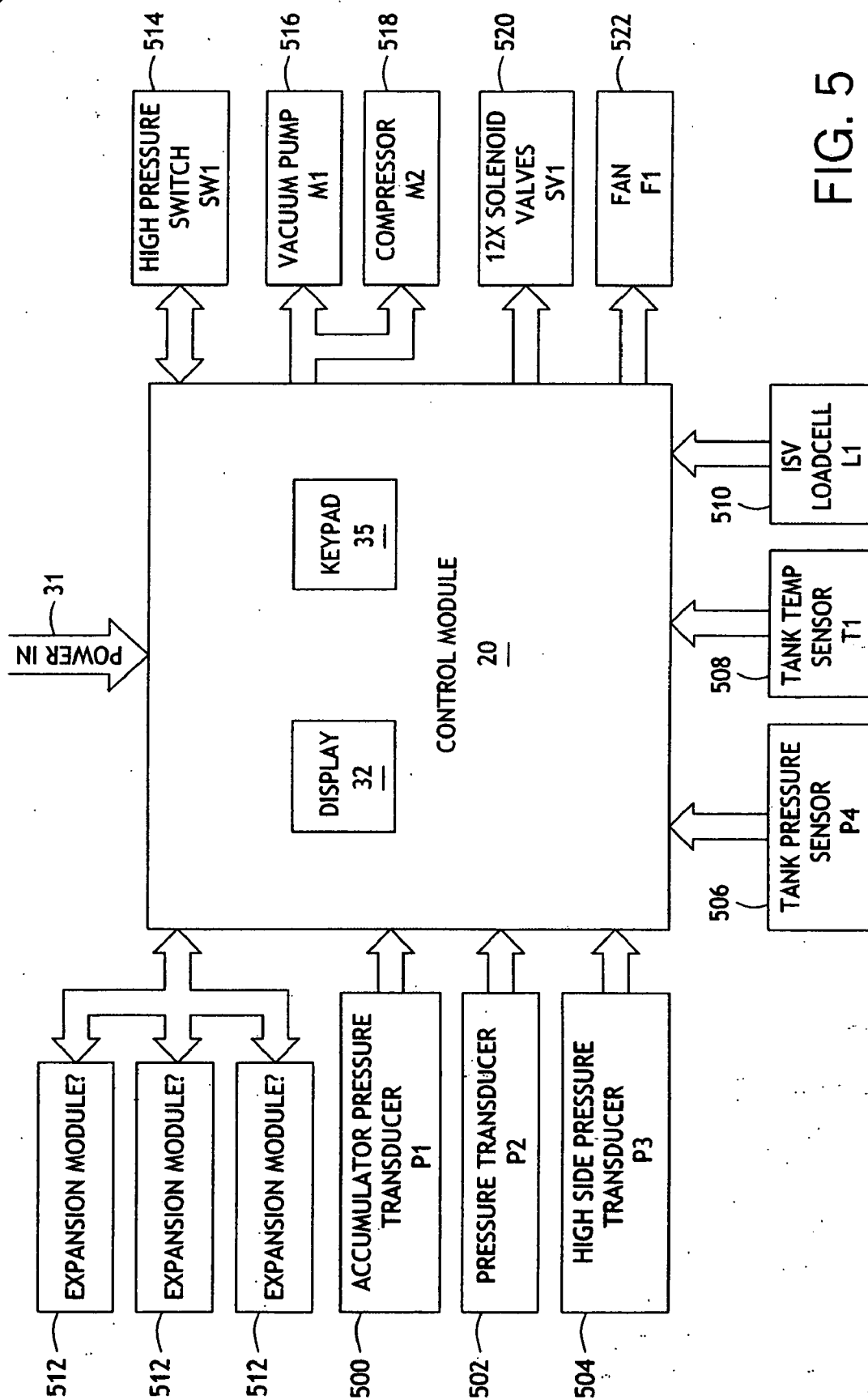


FIG. 5

MODULAR RECOVERY APPARATUS AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to provisional U.S. patent application entitled, MODULAR RECOVERY APPARATUS AND METHOD, filed Nov. 30, 2004, having a Ser. No. 60/631,626, now pending, the disclosure of which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates generally to an apparatus and method for servicing refrigeration systems. More particularly, the present invention relates to expandability of a refrigeration servicing unit which includes integrated modules.

BACKGROUND OF THE INVENTION

[0003] In recent years, the maintenance of vehicle refrigerant systems has been accomplished utilizing closed-circuit recovery devices that prevent the discharge of refrigerant into the atmosphere. Such systems are typically self-contained units with the capability of recovering the refrigerant from the vehicle and subsequently recharging the system.

[0004] As the units for recovery devices have developed and additional requirements and capabilities increase, a wide range of functions have been developed which may be implemented in some preferred platforms of recovery devices. While providing some enhanced capability, the development and incorporation of such features on some recovery device platforms can be costly. Additionally, it is not always clear from the outset as to what specific capability to provide for a recovery device platform. Thus, it is not always expedient to redesign or retrofit a recovery device to include additional functionality after the original design and/or delivery of a preferred platform. Furthermore, while a particular platform functionally may be preferred by some, others may prefer another kind of functionality designed and/or implemented within the platform of a recovery device. Accordingly, it is desirable to provide a method and apparatus that provide a preferred design and expandability of a refrigeration servicing unit.

SUMMARY OF THE INVENTION

[0005] The foregoing needs are met, to a great extent, by the present invention, wherein in one aspect an apparatus is provided that in some embodiments a refrigerant recovery system that is adapted to receive modules in order to add functionality to the recovery system.

[0006] In accordance with one embodiment of the present invention a refrigerant recovery unit for maintenance of a cooling system of a vehicle that can include a recovery circuit configured to recover refrigerant from the cooling system, a processor that communicates with components of the recovery circuit, a housing configured to house the components of the refrigerant recovery unit, and at least one module that can provide a function to the refrigerant recovery unit and communicates with the processor.

[0007] In accordance with another embodiment of the present invention, a refrigerant recovery system for main-

tenance of a cooling system of a vehicle can include a means for controlling components of the refrigerant recovery system, a means for recovering refrigerant from the cooling system, a means for providing functionality to the refrigerant recovery system that can communicate with the means for controlling, and a means for housing the components of the refrigerant recovery system.

[0008] Yet another embodiment according to the present invention provides a method of adding functionality to a refrigerant recovery unit that can provide the refrigerant recovery unit having a recovery circuit configured to recover refrigerant from the cooling system, a processor that can communicate with components of the recovery circuit, and a housing configured to house the components of the refrigerant recovery unit. The method can also add at least one module to expand the functionality of the refrigerant recovery unit.

[0009] 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.

[0010] 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.

[0011] 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

[0012] **FIG. 1** is a front elevational view, partly broken away, of a refrigerant maintenance system for a vehicle which incorporates an embodiment of the present invention.

[0013] **FIG. 2** is a schematic flow diagram of the refrigerant maintenance system incorporated in the system shown in **FIG. 1**.

[0014] **FIG. 3** illustrates the initial clear function diagram according to an embodiment of the present invention.

[0015] **FIG. 4** illustrates an automatic oil drain method according to an embodiment of the invention.

[0016] **FIG. 5** illustrates an electronic control unit in communication with various components of the unit.

DETAILED DESCRIPTION

[0017] An embodiment in accordance with the present invention provides a method and apparatus for providing

expandability and functionality of a refrigeration servicing unit. Preferred embodiments of the invention will now be described with reference to the drawing figures, in which like reference numerals refer to like parts throughout.

[0018] **FIG. 1** is a front elevational view, partly broken away, of a refrigerant maintenance system, which incorporates an embodiment of the present invention. The maintenance system can be a refrigeration servicing unit **10** that couples to and maintains a cooling system such as, for example, a refrigerant circuit for a vehicle's air conditioning system. The unit **10** can be configured as a portable machine mounted within a cabinet or housing **12**. The housing **12** can be supported by a plurality of wheels **14**, such that it can be conveniently moved to the situs of a vehicle. Unit **10** can include a recovery circuit for coupling to the vehicle's cooling system. The recovery circuit can include a high pressure hose **16** with a coupling **17** which may be coupled, for instance, to a vehicle's high pressure port. The recovery circuit can further include a low pressure hose **18** having a coupling **19**, which may be coupled to a low pressure port of the vehicle's refrigerant circuit. The front panel of the housing is shown broken away in **FIG. 1** to show the major elements of the system which are also identified by similar numbers in the flow diagram of **FIG. 2**.

[0019] In one embodiment, the unit **10** can include an electronic control unit **20** integrally including a microprocessor on a circuit board **22** for controlling the electromechanical solenoid valves and for receiving input information from the pressure sensors and control switches of unit **10** so as to control the recovery and/or flushing processes. A control panel **30** can further include an on/off switch **31** and a display **32** for displaying the operational status of the unit's **10** operation. The display **32** may be an LCD display or other suitable electronic display coupled to the microprocessor via a conventional input/output circuit. The control panel **30** can further include a switch panel **34** having a conventional keyboard **35** and a plurality of push-button switches **36** for controlling the operation of the unit **10** through its various phases of operation and/or for selecting parameters for display. Thus, the keyboard **35** in conjunction with the operational switches **36** and display **32** can allow an operator to enter the desired operational parameters for the unit **10** according to manufacturer's specifications for servicing an air conditioner unit in a particular vehicle.

[0020] The input hoses **16** and **18** can be coupled to mechanical pressure gauges **13** and **15**, respectively, which can be mounted on the front panel of the unit **10**, as seen in **FIG. 1**. In addition, electrical pressure transducers **13'** and **15'** can be coupled to the hoses **16** and **18** as shown in **FIG. 2**, and can be further coupled to the microprocessor through conventional input/output circuits to provide the microprocessor with information as to the current pressure in the hoses during operation of the unit. Gauges **13** and **15** may further provide the operator with a conventional analog display of the pressure as well. A sight gauge **50** can be mounted to a top surface **33** of housing **12**, and a filter cartridge **52** can be mounted to the housing **12** for filtering particulate material from the refrigerant during the flushing cycle, as described in greater detail below. The unit **10** can further include a compressor **60** and a vacuum pump **70** disposed within the housing **12**.

[0021] The unit **10** can also include a flushing circuit for facilitating the internal clearing function of the unit **10**. More

specifically, the flushing circuit can include a clean refrigerant source. The source can be provided by a main tank **80** and a supply tank **90** of clean refrigerant (**FIG. 2**). The main tank **80** and the supply tank **90** can be disposed within the housing **12**, for example, mounted behind the front of housing **12** and on an extension of floor **35**. The supply tank **90** may be utilized to supply additional refrigerant to the main tank **80**. Further disposed within the housing **12** and forming a portion of the recovery circuit can be a filtration system such as, for example, an oil separation system coupled to or integrated with the recovery circuit and/or flushing circuit for cleaning the recovered refrigerant. The oil separation system can include an oil accumulator tank **100**, and an oil separator filter **110**. The unit **10** can further include a fresh oil canister **140**, which can be mounted within the housing **12**. A recover oil container **142** can also be provided and mounted within the housing **12** so as to receive oil drained from the accumulator tank **100**. Having briefly described the major components in one embodiment of the unit **10** shown in **FIGS. 1 and 2**, a more detailed description of the system follows in connection with **FIG. 2**.

[0022] **FIG. 2** is a schematic flow diagram of the refrigerant maintenance system incorporated in the system shown in **FIG. 1**. In a refrigerant recovery operation, the hoses **16** and **18** can be coupled to the vehicle and the recovery cycle can be initiated by the opening of the dual back-to-back high pressure and low pressure solenoids **150** and **152**, respectively. This allows the refrigerant within the vehicle to flow through conduits **154** through a check valve **156** and a recovery valve **158** into a manifold **120**. A low pressure switch **160** can be configured to sense pressure in the recovery circuit and provide an output signal to the microprocessor through a suitably programmed interface circuit so as to detect when the pressure of the recovered refrigerant is down to, for example, 13 inches of mercury. The refrigerant can then flow through the remainder of the recovery circuit, which can further include valve **162** and conduit **166** into the accumulator tank **100** where it travels through an output conduit **168** through a water separating molecular sieve **170** to an input of compressor **60**. Compressor **60** can draw the refrigerant through a valve **172** and through the oil separating filter **110** which circulates compressor oil back to the compressor through conduit **174** and oil return valve **176**. A pressure transducer **178** can be coupled to the microprocessor which can be further programmed to determine the upper pressure limit of, for example, 435 p.s.i. to shut down the compressor in the event the pressure becomes excessive for the unit **10**. The compressed refrigerant can exit the oil separator **110** and into the remainder of the recovery circuit, which can further include a conduit **180**, a check valve **182** and a heating coil **102**. The heating coil **102** can assist in maintaining the temperature in accumulator **100** within a working range. The refrigerant can continue through recovery circuit including through conduit **186** to a condenser **130** and next flows through check valve **188** and into the main tank **80**. With the main tank **80** holding clean refrigerant, a clean source of refrigerant can be made available for the flushing operation. The clean refrigerant source can be supplemented if needed by the supply tank **90** coupled to the main tank **80**.

[0023] The unit **10** can include means to flush the recovery circuit with a source of clean refrigerant. More specifically, the flushing circuit can be coupled to the recovery circuit and the main or internal refrigerant storage tank **80** to flush the

recovery circuit, including the service hoses **16** and **18** and any associated solenoids, with clean refrigerant so as to remove residual additives and oils remaining in the circuit. Any additives and/or oils in the unit **10** can be further separated, for example, using the oil separator **110** and may be further drained and disposed appropriately.

[0024] The flushing operation can include determining that the couplings **17** and **19** are disconnected from the vehicle so as to prevent damage to the vehicle's air conditioning or cooling system. For example, a sensor can be provided to detect when the couplings **17** and **19** are connected to a prescribed connection point on the unit **10** and disconnected from a cooling system. Such connection may be considered a "hose holder" connection (where the hoses can be stored with the unit when not in use), for example. The sensor can be further configured so as to disable the flushing operation upon detecting a connection between the unit **10** and a cooling system. Alternatively, the electronic control unit **20** can be configured or programmed to prompt a technician that a flush process can be initiated after detecting that the couplings **17** and **19** are not connected to a vehicle.

[0025] For example, a pressure sensing operation can be configured and provided in which high-side and low-side pressure transducers **13'** and **15'**, respectively, determine the connectivity of unit **10** to a vehicle for the recovery process as described above. In response, various components such as low-side inlet, high-side inlet, solenoids may be triggered to open so as to initiate and carry out the recovery process. When the recovery process is complete, the transducers **13'** and **15'** can sense vacuum pressure so as to initiate the flushing operation of the recovery circuit and its associated components.

[0026] As part of the flushing process, the recovery circuit can be placed under a vacuum pressure. More specifically, the hoses **16** and **18** can be subjected to a vacuum to relieve any residual oils and/or additives remaining therein. The flushing process can further involve opening additional inlets and solenoids to initiate liquid refrigerant from supply tanks, for instance, main tank **80** and/or supply tank **90** coupled to main tank **80**, through the flushing circuit and into the recovery circuit. The flushing circuit can be coupled to the recovery circuit at a joint such as, for example, manifold **120** to continue to flush clean refrigerant through a low-side charge solenoid out a low-side coupler and back into a high-side coupler, through a high-side inlet recover solenoid and into the system oil separator **110**. The process is completed as clean refrigerant is pumped through the compressor **60**, the oil separator **110** and back into the supply tank **90**. The flush process may be additionally repeated, for instance, including opening a high-side charge solenoid and closing a low-side charge solenoid with a high-side inlet closed and a low-side inlet opened in order to flush a low-side inlet portion of the flushing and/or recovery circuit.

[0027] During the recovery and flushing processes, an oil separation system can be provided to separate oil from the recovered refrigerant. The oil separation system can include the accumulator **100** and oil separator **110**, which comprises a generally cylindrical tank as seen in **FIG. 1**. The separator **100** can have an oil drain **104** at the bottom thereof (**FIGS. 1 and 2**), which can further communicate with a conduit **105**

coupled to an orifice **106** that can restrict oil flow. Orifice **106** can be configured as an inline fitting, which is schematically shown in **FIG. 2**. Orifice **106** can have a diameter ranging from about 0.035" to about 0.050" and preferably to about 0.042," and selected to limit the flow rate of oil from accumulator **100** to an oil tank **142**. The orifice **106** can be configured, in connection with the control of oil drain solenoid **109** and check valve **108** to minimize or otherwise prevent the loss of refrigerant. For example, a pressure sensing switch **107** and electrically actuated oil drain solenoid **109** can be provided and coupled to or in communication with microprocessor carried on circuit board **22**. The oil drain **104** can be coupled by conduit **113** to an oil separator associated with a refrigerant identifier instrument, which can be integrated into the maintenance unit **10**. The refrigerant identifier instrument can identify the type of refrigerant in the system.

[0028] **FIG. 3** illustrates the initial clear function diagram **300** according to an embodiment of the invention. The clear function can be programmed into the unit and executed by the processor. The operator can initiate the clear or flush function by pressing a clear button on the control panel at step **302**. The microprocessor through the sensors, described above, can sense whether the couplings **17** and **19** are disconnected from a vehicle's cooling system. If no or the couplings are still attached to the vehicle's cooling system, the unit can warn the operator at step **306** to disconnect the couplings from the vehicle's cooling system and returns to step **302**. If yes or the couplings are disconnected from the vehicle's cooling system, the unit proceeds to step **308**, where the refrigerant remaining the hoses **16**, **18** are recovered. At step **310**, the unit determines if the hoses **16**, **18** are in a vacuum in order to recover any remaining refrigerant or contaminants, such as oil. If no, then the unit returns to steps **308** and **310** until a vacuum is detected. If yes, the unit proceeds to evacuate the hoses **16**, **18**. The vacuum operation can last for about 30 seconds, but can last as long or as short as desired by the operator. At step **314**, the hoses **16**, **18** are again charged with refrigerant so that any remaining contaminants can be flushed from the hoses. Step **314** can be operated for about 10 seconds, but can be operated as long or as short as desired by the operator. Additionally, step **314** can be repeated as needed to clear out any remaining contaminants. After, step **314**, the unit proceeds to step **316** to recover the refrigerant from the hoses **16**, **18**. Again, at step, **318**, the unit determines if the hoses are in a vacuum. If no, then the unit returns to steps **316** and **318** until a vacuum is detected. If yes, the unit proceeds to evacuate the hoses **16**, **18**. At step **320**, the unit proceeds to the oil drain function as described in **FIG. 4**.

[0029] **FIG. 4** illustrates an automatic oil drain method **400** according to an embodiment of the invention. From the recovery and flushing processes described above, the accumulator tank **100** holds recovered oil from the vehicle's air conditioning system or other refrigeration circuit being serviced. After the completion of the flushing or clear function, the automatic oil drain subroutine **400** programmed into the unit and executed by the microprocessor can begin, as indicated by block **402**. Initially, the recycle solenoid **192** can be opened, as indicated at step **404**, to pressurize the system by allowing liquid refrigerant from tank **80** into the accumulator tank **100**. The microprocessor can further monitor the oil drain pressure switch **107** at step **406** and close the recycle solenoid **192** at step **408** (if

pressure switch is open) once the oil drain pressure switch detects a set pressure such as about 16 psi.

[0030] Switch 107 can be configured to open and close at predetermined pressures, for example, to open at about 16 psi and close at about 9 psi. Upon detecting approximately 16 psi pressure, the microprocessor can receive a signal from the opening of switch 107 in order to open the oil drain solenoid 109, as performed in step 410, thus allowing oil to drain through orifice 106 located at the outlet of the accumulator tank. During the draining process, the pressure begins to drop between the accumulator tank and the oil drain pressure switch 107. The microprocessor can further monitor the pressure switch 107 to determine when pressure drop reaches 9 psi, as indicated by step 412, to provide a signal for closing the oil drain solenoid 109, as indicated by step 414. Once the oil drain solenoid is opened, the microprocessor can monitor the state of the oil drain pressure switch 107 to determine whether it is opened or closed, as indicated by block 412. If it remains open, the drain solenoid stays open as the program cycles through steps 410 and 412. Once the switch 107 closes indicating that 9 psi has been reached, the oil drain solenoid 109 is closed, as indicated by step 414. The program continues monitoring the oil drain pressure switch 107, as indicated by step 416, to determine whether it is open or closed. Once it opens again the drain solenoid is opened, as indicated by the loop 417 back to step 410. If the drain switch is not opened, the program determines, at step 418, if it has been at least three seconds since the oil drain switch was closed. If not, the program cycles back to step 310, continuing the draining process. If it has been three seconds or longer since the oil drain switch has been closed, the automatic oil drain sequence is completed, as indicated by step 420, and the drain solenoid 109 remains closed.

[0031] The microprocessor can thus continue to monitor the status of switch 107 and control the oil drain solenoid valve 109. By using the rise time of the pressure, the amount of refrigerant loss is kept to a minimum necessary only to push the recovered oil out of the accumulator tank regardless of the amount of oil. The pressure in the accumulator tank drops off relatively slowly until the oil is pushed through the orifice, then very rapidly drops as refrigerant vapor passes through, quickly ending the oil draining process. The check valve 108 prevents the oil drain solenoid from being forced open when there is a vacuum in the accumulator tank.

[0032] Upon completion of the recovery and flushing cycles, an operator can estimate the amount of oil accumulated in tank 142 and injects the same estimated amount of oil from the fresh supply of oil 140 through valve 141 (FIG. 2) and into the vehicle's air conditioning system or other cooling system being serviced. The electrically operated solenoid valve 141 may be controlled by the microprocessor to meter a precise amount of oil through entry of the fluid amount of oil necessary as entered by keyboard 35 based upon the amount of recovered oil. The new oil is supplied to the refrigerant circuit during the charging portion of the maintenance cycle.

[0033] Thus, it is seen with the system of the present invention, the recovered oil from a refrigerant circuit being serviced is automatically drained from the separator/accumulator with a minimal loss of refrigerant from the system, thereby providing an environmentally appropriate recovery

system which allows the accurate determination of oil necessary to replace the recovered oil from the system. It accomplishes this goal without operator intervention, thereby greatly facilitating the collection or recovered oil.

[0034] FIG. 5 illustrates an electronic control unit 20 in communication with various components of the unit 10. Based upon various communications with the components described above, the electronic control unit 20 works to respond and direct further instruction to additional components of the unit 10, accordingly. The electronic control unit 20 may receive input signals from a variety of components including, for example, an accumulator pressure transducer 500, a pressure transducer 502, a high side pressure transducer 504, a tank pressure sensor 506, a tank temperature sensor 508 and an internal storage vessel 510. The information provided by the aforementioned components allows the unit 10 to operate properly. Additionally, the control unit 20 can be powered 31 by an internal battery or by the current that powers the unit 10.

[0035] The electronic control unit 20 also controls the display 32 and receives input from the operator via keyboard 35. Other components such as a high pressure switch 514, a vacuum pump 516, a compressor 518, solenoid valves 520 and/or a fan 522 can be controlled or otherwise communicate with the control unit.

[0036] Expandability to the unit 10 can be provided via at least one or more modules 512 that are adapted to interface with the electronic control unit 20. The modules 512 may provide additional functionality to the unit 10 to address a variety of issues.

[0037] The modules 512 can be configured to mate with the housing 12 either on an outside or an inside portion. The connection between modules 512 and the control unit 20 can be any mechanical/electrical connection and can include a cable connection or direct integral connection with the housing. Some examples of connections can include USB (Universal Serial Bus), Firewire (IEEE 1394), RS-485, RS-422, RS-232, RS-423, parallel port, 12C (standard Inter-IC (integrated circuit) bus), SPI (Serial Peripheral Interface), serial, wirelessly (as discussed below) or any combination thereof. Any communication protocol or connections can be utilized with the present invention in order for the modules 512 to communicate with the control unit 20. The communication can be one or bi-directional depending on the module.

[0038] The modules 512 can provide additional functionality to the unit 10, for instance, via the electronic control unit 20. An example of functionality may include a communication module that connects to a remote device, such as a diagnostic service tool (scan tool, etc.), a personal digital assistant, a personal computer, a bar code reader, a network (including the internet). The connection may be done through a wired connection or wirelessly, such as Wi-Fi, infrared, Bluetooth, radio frequency, other types of wireless connections or any combination thereof. Data (amount of recovered refrigerant and other data) can be transmitted to the remote device for further analysis or storage. Additionally, software updates may be transmitted to the unit 10 or other types of information can be exchanged with the unit 10 via the communication module.

[0039] Another example of a module can include an information module that provides user installable software

upgrades, and access to a database or information. The software upgrades can add functionality to the unit, such as software related to automatic clear function, as described above. The information module can also provide software update in order to update firmware to the unit **10**. The database can be an up-to-date database so that the operator can access air condition system diagnostic database and the information contained in the database can be displayed on the display. The information can also include information of a new type of refrigerant being used in newer model vehicles and can advise the operator as to how to recover the new refrigerant. The information module can provide any type of information or data as needed by the operator.

[0040] Still another example of a module includes a refrigerant identifier. The refrigerant identifier can be added to the unit so that the type of refrigerant that is in the cooling system being serviced can be correctly identified so that the correct refrigerant can be added back into the cooling system. The refrigerant identifier can determine, for example, E.P.A., S.N.A.P approved refrigerants, R12, R134a, R22, HC and air.

[0041] A further example of a module can include a connection for a printer. The printer connection can be a wired connection, such as a parallel port, firewire port, a USB port or other printer wired connection. Additionally, the printer can communicate with the unit **10** via a wireless connection, such as Wi-Fi, Bluetooth or other wireless communication protocols. By connecting the unit **10** to a printer, the information collected during the service of the cooling system can be provided to the operator. The printer can also be used to print any other information desired by the operator.

[0042] The module can add bar code functionality to the unit **10**. The module can be a bar code reader or bar code generator. The unit through the bar code module can retrieve information stored on the bar code, such as, for example, the refrigerant used in the cooling system under service or the vehicle model under service. Additionally, the module can also generate its own bar code that contains any information desired by the operator. The unit **10** can print out a bar code label through the use of the printer module or a built in printer connection on the unit **10**.

[0043] The module can include a diagnostic scan module to run diagnostic tests of the cooling system under test. The diagnostic module with the assistance of the control unit can run diagnostic tests to determine if the cooling system components or if the unit **10** components, such as vacuum pressure, are working properly.

[0044] The aforementioned modules **512** are exemplary and do not preclude additional modules or kinds of modules for performing additional functions from being added to the unit **10** of the present invention.

[0045] Thus the electronic control unit **20** will perform in accordance with the kind of module **512** integrated with the unit **10**. Additional components such as the high pressure switch **514**, the vacuum pump **516**, the compressor **518** solenoid valves **520** and/or the fan **522** may also be affected based upon control signals received from the electronic control unit **20** in accordance with module integration.

[0046] By having the unit **10** capable of receiving the modules, the unit can have flexibility for the customer and

the provider. The unit **10** can be updated with new software functionality or firmware with the modules. Additionally, the customer can purchase a basic unit **10** and then later add the desired functionality(ies) depending on his budget. Additionally new features can be added without having to rewire the unit or reprogram the control unit.

[0047] 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 for maintenance of a cooling system of a vehicle, comprising:

a recovery circuit configured to recover refrigerant from the cooling system;

a processor that communicates with components of the recovery circuit;

a housing configured to house the components of the refrigerant recovery unit; and

at least one module that provides a function to the refrigerant recovery unit and communicates with the processor.

2. The unit of claim 1 further comprising:

a clean refrigerant source; and

a flushing circuit coupled to the recovery circuit and the refrigerant source, the flushing circuit flushes clean refrigerant through the recovery circuit, wherein the clean refrigerant source and the flushing circuit are in communications with the processor.

3. The unit of claim 1, wherein the communication between the processor and the at least one module is through a wired connection.

4. The unit of claim 3, wherein the wired connection can be one of the following: USB, IEEE 1394, RS-485, RS-422, RS-232, RS-423, parallel port, I2C, SPI (Serial Peripheral Interface), serial and a combination thereof.

5. The unit of claim 1, wherein the communication between the processor and the at least one module is through a wireless connection.

6. The unit of claim 5, wherein the wireless connection can be one of the following: Wi-Fi, infrared, Bluetooth, radio frequency, other types of wireless connections and any combination thereof.

7. The unit of claim 1, wherein the module is an information module.

8. The unit of claim 1, wherein the module is a refrigerant identifier module.

9. The unit of claim 1, wherein the module is a communication module.

10. The unit of claim 1, wherein the module is a bar code module.

11. The unit of claim 1, wherein the module is a diagnostic module.

12. A refrigerant recovery system for maintenance of a cooling system of a vehicle comprising:

means for controlling components of the refrigerant recovery system;

means for recovering refrigerant from the cooling system;

means for providing functionality to the refrigerant recovery system that communicates with the means for controlling; and

means for housing the components of the refrigerant recovery system.

13. The system of claim 12, further comprising:

means for providing clean refrigerant source; and

means for flushing coupled to the means for recovery and means for providing clean refrigerant source, the means for flushing flushes clean refrigerant through the means for recovery, wherein the means for providing clean refrigerant source and the means for flushing are in communications with the means for controlling.

14. The system of claim 12, wherein the communication between the means for controlling and the means for providing functionality is through a wired or wireless connection.

15. The system of claim 14, wherein the wired connection can be one of the following: USB, IEEE 1394, RS-485, RS-422, RS-232, RS-423, parallel port, I2C, SPI (Serial Peripheral Interface), serial and a combination thereof.

16. The system of claim 14, wherein the wireless connection can be one of the following: Wi-Fi, infrared, Bluetooth, radio frequency, other types of wireless connections and any combination thereof.

17. The system of claim 12, wherein the means for providing functionality is an information module.

18. The system of claim 12, wherein the means for providing functionality is a refrigerant identifier module.

19. The system of claim 12, wherein the means for providing functionality is a communication module.

20. The system of claim 12, wherein the means for providing functionality is a bar code module.

21. The system of claim 12, wherein the means for providing functionality is a diagnostic module.

22. A method of adding functionality to a refrigerant recovery unit, comprising:

providing the refrigerant recovery unit having a recovery circuit configured to recover refrigerant from the cooling system, a processor that communicates with components of the recovery circuit, and a housing configured to house the components of the refrigerant recovery unit; and

adding at least one module to expand the functionality of the refrigerant recovery unit.

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