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(54) **METHOD AND APPARATUS FOR STAGED STARTUP OF AIR-COOLED LOW CHARGED
PACKAGED AMMONIA REFRIGERATION SYSTEM**

VERFAHREN UND VORRICHTUNG ZUR GESTUFTEN INBETRIEBNAHME EINES
LUFTGEKÜHLTEN NIEDRIGGELADENEN VERKAPSELTEN AMMONIAKKÄLTESYSTEMS

PROCÉDÉ ET APPAREIL DE DÉMARRAGE SÉQUENCÉ D'UN SYSTÈME DE RÉFRIGÉRATION À
L'AMMONIAC CONDITIONNÉ À BASSE CHARGE REFROIDIE PAR AIR

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Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to ammonia refrigeration systems; methods for start-up of ammonia refrigeration systems; and methods for modifying ammonia refrigeration systems.

DESCRIPTION OF THE BACKGROUND

[0002] Air-cooled (non-evaporative), ammonia refrigeration systems struggle to start during low-ambient conditions. As the compressor discharges superheated vapor into the condenser, the cold condenser coils immediately condense any vapor, preventing the discharge pressure to increase. Screw compressors require a minimum pressure delta across the housing to maintain proper oil flow to the compressor's components. The air-cooled condenser surface area is too large, due the very low ambient conditions (very high temperature differences) to allow the delta pressure to build at start-up. Chlorofluorocarbon refrigerant (CFC, HFC, HCFC) systems have utilized isolating valves on the outlet of condenser coils, which force liquid to back up in the condenser, reducing the surface area of the coil that is capable of condensing vapor. However, this requires significant charge that must be stored elsewhere in the system during normal operation. This is not acceptable to achieving low-charge and critically charged ammonia refrigeration systems. A known low charged packaged refrigeration system is disclosed in US2016/0178257. A method for start-up of a refrigeration system including a sequential start of several condenser coils is known from CN204063368U.

SUMMARY OF THE INVENTION

[0003] The present invention overcomes the problems of the prior art by allowing the condenser coils to isolate individually during the startup period, allowing individual sequencing of the coils until the condenser is warm enough to maintain discharge and oil pressure. This invention also eliminates the need for a stand-alone oil pump to maintain oil pressure during start-up. A refrigeration system according to the invention is defined in independent claim 1; a method for start-up of an air-cooled low charged packaged ammonia refrigeration system according to the invention is defined in independent claim 10; and a method for modifying an air-cooled low charged packaged ammonia refrigeration system according to the invention is defined in independent claim 11. Optional features of the invention are defined in the dependent claims.

[0004] Several components provide the control required to stably and reliably operate the system during

start-up: Motorized valves can be installed on all or one of the condenser coil inlets, a main compressor discharge motorized valve is installed, a bypass pressure regulator valve in the main compressor piping is installed, check valves on the condenser outlets are installed and speed control of the condenser fans. The condenser inlet motorized valves provide precise control of gas feed or act as an on/off valve for the condensers allowing pressure to build without collapsing the oil pressure. The motorized valves provide precise control of the gas flow at a very low pressure drop or provide on/off control as needed. The air-cooled condensers may be any style: tube and fin or microchannel, etc. in horizontal or vertical tube arrangements. The condenser coil outlet contains vertically-oriented inline check valves to prevent liquid backflow when a coil is isolated. This allows each condenser coil to be isolated without trapping significant liquid refrigerant charge in a low-charge ammonia, refrigeration system. Trapping an appreciable amount of liquid in the condenser coils upsets startup of a packaged ammonia refrigeration system. The compressor discharge line contains a single motorized valve for regulating discharge pressure. The motorized valve is used for coarse gas control at start-up. The motorized valve in the compressor discharge piping also includes a bypass with a mechanical pressure regulator to allow precise regulation at the minimum discharge pressure. Once discharge pressure rises above the minimum setpoint, the condenser inlet solenoid coils will open one at a time. The discharge pressure regulating motorized valve will simultaneously regulate the discharge pressure until the condenser coil has warmed up enough to maintain discharge pressure. Fan speed control is also utilized to maintain stable operation at start-up.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

Figure 1 is a schematic of a refrigeration system according to a single compressor embodiment of the invention.

Figure 2 is a blow-up of the upper right hand portion of Figure 1.

Figure 3 is a schematic of a refrigeration system according to a dual compressor embodiment of the invention.

Figure 4 is a blow-up of the upper right hand portion of Figure 3.

DETAILED DESCRIPTION

[0006] Figure 1 is a process and instrumentation diagram for a single compressor, air-cooled (non-evaporative) condenser, low charge packaged penthouse refrigeration system according to an embodiment of the invention. A blow-up of the upper right quadrant of Figure 1 is presented in Figure 2. Figure 3 is a process and

instrumentation diagram for a dual compressor, air-cooled condenser, low charge packaged penthouse refrigeration system according to an embodiment of the invention. A blow-up of the upper right quadrant of Figure 3 is presented in Figure 4.

[0007] The system includes evaporators 2a and 2b, including evaporator coils 4a and 4b, respectively, condenser 8, compressor(s) 10, expansion devices 11a and 11b (which may be provided in the form of valves, metering orifices or other expansion devices), pump 16, liquid-vapor separation device 12, and economizer 14. According to one embodiment, liquid-vapor separation device 12 may be a recirculator vessel. According to other embodiments, liquid-vapor separation device 12 and economizer 14 may one or both provided in the form of single or dual phase cyclonic separators. The foregoing elements may be connected using standard refrigerant tubing in the manner shown in Figures 1-4. As used herein, the term "connected to" or "connected via" means connected directly or indirectly, unless otherwise stated.

[0008] According to the embodiment shown in Figures 1-4, low pressure liquid refrigerant ("LPL") is supplied to the evaporator by pump 16 via expansion devices 11. The refrigerant accepts heat from the refrigerated space, leaves the evaporator as low pressure vapor ("LPV") and liquid and is delivered to the liquid-vapor separation device 12 (which may optionally be a cyclonic separator) which separates the liquid from the vapor. Liquid refrigerant ("LPL") is returned to the pump 16, and the vapor ("LPV") is delivered to the compressor 10 which condenses the vapor and sends high pressure vapor ("HPV") to the condenser 8 which compresses it to high pressure liquid ("HPL"). The HPL is delivered to the economizer 14 which improves system efficiency by reducing the high pressure liquid ("HPL") to intermediate pressure liquid ("IPL") then delivers it to the liquid-vapor separation device 12, which supplies the pump 16 with low pressure liquid refrigerant ("LPL"), completing the refrigerant cycle.

[0009] Figures 1-4 also include numerous control, isolation, and safety valves, as well as temperature and pressure sensors (a.k.a. indicators or gages) for monitoring and control of the system.

Single Compressor Penthouse Improved Startup Configuration and Method

[0010] Referring to the single compressor embodiment (Figures 1 and 2, and particularly Figure 2), motorized condenser inlet 101, 102 and 103 valves are installed on the inlet of the condenser coil bundles. The motorized valves can function as variable control valves or on/off valves.

[0011] A single condenser bundle is open to ensure proper surface is available during start-up. As the system begins increasing load, valves 101, 102 and 103 will begin to open. Once all valves are open, variable fan control takes over pressure control. The sequencing of

the use of valves and fan operation can vary, based on system operation and design.

[0012] Motorized valve 104 and ammonia pressure regulator valve 105 provide precise ammonia gas control during start-up of the system in low ambient conditions. During start-up, all motorized valves are closed and the pressure regulator provides compressor differential pressure control to ensure proper oil flow. The ammonia pressure regulator 105 provides low volume flow control. As the compressor begins to load, more ammonia gas flow is generated. Motorized valve 104 begins to open and control the discharge pressure, compressor differential pressure and oil flow.

[0013] The next step during system start-up is to begin opening the condenser motorized valves 101, 102 and 103 and concomitant staging the startup of the condenser fans.

[0014] Check valves 106, 107, 108 and 109 installed at the outlet to the condenser bundles are utilized to ensure liquid ammonia does not backflow into the condenser or other coil bundles during periods of downtime or normal operating periods.

[0015] Each of valves 101, 102, 103 and 105 are activated by attached microcontrollers or PLC (programmable logic control). A central microcontroller or PLC monitors the status of each valve, as well as discharge pressure, and directs the action of the valves accordingly for sequential startup of the condenser coils while maintaining gas and oil pressure.

[0016] Not all valves are required for a every ambient condition. In fact, above a certain ambient temperature, low ambient control may not be required. Therefore, valves can be installed and arranged to optimize operation at startup based on the ambient temperature.

Dual Compressor Penthouse Improved Startup Configuration and Method (isolated compressor operation)

[0017] Figures 3 and 4 show a process and instrumentation diagram for a dual compressor, air-cooled condenser, low charge packaged penthouse refrigeration system. The dual compressor design utilizes and isolated compressor concept. The compressors use different oil separators, oil coolers, and condenser bundles.

[0018] Motorized valves 110, 111, 112 and 113 are installed on the inlet of the condenser coil bundles. The motorized valves can function as variable control valves or on/off valves.

[0019] During startup, motorized valves 111 and 112 will be opened to a minimum position to allow ammonia gas flow to the condenser coil. As the system begins increasing load, valves 111 and 112 will open to 100% and valves 113 and 110 will begin opening. Once all valves are open, variable fan control takes over pressure control. The sequencing of the use of valves and fan operation can vary, based on system operation and design.

[0020] Fine ammonia gas control during start-up of the system is provided by:

Compressor #1

- a. Valve #114 Motorized valve
- b. Valve #115 Pressure regulator
- c. Start-up requires all motorized valves are closed and the pressure regulator provides compressor differential pressure to ensure proper oil flow. During start-up, all motorized valves are closed and the pressure regulator provides compressor differential pressure control to ensure proper oil flow. The ammonia pressure regulator provides low volume flow control. As the compressor begins to load, more ammonia gas flow is generated. Motorized valve #114 begins to open and control the discharge pressure, compressor differential pressure and oil flow.

Compressor #2

- a. Valve #116 Motorized valve
- b. Valve #117 Pressure regulator
- c. Start-up requires all motorized valves are closed and the pressure regulator provides compressor differential pressure to ensure proper oil flow. During start-up, all motorized valves are closed and the pressure regulator provides compressor differential pressure control to ensure proper oil flow. The ammonia pressure regulator provides low volume flow control. As the compressor begins to load, more ammonia gas flow is generated. Motorized valve #116 begins to open and control the discharge pressure, compressor differential pressure and oil flow.

[0021] The next stage is to begin opening the condenser motorized valves (110, 111, 112 and 113) and staging the condenser fans accordingly.

[0022] Check valves (118, 119, 120 and 121) are utilized to ensure liquid ammonia does not backflow into the condenser or other coil bundles during periods of downtime or normal operating periods.

[0023] As with the single compressor embodiment, each of valves 110-117 is activated by attached microcontrollers or PLC. A central microcontroller or PLC monitors the status of each valve, as well as discharge pressure, and directs the action of the valves accordingly for sequential startup of the condenser coils while maintaining gas and oil pressure. Not all valves are required for every ambient condition. In fact, above a certain ambient temperature, low ambient control may not be required. Therefore, valves can be installed and arranged to optimize operation at startup based on the ambient temperature.

[0024] According to various embodiments, the evaporator is housed in the evaporator (penthouse) module,

and the remaining components of the system shown in Figures 1-4 (except for the condenser coils and fans and associated structures) are housed in an enclosure such as a machine room module. The condenser coils and fans may be mounted on top of the enclosure or machine room module for a complete self-contained rooftop system. The air-cooled condenser may optionally be fitted with an adiabatic air pre-cooling system. The entire system may be completely self-contained in two roof-top modules making it very easy for over-the-road transport to the install site, using e.g., flat bed permit load non-escort vehicles. The penthouse and machine room modules can be separated for shipping and/or for final placement, but according to most preferred embodiments, the penthouse and machine room modules are mounted adjacent to one-another to maximize the reduction in refrigerant charge. According to a most preferred embodiment, the penthouse module and the machine room module are integrated into a single module, although the evaporator space is separated and insulated from the machine room space to comply with industry codes. According to an alternative embodiment, the evaporator coil may be mounted in a refrigerated space adjacent to, below, or remote from, the machine room module.

[0025] While the present invention has been described primarily in the context of refrigeration systems in which ammonia is the refrigerant, it is contemplated that this invention will have equal application for refrigeration systems using other natural refrigerants, including carbon dioxide.

Claims

1. A refrigeration system comprising:

- a refrigerant evaporator coil (4a; 4b), vapor/liquid separation structure (12) connected to an outlet of said evaporator coil via a refrigerant line configured to separate low pressure refrigerant vapor from low pressure refrigerant liquid;
- a refrigerant compressor (10) connected to an outlet of said liquid-vapor separation device via the refrigerant line and configured to compress refrigerant vapor from said vapor liquid separation structure;
- a compressor discharge motorized valve (104) connected to an outlet of said refrigerant compressor via the refrigerant line and configured for coarse regulation of discharge pressure during system start-up;
- a bypass pressure regulator valve (105) connected to an outlet of said refrigerant compressor via the refrigerant line and configured for precise regulation of discharge pressure during start-up; an air-cooled refrigerant condenser (8) comprising a plurality of condenser coils con-

- connected to said compressor discharge motorized valve and said bypass pressure regulator valve via the refrigerant line and configured to condense refrigerant vapor produced in said compressor to refrigerant liquid,
 a motorized valve (101; 102; 103) connected to an inlet of at least one of said condenser coils configured to provide control of gas feed to the condenser coil to allow pressure to build without collapsing oil pressure;
 a vertically oriented inline check valve (106; 107; 108; 109) connected to an outlet of at least one of said condenser coils configured to prevent liquid backflow;
 a collection vessel (14) connected to an outlet of said condenser via refrigerant line for receiving refrigerant liquid from said condenser;
 the refrigerant line connecting an outlet of said collection vessel to an inlet of said vapor/liquid separation structure and configured to deliver refrigerant liquid to said separation structure;
 said vapor/liquid separation structure having a liquid outlet that is connected via the refrigerant line to an inlet of said evaporator coil;
 a pre-packaged modular enclosure;
 and wherein said vapor/liquid separation structure, said compressor, and said collection vessel, are situated inside the pre-packaged modular enclosure.
2. A refrigeration system according to claim 1, further comprising a refrigerant wherein said refrigerant is ammonia.
 3. A refrigeration system according to claim 1, wherein said vapor/liquid separation structure (12) comprises a recirculator vessel.
 4. A refrigeration system according to claim 1, wherein said collection vessel (14) comprises an economizer.
 5. A refrigeration system according to claim 1, further comprising an oil separator vessel configured to separate compressor oil from refrigerant vapor received from said refrigerant compressor (10).
 6. A refrigeration system according to claim 1, wherein said air-cooled refrigerant condenser (8) comprises condenser fans and is located on top of or adjacent to said pre-packaged modular enclosure.
 7. A refrigeration system according to claim 1, wherein said air-cooled refrigerant condenser (8) comprises an adiabatic air pre-cooling system.
 8. A refrigeration system according to claim 1, further comprising a prefabricated modular evaporator room wherein said refrigerant evaporator coil (4a; 4b), is mounted in the prefabricated modular evaporator room.
 9. A refrigeration system according to claim 1, further comprising a refrigerated space wherein said refrigerant evaporator coil (4a; 4b) is mounted in the refrigerated space adjacent to or below said prefabricated modular enclosure.
 10. A method for start-up of an air-cooled low charged packaged ammonia refrigeration system having an evaporator, liquid/vapor separator (12), a compressor (10), an air-cooled condenser (8) having a plurality of condenser coils, and a collection vessel (14) without the need for a stand-alone oil pump to maintain oil pressure during start-up, said method comprising:
 - starting refrigerant flow through said condenser coils one at a time until each condenser coil is warm enough to maintain discharge and oil pressure;
 - using a motorized valve in a discharge line from said compressor for coarse control of gas flow out of said compressor;
 - using a bypass pressure regulator valve (105) in said discharge line from said compressor for fine control of gas flow out of said compressor;
 - using motorized valves (101; 102; 103) at an inlet of at least one condenser coil in said air-cooled condenser to control gas feed to said condenser coil;
 - using check valves at an outlet of at least one condenser coil to prevent liquid backflow during coil isolation;
 - monitoring gas pressure in said discharge line from said compressor and controlling the opening of said motorized valves at an inlet of at least one condenser coil based on said monitored gas pressure using a microcontroller or programmable logic controller.
 11. A method for modifying an air-cooled low charged packaged ammonia refrigeration system having an evaporator (4a; 4b), liquid/vapor separator (12), a compressor (10), an air-cooled condenser (8) having a plurality of condenser coils, and a collection vessel (14), said method comprising:
 - installing a motorized valve (101; 102; 103) in at least one condenser coil inlet, installing a motorized valve in a main compressor discharge line;
 - installing a bypass pressure regulator valve (105) in said main compressor discharge line, and installing inline check valves (106; 107; 108; 109) on at least one condenser coil outlet.

12. A method according to claim 11, comprising installing motorized valves in all but one condenser coil inlet.

Patentansprüche

1. Kältesystem, Folgendes umfassend:

eine Kältemittelverdampferspule (4a; 4b),
 eine Dampf/Flüssigkeit-Abscheidestruktur (12),
 die über eine Kältemittelleitung mit einem Auslass der Verdampferspule verbunden ist und konfiguriert ist, um Niederdruck-Kältemitteldampf von Niederdruck-Kältemittelflüssigkeit abzuscheiden;
 einen Kältemittelkompressor (10), der über die Kältemittelleitung mit einem Auslass der Flüssigkeit-Dampf-Abscheidevorrichtung verbunden ist und konfiguriert ist, um Kältemitteldampf aus der Dampf-Flüssigkeit-Abscheidestruktur zu komprimieren;
 ein motorisiertes Kompressorausgangsventil (104), das über die Kältemittelleitung mit einem Auslass des Kältemittelkompressors verbunden ist und zum groben Regeln des Ausgangsdrucks während der Inbetriebnahme des Systems konfiguriert ist;
 ein Bypass-Druckregelventil (105), das über die Kältemittelleitung mit einem Auslass des Kältemittelkompressors verbunden ist und zum präzisen Regeln des Ausgangsdrucks während der Inbetriebnahme konfiguriert ist; einen luftgekühlten Kältemittelkondensator (8), der eine Vielzahl von Kondensatorspulen umfasst, die über die Kältemittelleitung mit dem motorisierten Kompressorausgangsventil und dem Bypass-Druckregelventil verbunden ist und konfiguriert ist, um in dem Kompressor erzeugten Kältemitteldampf zu Kältemittelflüssigkeit zu kondensieren,
 ein motorisiertes Ventil (101; 102; 103), das mit einem Einlass mindestens einer der Kondensatorspulen verbunden ist und konfiguriert ist, um eine Steuerung der Gaszufuhr zu der Kondensatorspule bereitzustellen, um einen Druckaufbau ohne Zusammenbruch des Öldrucks zu ermöglichen;
 ein vertikal ausgerichtetes Inline-Rückschlagventil (106; 107; 108; 109), das mit einem Auslass mindestens einer der Kondensatorspulen verbunden ist und konfiguriert ist, um einen Flüssigkeitsrückfluss zu verhindern;
 einen Sammelbehälter (14), der über die Kältemittelleitung mit einem Auslass des Kondensators verbunden ist, um Kältemittelflüssigkeit von dem Kondensator aufzunehmen;
 wobei die Kältemittelleitung einen Auslass des

Sammelbehälters mit einem Einlass der Dampf/Flüssigkeit-Abscheidestruktur verbindet und konfiguriert ist, um Kältemittelflüssigkeit an die Abscheidestruktur zu liefern;
 wobei die Dampf/Flüssigkeit-Abscheidestruktur einen Flüssigkeitsauslass aufweist, der über die Kältemittelleitung mit einem Einlass der Verdampferspule verbunden ist;
 ein vorverkapseltes modulares Gehäuse;
 und wobei die Dampf/Flüssigkeit-Abscheidestruktur, der Kompressor und der Sammelbehälter innerhalb des vorverkapselten modularen Gehäuses angeordnet sind.

2. Kältesystem nach Anspruch 1, ferner umfassend ein Kältemittel, wobei das Kältemittel Ammoniak ist.
3. Kältesystem nach Anspruch 1, wobei die Dampf-/Flüssigkeit-Abscheidestruktur (12) ein Rezirkulatorgefäß umfasst.
4. Kältesystem nach Anspruch 1, wobei das Sammelgefäß (14) einen Ekonomiser umfasst.
5. Kältesystem nach Anspruch 1, ferner umfassend einen Ölabscheidebehälter, der konfiguriert ist, um Kompressoröl von Kältemitteldampf abzuscheiden, der von dem Kältemittelkompressor (10) aufgenommen wird.
6. Kältesystem nach Anspruch 1, wobei der luftgekühlte Kältemittelkondensator (8) Kondensatorlüfter umfasst und sich auf oder neben dem vorverkapselten modularen Gehäuse befindet.
7. Kältesystem nach Anspruch 1, wobei der luftgekühlte Kältemittelkondensator (8) ein adiabatisches Luftvorkühlsystem umfasst.
8. Kältesystem nach Anspruch 1, ferner umfassend einen vorgefertigten modularen Verdampferraum, wobei die Kältemittelverdampferspule (4a; 4b) in dem vorgefertigten modularen Verdampferraum montiert ist.
9. Kältesystem nach Anspruch 1, ferner umfassend einen gekühlten Raum, wobei die Kältemittelverdampferspule (4a; 4b) in dem gekühlten Raum benachbart zu oder unter dem vorgefertigten modularen Gehäuse montiert ist.
10. Verfahren zum Inbetriebnehmen eines luftgekühlten, niedriggeladenen, verkapselten Ammoniakkältesystems, das einen Verdampfer, einen Flüssigkeit/Dampf-Abscheider (12), einen Kompressor (10), einen luftgekühlten Kondensator (8) mit einer Vielzahl von Kondensatorspulen und einen Sammelbehälter (14) aufweist, ohne dass eine eigen-

ständige Ölpumpe erforderlich ist, um den Öldruck während der Inbetriebnahme aufrechtzuerhalten, wobei das Verfahren Folgendes umfasst:

- Inbetriebnehmen des Kältemittelflusses durch die Kondensatorspulen nacheinander, bis jede Kondensatorspule warm genug ist, um den Ausgang und den Öldruck aufrechtzuerhalten;
Verwenden eines motorisierten Ventils in einer Ausgangsleitung aus dem Kompressor zur Kurssteuerung des Gasflusses aus dem Kompressor;
Verwenden eines Bypass-Druckregelventils (105) in der Ausgangsleitung von dem Kompressor zur Feinsteuerung des Gasflusses aus dem Kompressor;
Verwenden von motorisierten Ventilen (101; 102; 103) an einem Einlass mindestens einer Kondensatorspule in dem luftgekühlten Kondensator, um die Gaszufuhr zu der Kondensatorspule zu steuern;
Verwenden von Rückschlagventilen an einem Auslass mindestens einer Kondensatorspule, um einen Flüssigkeitsrückfluss während der Spulenisolation zu verhindern;
Überwachen des Gasdrucks in der Ausgangsleitung von dem Kompressor und Steuern des Öffnens der motorisierten Ventile an einem Einlass von mindestens einer Kondensatorspule basierend auf dem überwachten Gasdruck unter Verwendung einer Mikrosteuerung oder einer programmierbaren logischen Steuerung.
11. Verfahren zum Modifizieren eines luftgekühlten, niedriggeladenen, verkapselten Ammoniakkältesystems, das einen Verdampfer (4a; 4b), einen Flüssigkeit/Dampf-Abscheider (12), einen Kompressor (10), einen luftgekühlten Kondensator (8) mit einer Vielzahl von Kondensatorspulen und einen Sammelbehälter (14) aufweist, wobei das Verfahren Folgendes umfasst:
- Installieren eines motorisierten Ventils (101; 102; 103) in mindestens einen Kondensatorspuleneinlass, Installieren eines motorisierten Ventils in eine Hauptausgangsleitung des Kompressors;
Installieren eines Bypass-Druckregelventils (105) in der Hauptausgangsleitung des Kompressors und Installieren von Inline-Rückschlagventilen (106; 107; 108; 109) an mindestens einem Kondensatorspulenauslass.
12. Verfahren nach Anspruch 11, umfassend das Installieren von motorisierten Ventilen in allen bis auf einen Kondensatorspuleneinlass.

Revendications

1. Système de réfrigération comprenant :

un serpentin d'évaporateur de réfrigérant (4a ; 4b),
une structure de séparation vapeur/liquide (12) reliée à une sortie dudit serpentin d'évaporateur par l'intermédiaire d'une conduite de réfrigérant configurée pour séparer une vapeur de réfrigérant basse pression à partir d'un liquide réfrigérant basse pression ;
un compresseur de réfrigérant (10) relié à une sortie dudit dispositif de séparation liquide-vapeur par l'intermédiaire de la conduite de réfrigérant et configuré pour comprimer une vapeur de réfrigérant à partir de ladite structure de séparation vapeur-liquide ;
une vanne motorisée de refoulement de compresseur (104) reliée à une sortie dudit compresseur de réfrigérant par l'intermédiaire de la conduite de réfrigérant et configurée pour une régulation approximative d'une pression de refoulement lors du démarrage de système ;
une vanne de régulation de pression de dérivation (105) reliée à une sortie dudit compresseur de réfrigérant par l'intermédiaire de la conduite de réfrigérant et configurée pour une régulation précise de la pression de refoulement pendant le démarrage ; un condenseur de réfrigérant refroidi par air (8) comprenant une pluralité de serpentins de condenseur reliés à ladite vanne motorisée de refoulement de compresseur et à ladite vanne de régulation de pression de dérivation par l'intermédiaire de la conduite de réfrigérant et configurés pour condenser la vapeur de réfrigérant produite dans ledit compresseur en liquide réfrigérant,
une vanne motorisée (101 ; 102 ; 103) reliée à une entrée d'au moins un desdits serpentins de condenseur configurée pour fournir une commande d'alimentation en gaz au serpentin de condenseur pour permettre à la pression de monter sans effondrement de la pression d'huile ;
une vanne d'arrêt en ligne orienté verticalement (106 ; 107 ; 108 ; 109) reliée à une sortie d'au moins un desdits serpentins de condenseur configuré pour empêcher un reflux de liquide ;
un récipient de collecte (14) relié à une sortie dudit condenseur par l'intermédiaire d'une conduite de réfrigérant pour recevoir le liquide réfrigérant à partir dudit condenseur ;
la conduite de réfrigérant reliant une sortie dudit récipient de collecte à une entrée de ladite structure de séparation vapeur/liquide et configurée pour délivrer du liquide réfrigérant à ladite structure de séparation ;

- ladite structure de séparation vapeur/liquide ayant une sortie de liquide qui est reliée par l'intermédiaire de la conduite de réfrigérant à une entrée dudit serpentin d'évaporateur ;
 une enceinte modulaire pré-conditionnée ;
 et dans lequel ladite structure de séparation vapeur/liquide, ledit compresseur et ledit récipient de collecte sont situés à l'intérieur de l'enceinte modulaire pré-conditionnée.
2. Système de réfrigération selon la revendication 1, comprenant en outre un réfrigérant, dans lequel ledit réfrigérant est de l'ammoniac.
3. Système de réfrigération selon la revendication 1, dans lequel ladite structure de séparation vapeur/liquide (12) comprend un récipient de recirculation.
4. Système de réfrigération selon la revendication 1, dans lequel ledit récipient de collecte (14) comprend un économiseur.
5. Système de réfrigération selon la revendication 1, comprenant en outre un récipient séparateur d'huile configuré pour séparer l'huile de compresseur à partir de la vapeur de réfrigérant reçue à partir dudit compresseur de réfrigérant (10).
6. Système de réfrigération selon la revendication 1, dans lequel ledit condenseur de réfrigérant refroidi par air (8) comprend des soufflantes de condenseur et est situé au-dessus de ladite enceinte modulaire pré-conditionnée ou adjacent à celle-ci.
7. Système de réfrigération selon la revendication 1, dans lequel ledit condenseur de réfrigérant refroidi par air (8) comprend un système de pré-refroidissement d'air adiabatique.
8. Système de réfrigération selon la revendication 1, comprenant en outre une salle d'évaporateur modulaire préfabriquée dans lequel ledit serpentin d'évaporateur de réfrigérant (4a ; 4b) est monté dans la salle d'évaporateur modulaire préfabriquée.
9. Système de réfrigération selon la revendication 1, comprenant en outre un espace réfrigéré dans lequel ledit serpentin d'évaporateur de réfrigérant (4a ; 4b) est monté dans l'espace réfrigéré adjacent à ladite enceinte modulaire préfabriquée ou au-dessous de celle-ci.
10. Procédé de démarrage d'un système de réfrigération à l'ammoniac conditionné à basse charge refroidie par air, ayant un évaporateur, un séparateur liquide/vapeur (12), un compresseur (10), un condenseur refroidi par air (8) ayant plusieurs serpentins de condenseur et un récipient de collecte (14), sans nécessiter de pompe à huile autonome pour maintenir la pression d'huile pendant le démarrage, ledit procédé comprenant :
- un démarrage de flux de réfrigérant à travers lesdits serpentins de condenseur un à la fois jusqu'à ce que chaque serpentin de condenseur soit suffisamment chaud pour maintenir la pression de refoulement et d'huile ;
 l'utilisation d'une vanne motorisée dans une conduite de refoulement à partir dudit compresseur pour une commande de course de flux de gaz sortant dudit compresseur ;
 l'utilisation d'une vanne de régulation de pression de dérivation (105) dans ladite conduite de refoulement à partir dudit compresseur pour une commande précise de flux de gaz sortant dudit compresseur ;
 utilisation de vannes motorisées (101 ; 102 ; 103) à une entrée d'au moins un serpentin de condenseur dans ledit condenseur refroidi par air pour commander une alimentation en gaz dudit serpentin de condenseur ;
 l'utilisation de vannes d'arrêt au niveau d'une sortie d'au moins un serpentin de condenseur pour empêcher le reflux de liquide pendant l'isolation de serpentin ;
 la surveillance de la pression de gaz dans ladite conduite de refoulement à partir dudit compresseur et la commande de l'ouverture desdites vannes motorisées au niveau d'une entrée d'au moins un serpentin de condenseur sur la base de ladite pression de gaz surveillée en utilisant un micro-dispositif de commande ou un dispositif de commande logique programmable.
11. Procédé de modification d'un système de réfrigération à l'ammoniac conditionné à basse charge refroidie par air, ayant un évaporateur (4a ; 4b), un séparateur liquide/vapeur (12), un compresseur (10), un condenseur refroidi par air (8) ayant une pluralité de serpentins de condenseur, et un récipient de collecte (14), ledit procédé comprenant :
- l'installation d'une vanne motorisée (101 ; 102 ; 103) dans au moins une entrée de serpentin de condenseur, l'installation d'une vanne motorisée dans une conduite de refoulement de compresseur principal ;
 l'installation d'une vanne de régulation de pression de dérivation (105) dans ladite conduite de refoulement de compresseur principal, et l'installation de vannes d'arrêt en ligne (106 ; 107 ; 108 ; 109) sur au moins une sortie de serpentin de condenseur.
12. Procédé selon la revendication 11, comprenant l'ins-

tallation de vannes motorisées dans toutes les entrées de serpentin de condenseur sauf une.

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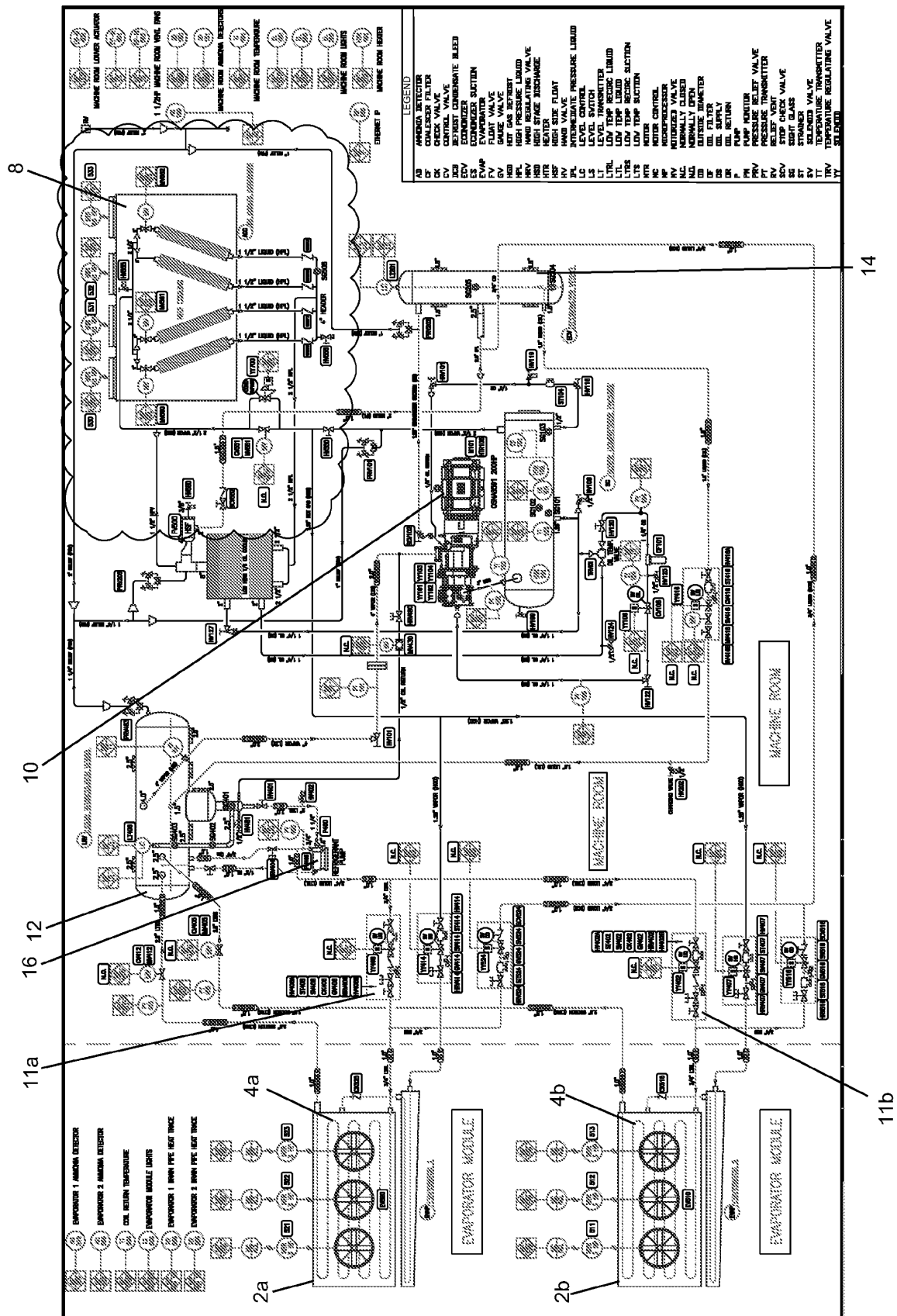


Figure 1

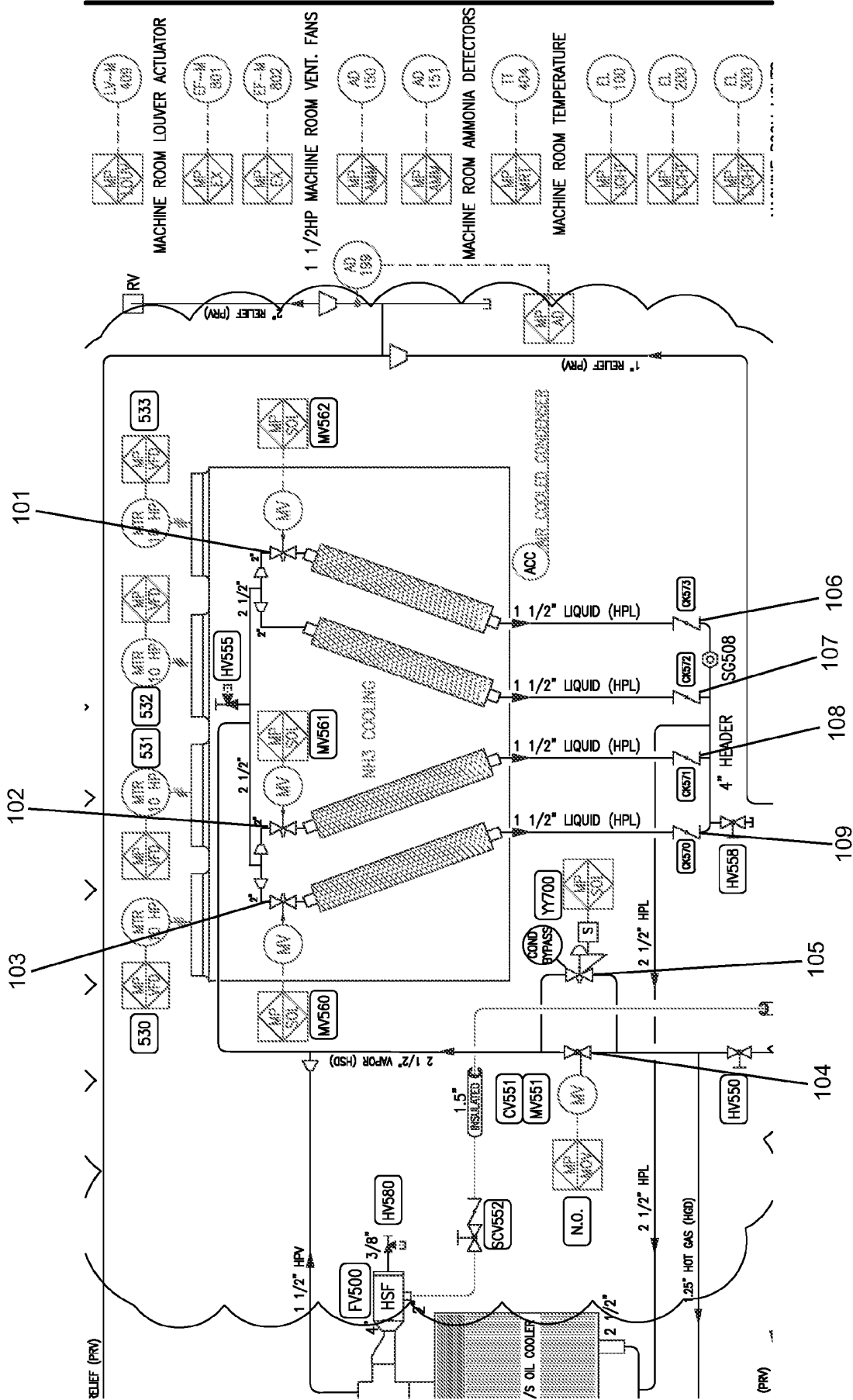


Figure 2

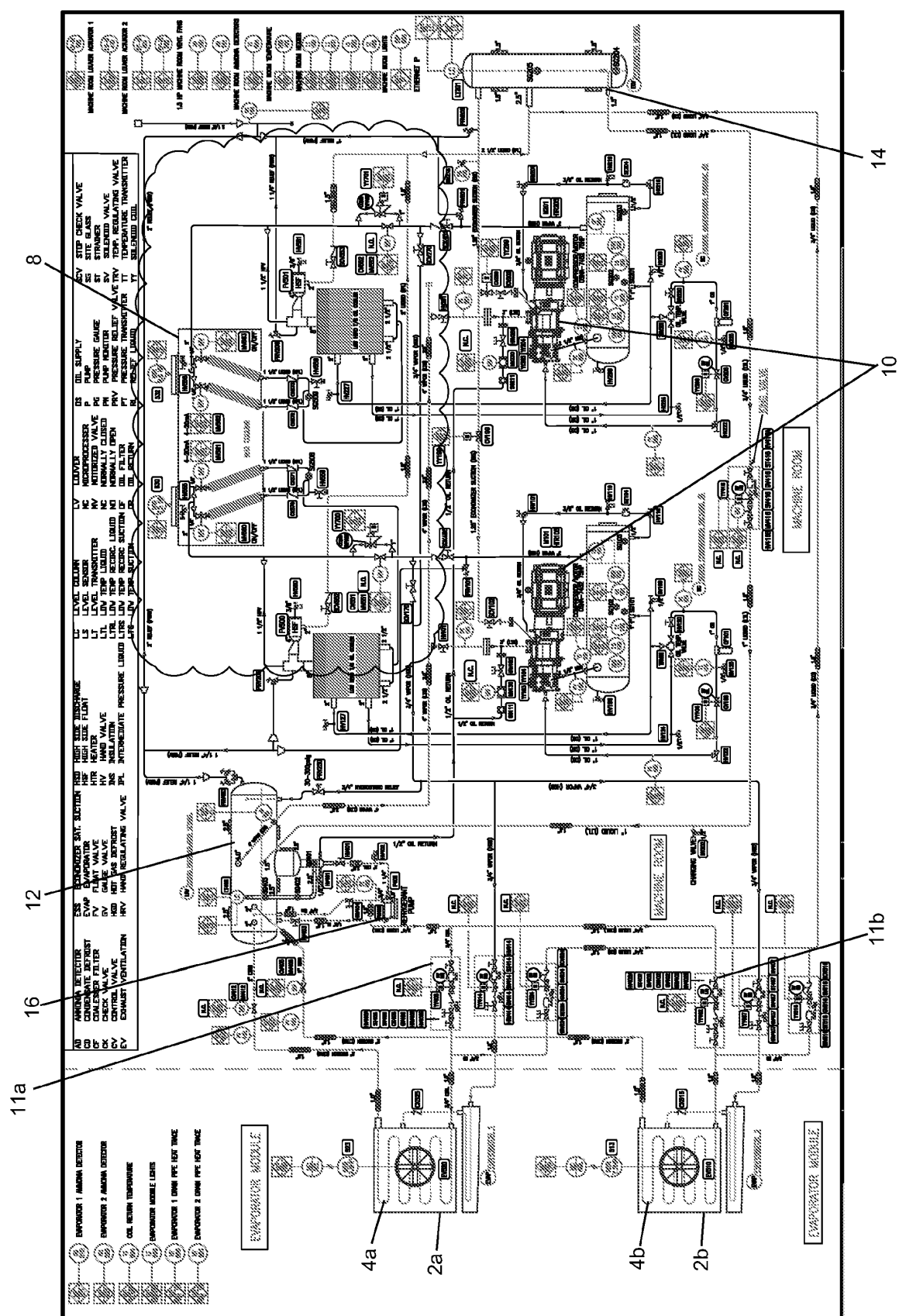


Figure 3

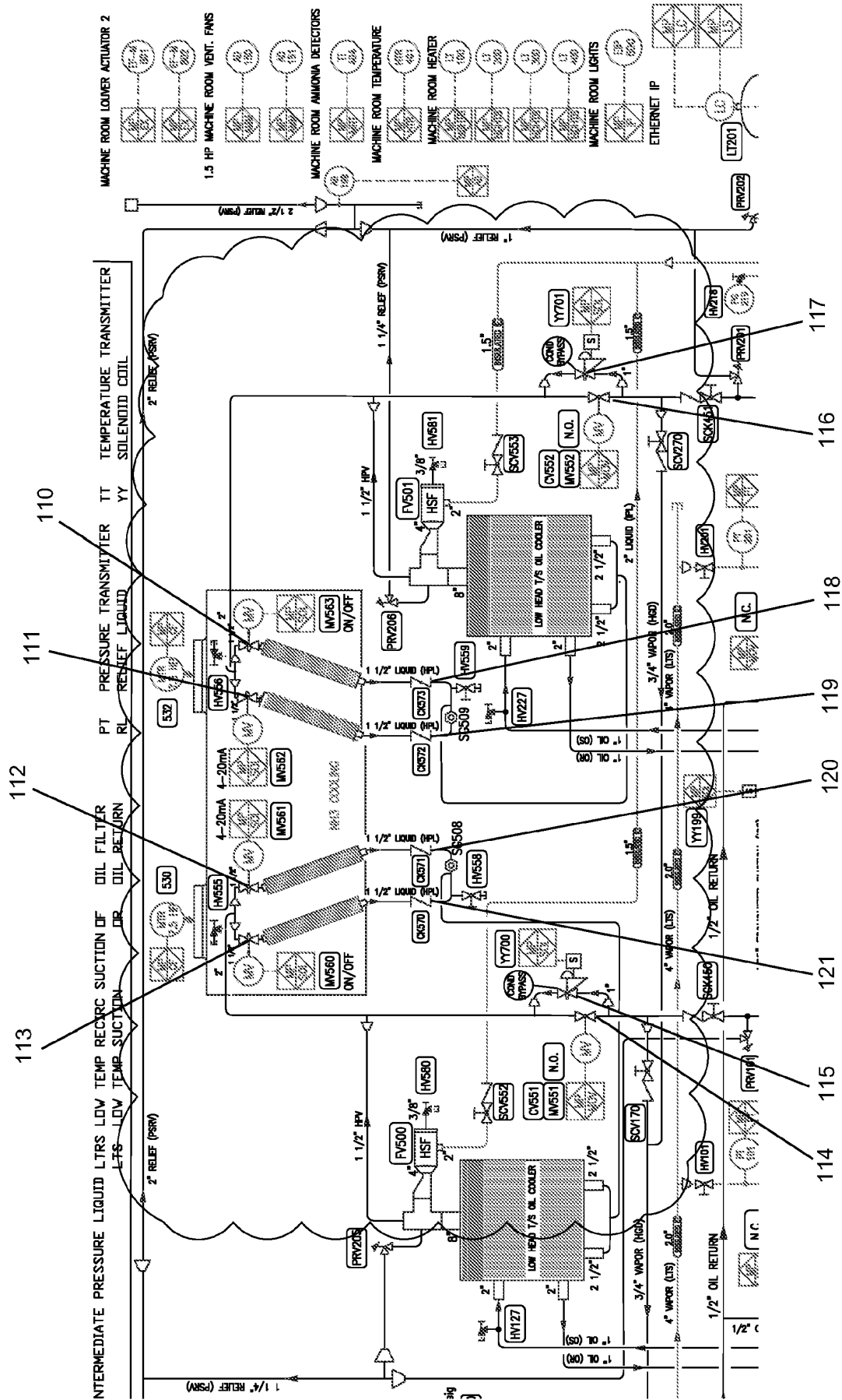


Figure 4

REFERENCES CITED IN THE DESCRIPTION

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