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(54) **REFRIGERATION COMPRESSOR PROTECTION**

KÄLTEKOMPRESSORSCHUTZ

PROTECTION DE COMPRESSEUR DE RÉFRIGÉRATION

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Description

[0001] The invention relates to a compressor protection module and an extension module that can be received and operated by such a compressor protection module. Moreover, the invention also relates to a modular compressor protection system including both the compressor protection module and the extension module.

[0002] Compressors running in refrigeration systems must be protected from malfunction in order to ensure reliable operation of the refrigeration system. Refrigeration systems used for preserving food must be particularly reliable in order to prevent food from getting spoiled. For example, supermarket operators benefit from improved reliability resulting in increased system uptime, reduction in food loss and reduced maintenance costs.

[0003] Other applications may be less sensitive to compressor maintenance, and may thus be less demanding in terms of refrigeration system diagnostic and protection control. For example, air conditioning systems may achieve optimal performance when maintaining a fixed air temperature over a period of time. However, although a deviation from such an optimal air temperature can deteriorate the comfort of using the air conditioning system, such a deviation is not necessarily serious in terms of affecting human or environmental safety aspects.

[0004] In other words, refrigeration system diagnostic and protection control requirements can vary significantly between the different applications and circumstances of use.

[0005] Applications are known in the prior art that equip refrigeration compressors with protection controls to prevent compressor failure, for example by detecting system anomalies and predicting compressor failures even before they arise.

[0006] Known state of the art refrigeration compressors can at least be found in US 2003/0077179 A1, US 2008/0077260 A1 and WO 2017/211128 A1.

[0007] However, as the required compressor protection functions can vary significantly between the different applications, conventional compressor platforms have generally each been designed to service a rather wide range of possible applications.

[0008] In fact, conventional compressor platforms are usually released with a large spectrum of refrigeration compressor protection functions, because it may be impossible, or at least very costly and difficult, to upgrade such systems with additional compressor protection services.

[0009] Thus, a customer requiring only a very limited scope of compressor protection functions is still required to pay the asking price for obtaining all features offered by the respective compressor platform.

[0010] In view of the above it is an object of the present invention to improve the flexibility, reliability and efficiency of using refrigeration compressor protection functions.

[0011] This object is satisfied by a compressor protec-

tion module according to claim 1, and an extension module according to claim 14, wherein the extension module can be received and operated by the compressor protection module. Moreover, the object is also satisfied by a modular compressor protection system according to claim 15 including both the compressor protection module and the extension module.

[0012] In accordance with the present invention a compressor protection module comprises:

a signal processing means;

a first connecting means adapted to couple the signal processing means to a compressor of a refrigerant system such as to have the signal processing means provide the compressor with at least one protection function; and a second connecting means adapted to receive and operate at least one extension module, wherein the extension module provides the compressor with at least one optional function, and wherein the extension module is a plug-in module.

[0013] In other words, the compressor protection module is equipped with a signal processing means and a first connecting means, wherein the first connecting means couples the signal processing means to the refrigeration compressor to provide at least one protection function.

[0014] Moreover, depending on the required protection features, it is possible to extend the protection functions provided by the compressor protection module by adding at least one extension module. More specifically, a second connecting means of the compressor protection module is adapted to receive and operate at least one extension module, wherein the extension module provides the compressor with at least one optional function. The extension module is a plug-in module that can, for example, be removably coupled to sockets or slots of the second connecting means.

[0015] The compressor protection module can be formed as an electrical component, device or control unit, for example a unit that is integrated into the compressor, or a physically separate unit coupled to the compressor, for example a module encompassed by a separate housing such as to be mounted on a surface of the compressor. Alternatively, the compressor protection module can represent an external device that is coupled to the compressor via signal conductors, such as for example industrial bus systems or wired or wireless communication networks, for example a racked control unit coupled to communicate with the compressor via a communication network.

[0016] In any case, the compressor protection module comprises a signal processing means, for example a computer, a digital signal processor coupled to a storage unit, or an integrated circuit adapted to perform signal processing and determine control actions related to the compressor.

[0017] The first connecting means of the compressor

protection module is adapted to couple the signal processing means to the refrigeration compressor. In this way, the signal processing means is provided with means of communication allowing the signal processing means to provide the compressor with at least one protection function.

[0018] For example, the first connecting means can be used by the signal processing means to receive sensor data describing physical parameters of the compressor. Then, the signal processing means can determine in the operating scope of a protection function, if the sensor data appears to indicate that a compressor maintenance is imminent, and/or if an action needs to be taken to prevent damaging the compressor. Preferably, the action that needs to be taken can be selectable by the operator. For example, the signal processing means can be configured to allow the operator to decide about the level of compressor / system protection, and/or to allow the operator to adjust system parameters within pre-specified ranges.

[0019] For example, the signal processing means can be coupled to a human-machine-interface such as to issue a warning or inform the user about the operational status of the compressor. Further, the signal processing means can use the coupling to the compressor, provided by first connecting means, to issue control commands to the compressor. For example, the signal processing means can control the compressor to shut down when a predefined system condition occurs, for example when a certain system parameter exceeds a predefined limit, or to temporarily shut down the compressor to prevent damage, for example due to overheating.

[0020] It follows that the signal processing means and the first connecting means of the compressor protection module are adapted to provide the compressor with at least one protection function. In an example, the at least one protection function corresponds to commonly used protection functions, such as for example motor overheat protection functions and oil differential pressure protection functions, which are likely to be used in most refrigeration compressor arrangements.

[0021] In other words, the compressor protection module is adapted to provide built-in protection functions for the compressor. In an example, the built-in protection functions can correspond to common protection functions which are likely to be useful when operating the compressor.

[0022] In order to allow the provisioning of additional protection functions, the compressor protection module further comprises a second connecting means adapted to receive and operate at least one extension module. In this way, the extension module can be coupled to the second connecting means of the compressor protection module such as to provide the compressor with at least one optional function.

[0023] It follows that the functions provided by the compressor protection module can be extended by coupling extension modules to the compressor protection module.

Hence, the functions provided by or via the compressor protection module are two-fold: the build-in protection functions of the compressor protection module, and the optional functions which can be added by coupling extension modules to the second connecting means of the compressor protection module.

[0024] In this way, optional functions can be added to tailor the compressor protection services provided by the compressor protection module. In particular, it can be desired to tailor the compressor protection services to the type of application and other implementation consideration related to the underlying refrigerator system.

[0025] Moreover, this arrangement allows new optional functions to be developed and added to existing compressor protection modules, for example to allow upgrading previous systems with newly developed compressor protection services.

[0026] Preferably, the second connecting means is adapted to receive the at least one extension module in a removable manner. In other words, it is preferred that the at least one extension module can be coupled to and then removed from the compressor protection module.

[0027] In this way, the scope of compressor protection services can be adapted to changes or defects in the system. For example, an extension module can be replaced with a different extension module, in particular if changes in the refrigeration arrangement require a change in the provided compressor protection services.

[0028] Moreover, a replaceable extension module can be more easily serviced in the field.

[0029] It is further preferred that the plug-in module corresponds to a plug-and-play module which, upon coupling the plug-and-play module to the second connecting means, automatically sets up and/or configures the provisioning of a compressor protection service.

[0030] Preferably, the second connecting means comprises a bus system including bus connector elements connected in series in a bus arrangement, wherein the bus connector elements are adapted to receive said plug-in modules in a removable manner.

[0031] For example, the bus connector elements can represent connector slots of a bus system. Preferably, the bus system is arranged to electrically connect pins of the connector slots, for example by using a serial or parallel bus system for coupling the pins of adjacent connector slots.

[0032] Preferably, the first connecting means includes a sensor unit adapted to measure at least one physical parameter of the compressor, and a sensor connector means adapted to convey the measurement result. In this way, the first connecting means can be adapted to couple the signal processing means to a compressor of a refrigerant system such as to have the signal processing means receive a sensor signal representing a physical parameter of the compressor. It follows that the signal processing means can process or analyze the sensor signal such as to determine the operational status of the compressor, in particular to determine if anomalies in the

sensor signal indicate that the compressor is damaged and/or should be maintained or protected. In this way, the sensor signal can be used by the signal processing means to provide the compressor with at least one protection function.

[0033] For example, the sensor unit can include a temperature sensor adapted to measure a temperature of the compressor, preferably the temperature of motor windings of the compressor. The temperature sensor can, for example, include a positive temperature coefficient thermistor chain arranged on the motor windings, such as to determine a sensor signal indicating the temperature, or changes in the temperature, of the respective motor windings.

[0034] Similarly, the sensor unit can include any of: a pressure sensor adapted to measure or detect an oil pressure of the compressor, for example by using a Hall sensor, a temperature sensor adapted to measure the discharge temperature of the compressor, a current sensor adapted to measure the current of at least one motor winding of the compressor, and a voltage sensor adapted to measure the supply voltage received by the compressor or voltage imbalance between motor windings of the compressor.

[0035] Thus, the first connecting means can be adapted to measure and provide the signal processing means with a sensor signal that can be processed or analyzed such as to determine the operational status of the compressor, in particular to determine if the compressor is damaged and/or should be maintained or protected.

[0036] In any case, the signal processing means may require a connection for controlling the compressor. For this purpose, it is preferred that the first connecting means provides a connectivity between the signal processing means and the compressor such as to allow the signal processing means to control the compressor, in particular to provide the compressor protection module with a protection function.

[0037] In an example, the signal processing means can use said connectivity to provide at least one of the protection functions: an overheat protection function, an oil pressure protection function, for example by using a Hall sensor arranged in an oil pump or by applying an oil level control, a discharge temperature protection function, a locked rotor protection function, a low voltage protection function, a single phasing protection function, a voltage imbalance protection function, and a crankcase heater control.

[0038] It follows that the signal processing means and the first connecting means of the compressor protection module are adapted to provide the compressor with at least one protection function. In an example, the at least one protection function corresponds to commonly used protection functions, such as for example motor overheat protection functions and oil pressure protection functions, which are likely to be used in most refrigerator compressor arrangements.

[0039] In other words, the compressor protection mod-

ule can be adapted to provide built-in protection functions for the compressor. In an example, the built-in protection functions can correspond to common protection functions which are likely to be useful when operating the compressor.

[0040] In order to allow the provisioning of additional protection functions, the compressor protection module further comprises a second connecting means adapted to receive and operate at least one extension module. In this way, the extension module can be coupled to the second connecting means of the compressor protection module such as to provide the compressor with at least one optional function.

[0041] For example, the second connecting means can be adapted to receive and operate at least one extension module to provide the compressor with at least one of the optional protection functions: an overheat protection function, an oil pressure protection function, a discharge temperature protection function, a locked rotor protection function, a low voltage protection function, a single phasing protection function, a voltage imbalance protection function, a crankcase heater control.

[0042] Hence, the functions provided by or via the compressor protection module are two-fold: the build-in protection functions of the compressor protection module, and the optional functions which can be added by coupling extension modules to the second connecting means of the compressor protection module.

[0043] The optional functions can be added to tailor the compressor protection services provided by the compressor protection module to customer requests. In particular, it can be desired to tailor the compressor protection services to the type of application and other implementation consideration related to the underlying refrigerator system.

[0044] In this respect, the first and second connecting means can be adapted to allow the at least one extension module to use the coupling between the signal processing means and the compressor as provided by the first connecting means to provide the at least one optional protection function. In other words, an extension module can be coupled to the second connecting means of the compressor protection module, and can be adapted to provide the compressor with an optional protection function by using the coupling between the signal processing means and compressor provided by the first connecting means. In this way, the extension module can use an already existing connectivity between the signal processing means and compressor to provide the optional protection function, reducing the complexity and enhancing the flexibility of the compressor protection provision.

[0045] In an example, the at least one extension module provides an additional optional function that is particularly useful for operating or monitoring the compressor. For example, the extension module can provide a communication link between the compressor protection module and a device, for example to have a device receive data or information from the compressor protection mod-

ule, or from the compressor via the compressor protection module. Similarly, the communication link can allow the device to control the performance or behavior of the compressor protection module or the compressor.

[0046] Preferably, the device coupled to the compressor protection module, or to the compressor via the compressor protection module, can be a controller unit, a remote computer or a remote signal processing unit. Moreover, the communication link is preferably provided via a Modbus or wireless communication link, a WiFi or a Bluetooth wireless link.

[0047] A second aspect of the invention relates to the above described extension module that is adapted to be received and operated by the second connecting means of the compressor protection module.

[0048] A third aspect of the invention relates to a modular compressor protection system comprising the above described compressor protection module and the extension module, wherein the extension module is coupled to the compressor protection module.

[0049] Further embodiments of the invention are described in the following description of the attached Figures, in which is shown:

- Fig. 1 a compressor protection module coupled to a refrigeration compressor;
- Fig. 2 a compressor protection module;
- Fig. 3 an extension module; and
- Fig. 4 a modular compressor protection system.

[0050] In the following the same reference numerals will be used for parts having the same or equivalent function. Any statements made having regard to the direction of a component are made relative to the position shown in the drawing and can naturally vary in the actual position of application.

[0051] Fig. 1 shows a compressor protection module 200 coupled to a refrigeration compressor 100. The compressor protection module 200 comprises a signal processing means 230, and a first connecting means 205 adapted to couple the signal processing means 230 to the refrigeration compressor 100. In this way, the signal processing means 230 can provide the compressor 100 with at least one protection function.

[0052] The signal processing means 230 can, for example, be formed as a controller unit or printed circuit board with a signal processor and storage units adapted to provide the at least one protection function.

[0053] The first connecting means 205 includes sensor units 210 each adapted to measure a physical parameter of the compressor 100, and sensor connector means 220 adapted to convey measurement results from the sensor units 210 to the signal processing means 230.

[0054] In this example, one of the sensor units 210 is a temperature sensor adapted to measure a temperature of the compressor 100. For example, the temperature of motor windings of the compressor 100 can be measured to determine if the compressor 100 is overheating exces-

sively and may require damage protection.

[0055] The temperature sensor 210 includes a positive temperature coefficient thermistor chain that is arranged on the motor windings of the compressor 100. Alternatively, the sensor units 210 can include at least one of: a pressure sensor adapted to measure or detect an oil pressure of the compressor 100, a temperature sensor adapted to measure the discharge temperature of the compressor 100, a current sensor adapted to measure the current of at least one motor winding of the compressor 100, and a voltage sensor adapted to measure the supply voltage received by the compressor 100 or voltage imbalance between motor windings of the compressor 100.

[0056] In a different example of the present invention, the sensor units 210 and/or the sensor connector means 220 do not form part of the first connecting means 205 of the compressor protection module 200, but are rather provided as separate units of the refrigeration arrangement or are encompassed by the refrigeration compressor 100 itself. In this case, the first connecting means 205 of the compressor protection module 200 can comprise an interface adapted to be coupled to the sensor connector means 220 or sensor units 210.

[0057] Although not shown in Fig. 1, the first connecting means 205 of the compressor protection module 200 provides connectivity to allow the signal processing means 230 to control the compressor 100. Thus, the connectivity provided by the first connecting means 205 can be used by the signal processing means 230 to control the compressor 100, in particular to provide the compressor protection module 200 with a protection function.

[0058] In other words, the signal processing means 230 can use the connectivity to control the compressor 100. More specifically, if the measurement results conveyed by the sensor connector means 220 from the temperature sensor units 210 to the signal processing means 230 indicate that the compressor 100 may be overheating excessively and may require damage protection, the signal processing means 230 can use the connectivity to shut down, or at least temporarily shut down, the compressor 100 to avoid overheating damages.

[0059] It follows that the signal processing means 230 and the first connecting means 205 of the compressor protection module 200 are adapted to provide the compressor 100 with a motor overheat protection. In a different example, a similar arrangement can be used to provide any of: an oil pressure protection function, a discharge temperature protection function, a locked rotor protection function, a low voltage protection function, a single phasing protection function, a voltage imbalance protection function, and a crankcase heater control.

[0060] It follows that the compressor protection module 200 can be adapted to provide built-in protection functions for the compressor 100, in particular to provide common protection functions which are likely to be useful when operating the compressor 100.

[0061] For example, many refrigeration compressors

100 require a motor overheat protection and an oil pressure protection function, and it can be technically efficient and convenient to have the compressor protection module 200 provide these protection services as built-in protection functions.

[0062] In order to allow the provisioning of additional protection functions, in particular additional protection functions which are application specific, the compressor protection module 200 is configurable to allow optional protection services.

[0063] For this purpose, the compressor protection module 200 shown in Fig. 2 comprises second connecting means 240 adapted to receive and operate at least one extension module, such as for example the extension module 300 shown in Fig. 3. In other words, an extension module 300 can be coupled to the second connecting means 240 such as to provide the compressor 100 with at least one optional function.

[0064] Hence, the functions provided by or via the compressor protection module 200 are two-fold: the build-in protection functions of the compressor protection module 200, and the optional functions which can be added by coupling extension modules 300 to the second connecting means 240 of the compressor protection module 200.

[0065] The second connecting means 240 is adapted to receive the extension module 300 in a removable manner. For this purpose, the extension module 300 shown in Fig. 3 is a printed circuit board having conductors exposed at the surface of one of its ends such as to form plug connectors 310 allowing connectivity with connector slots 250 of the second connecting means 240.

[0066] More specifically, the extension module 300 shown in Fig. 3 is a plug-in module, wherein the plug connectors 310 are adapted to be received by connector slots 250 of the second connecting means 240 in a removable manner. In this example, the extension module 300 is a plug-and-play module which, upon coupling the plug-and-play module to the second connecting means 240, automatically sets up and/or configures the provisioning of a compressor protection service.

[0067] The use of extension modules 300 allows a very efficient and flexible approach to adapt the scope of compressor protection services to the underlying application, or to changes or defects in the system. For example, an extension module 300 can be replaced with a different extension module 300 if changes in the refrigeration arrangement require a change in the provided compressor protection services. Moreover, a replaceable extension module 300 can also be more easily maintained and/or replaced in case of malfunction.

[0068] It follows that optional functions can be added to tailor the compressor protection services provided by the compressor protection module 200 to customer requests. Moreover, new optional functions can be developed and added to existing compressor protection modules 200 without changing the compressor protection module 200, for example to allow upgrading previous systems with newly developed compressor protection

services.

[0069] As mentioned above, the added optional function provides a discharge temperature protection of the compressor 100. Other possible types of added optional compressor protection services include, for example: a locked rotor protection function, a low voltage protection function, a single phasing protection function, a voltage imbalance protection function, a crankcase heater control, depending on customer requests and/or the underlying type of refrigeration compressor application.

[0070] Fig. 4 shows a corresponding modular compressor protection system 400 comprising the compressor protection module 200 of Fig. 2 and the extension module 300 of Fig. 3, wherein the extension module 300 has been coupled to the second connecting means 240 of the compressor protection module 200.

[0071] The second connecting means 240 shown in Fig. 4 is designed as a bus system including bus connector elements connected in a bus arrangement, wherein the bus connector elements form said connector slots 250 adapted to receive the plug-in module 300 in a removable manner.

[0072] The first and second connecting means 205, 240 allow the extension module 300 to use the connectivity between the signal processing means 230 and the compressor 100 as provided by the first connecting means 205.

[0073] It follows that the extension module 300 can use an already existing connectivity between the signal processing means 230 and compressor 100 to provide the optional protection function, reducing the complexity and enhancing the flexibility of the compressor protection provision.

[0074] If further optional functions are required, the second connecting means 240 can be used for adding additional extension modules 300. For example, an extension module 300 can be inserted into one of the non-occupied second connecting means 240 to establish a communication link to a device, for example to couple a controller unit to the compressor 100. In an example, such a communication link can be provided via a Modbus or wireless communication link, a WiFi or a Bluetooth wireless link.

[0075] In any case, optional functions can be added to tailor the compressor protection services provided by the compressor protection module 200 to customer requests. This can be particularly useful when it is desired to tailor the compressor protection services to the type of application and other implementation consideration related to the underlying refrigerator system.

List of reference numerals:

[0076]

100	refrigeration compressor
200	compressor protection module
205	first connecting means

- 210 sensor unit
- 220 sensor connector means
- 230 signal processing means
- 240 second connecting means
- 250 connector slots
- 300 extension module
- 310 plug connectors
- 400 modular compressor protection system

Claims

1. A compressor protection module (200), comprising:
 - a signal processing means (230);
 - a first connecting means (205) adapted to couple the signal processing means (230) to a compressor (100) of a refrigerant system such as to have the signal processing means (230) provide the compressor (100) with at least one protection function; and
 - a second connecting means (240) adapted to receive and operate at least one extension module (300), wherein the extension module (300) provides the compressor (100) with at least one optional function;
 - characterized in that** the extension module (300) is a plug-in module.
2. The compressor protection module (200) of claim 1, wherein the second connecting means (240) is adapted to receive the at least one extension module (300) in a removable manner.
3. The compressor protection module (200) of claim 1 or 2, wherein the second connecting means (240) comprises a bus system including a plurality of bus connector elements connected in a bus arrangement, wherein each of the bus connector elements is adapted to receive an extension module (300) in a removable manner.
4. The compressor protection module (200) of claim 3, wherein each of the bus connector elements comprises a connector slot (250), preferably wherein the bus system corresponds to a serial or parallel bus system electrically connecting pins of the connector slots (250).
5. The compressor protection module (200) of any of claims 1 to 5, wherein the extension module (300) is a plug-and-play module.
6. The compressor protection module (200) of any of claims 1 to 5, wherein the first connecting means (205) includes a sensor unit (210) adapted to measure at least one physical parameter of the compressor (100), and a sensor connector means (220) adapted to convey the measurement result to the signal processing means (230).
7. The compressor protection module (200) of claim 6, wherein the sensor unit (210) includes a temperature sensor adapted to measure a temperature of the compressor (100), preferably the temperature of motor windings of the compressor (100), further preferred wherein the temperature sensor includes a positive temperature coefficient thermistor chain arranged on the motor windings.
8. The compressor protection module (200) of claim 6 or 7, wherein the sensor unit (210) includes at least one of: a pressure sensor adapted to measure or detect an oil pressure of the compressor (100), a temperature sensor adapted to measure the discharge temperature of the compressor (100), a current sensor adapted to measure the current of at least one motor winding of the compressor (100), and a voltage sensor adapted to measure the supply voltage received by the compressor (100) or voltage imbalance between motor windings of the compressor (100).
9. The compressor protection module (200) of any of claims 1 to 8, wherein the first connecting means (205) provides connectivity to allow the signal processing means (230) to control the compressor (100).
10. The compressor protection module (200) of claim 9, wherein the connectivity provided by the first connecting means (205) allows the signal processing means (230) to control the compressor (100) such as to have the compressor protection module (200) provide at least one of the protection functions: an overheat protection function, an oil pressure protection function, a discharge temperature protection function, a locked rotor protection function, a low voltage protection function, a single phasing protection function, a voltage imbalance protection function, and a crankcase heater control.
11. The compressor protection module (200) of any of the preceding claims, wherein the second connecting means (240) is adapted to receive and operate at least one extension module (300) to provide the compressor (100) with at least one of the optional protection functions: an overheat protection function, an oil pressure protection function, a discharge temperature protection function, a locked rotor protection function, a low voltage protection function, a single phasing protection function, a voltage imbalance protection function, a crankcase heater control.
12. The compressor protection module (200) of any of claims 6 to 11, wherein the first and second connect-

ing means (205, 240) are adapted to allow the at least one extension module (300) to use the coupling between the signal processing means (230) and the compressor (100) as provided by the first connecting means (205) such as to provide the at least one optional protection function.

13. The compressor protection module (200) of any of the preceding claims, wherein the second connecting means (240) is adapted to receive and operate at least one extension module (300) to provide as an optional function a communication link to a device, preferably wherein the device is a controller unit, coupled to the compressor (100), a remote computer or a remote signal processing unit, and further preferred wherein the communication link is provided via a Modbus or wireless communication link, a WiFi or a Bluetooth wireless link.
14. A plug-in extension module (300) adapted to be received and operated by the second connecting means (240) of the compressor protection module (200) according to any of the preceding claims.
15. A modular compressor protection system (400) comprising a compressor protection module (200) according to any of claims 1 to 13 and the extension module (300) according to claim 14, wherein the extension module (300) is coupled to the compressor protection module (200).

Patentansprüche

1. Verdichterschutzmodul (200), umfassend:

ein Signalverarbeitungsmittel (230);
 ein erstes Verbindungsmittel (205), das geeignet ist, das Signalverarbeitungsmittel (230) mit einem Verdichter (100) eines Kältemittelsystems zu koppeln, so dass das Signalverarbeitungsmittel (230) den Verdichter (100) mit mindestens einer Schutzfunktion versieht; und
 ein zweites Verbindungsmittel (240), das angepasst ist, um mindestens ein Erweiterungsmodul (300) aufzunehmen und zu betreiben, wobei das Erweiterungsmodul (300) den Verdichter (100) mit mindestens einer optionalen Funktion ausstattet;

dadurch gekennzeichnet, dass das Erweiterungsmodul (300) ein Steckmodul ist.

2. Verdichterschutzmodul (200) nach Anspruch 1, wobei das zweite Verbindungsmittel (240) dazu ausgebildet ist, das mindestens eine Erweiterungsmodul (300) in einer entfernbar Weise aufzunehmen.
3. Verdichterschutzmodul (200) nach einem der An-

sprüche 1 oder 2, wobei das zweite Verbindungsmittel (240) ein Bussystem mit einer Vielzahl von in einer Busanordnung verbundenen Busverbinderelementen umfasst, wobei jedes der Busverbinderelemente geeignet ist, ein Erweiterungsmodul (300) in einer entfernbar Weise aufzunehmen.

4. Verdichterschutzmodul (200) nach Anspruch 3, wobei jedes der Busverbinderelemente einen Verbindersteckplatz (250) umfasst, wobei das Bussystem vorzugsweise einem seriellen oder parallelen Bussystem entspricht, das Pins der Verbindersteckplätze (250) elektrisch verbindet.
5. Verdichterschutzmodul (200) nach einem der Ansprüche 1 bis 5, wobei das Erweiterungsmodul (300) ein Plug-and-Play-Modul ist.
6. Verdichterschutzmodul (200) nach einem der Ansprüche 1 bis 5, wobei das erste Verbindungsmittel (205) eine Sensoreinheit (210), die geeignet ist, mindestens einen physikalischen Parameter des Verdichters (100) zu messen, und ein Sensorverbindemittel (220) umfasst, das geeignet ist, das Messergebnis an das Signalverarbeitungsmittel (230) zu übertragen.
7. Verdichterschutzmodul (200) nach Anspruch 6, wobei die Sensoreinheit (210) einen Temperatursensor aufweist, der dazu geeignet ist, eine Temperatur des Verdichters (100), vorzugsweise die Temperatur von Motorwicklungen des Verdichters (100) zu messen, wobei weiter bevorzugt der Temperatursensor eine an den Motorwicklungen angeordnete Thermistor-kette mit positivem Temperaturkoeffizienten aufweist.
8. Verdichterschutzmodul (200) nach einem der Ansprüche 6 oder 7, wobei die Sensoreinheit (210) mindestens eines umfasst aus: einem Drucksensor, der angepasst ist, um einen Öldruck des Verdichters (100) zu messen oder zu erfassen, einem Temperatursensor, der angepasst ist, um die Austragstemperatur des Verdichters (100) zu messen, einem Stromsensor, der angepasst ist, um den Strom von mindestens einer Motorwicklung des Verdichters (100) zu messen, und einem Spannungssensor, der angepasst ist, um die vom Verdichter (100) empfangene Versorgungsspannung oder ein Spannungsungleichgewicht zwischen Motorwicklungen des Verdichters (100) zu messen.
9. Verdichterschutzmodul (200) nach einem der Ansprüche 1 bis 8, wobei das erste Verbindungsmittel (205) eine Konnektivität bereitstellt, um dem Signalverarbeitungsmittel (230) die Steuerung des Verdichters (100) zu ermöglichen.

10. Verdichterschutzmodul (200) nach Anspruch 9, wobei die durch das erste Verbindungsmittel (205) bereitgestellte Konnektivität ermöglicht, dass das Signalverarbeitungsmittel (230) den Verdichter (100) so steuert, dass das Verdichterschutzmodul (200) mindestens eine der Schutzfunktionen bereitstellt: eine Überhitzungsschutzfunktion, eine Öldruckschutzfunktion, eine Austragstemperaturschutzfunktion, eine Schutzfunktion für einen blockierten Rotor, eine Schutzfunktion für eine niedrige Spannung, eine Schutzfunktion für eine einzelne Phase, eine Schutzfunktion für ein Spannungsungleichgewicht und eine Kurbelgehäuseheizungssteuerung.
11. Verdichterschutzmodul (200) nach einem der vorhergehenden Ansprüche, wobei das zweite Verbindungsmittel (240) angepasst ist, um mindestens ein Erweiterungsmodul (300) aufzunehmen und zu betreiben, um den Verdichter (100) mit mindestens einer der optionalen Schutzfunktionen zu versehen: eine Überhitzungsschutzfunktion, eine Öldruckschutzfunktion, eine Austragstemperaturschutzfunktion, eine Schutzfunktion für einen blockierten Rotor, eine Schutzfunktion für eine niedrige Spannung, eine Schutzfunktion für eine einzelne Phase, eine Schutzfunktion für ein Spannungsungleichgewicht, eine Kurbelgehäuseheizungssteuerung.
12. Verdichterschutzmodul (200) nach einem der Ansprüche 6 bis 11, wobei das erste und zweite Verbindungsmittel (205, 240) so ausgebildet sind, dass das mindestens eine Erweiterungsmodul (300) die Kopplung zwischen dem Signalverarbeitungsmittel (230) und dem Verdichter (100), wie sie durch das erste Verbindungsmittel (205) bereitgestellt wird, verwendet, um die mindestens eine optionale Schutzfunktion bereitzustellen.
13. Verdichterschutzmodul (200) nach einem der vorhergehenden Ansprüche, wobei das zweite Verbindungsmittel (240) geeignet ist, mindestens ein Erweiterungsmodul (300) aufzunehmen und zu betreiben, um als eine optionale Funktion eine Kommunikationsverbindung zu einer Vorrichtung bereitzustellen, wobei die Vorrichtung vorzugsweise eine mit dem Verdichter (100) gekoppelte Steuereinheit, ein entfernter Computer oder eine entfernte Signalverarbeitungseinheit ist, und wobei die Kommunikationsverbindung weiter bevorzugt über eine Modbus- oder drahtlose Kommunikationsverbindung, ein Wi-Fi oder eine Bluetooth-Funkverbindung bereitgestellt wird.
14. Einsteck-Erweiterungsmodul (300), das geeignet ist, von dem zweiten Verbindungsmittel (240) des Verdichterschutzmoduls (200) nach einem der vorhergehenden Ansprüche aufgenommen und betrieben zu werden.
15. Modulares Verdichterschutzsystem (400) mit einem Verdichterschutzmodul (200) nach einem der Ansprüche 1 bis 13 und dem Erweiterungsmodul (300) nach Anspruch 14, wobei das Erweiterungsmodul (300) mit dem Verdichterschutzmodul (200) gekoppelt ist.

Revendications

1. Module de protection de compresseur (200), comprenant :
- un moyen de traitement de signal (230) ;
un premier moyen de connexion (205) adapté pour coupler le moyen de traitement de signal (230) à un compresseur (100) d'un système de réfrigération de sorte que le moyen de traitement de signal (230) fournit au compresseur (100) au moins une fonction de protection ; et
un second moyen de connexion (240) adapté pour recevoir et pour faire fonctionner au moins un module d'extension (300), dans lequel le module d'extension (300) fournit au compresseur (100) au moins une fonction en option ;
caractérisé en ce que
le module d'extension (300) est un module plug-in.
2. Module de protection de compresseur (200) selon la revendication 1, dans lequel le second moyen de connexion (240) est adapté pour recevoir ledit au moins un module d'extension (300) d'une manière détachable.
3. Module de protection de compresseur (200) selon la revendication 1 ou 2, dans lequel le second moyen de connexion (240) comprend un système de bus incluant une pluralité d'éléments connecteurs de bus connectés à un agencement de bus, dans lequel chacun des éléments connecteurs de bus est adapté pour recevoir un module d'extension (300) d'une manière détachable.
4. Module de protection de compresseur (200) selon la revendication 3, dans lequel chacun des éléments connecteurs de bus comprend une fente de connecteur (250), de préférence dans lequel le système de bus correspond à un système de bus en série ou en parallèle connectant électriquement des broches des fentes de connecteurs (250).
5. Module de protection de compresseur (200) selon l'une quelconque des revendications 1 à 5, dans lequel le module d'extension (300) est un module plug-and-play.
6. Module de protection de compresseur (200) selon

- l'une quelconque des revendications 1 à 5, dans lequel le premier moyen de connexion (205) inclut une unité de capteur (210) adaptée pour mesurer au moins un paramètre physique du compresseur (100), et un moyen connecteur de capteur (220) adapté pour transporter le résultat de mesure vers le moyen de traitement de signal (230).
- 5
7. Module de protection de compresseur (200) selon la revendication 6, dans lequel l'unité de capteur (210) inclut un capteur de température adapté pour mesurer une température du compresseur (100), de préférence la température des enroulements de moteur du compresseur (100), de toute préférence dans lequel le capteur de température inclut une chaîne de thermistances à coefficient de température positif agencées sur les enroulements de moteur.
- 10
8. Module de protection de compresseur (200) selon la revendication 6 ou 7, dans lequel l'unité de capteur (210) inclut au moins un capteur parmi : un capteur de pression adapté pour mesurer ou détecter une pression d'huile du compresseur (100), un capteur de température adapté pour mesurer la température de décharge du compresseur (100), un capteur de courant adapté pour mesurer le courant d'au moins un enroulement de moteur du compresseur (100), et un capteur de tension adapté pour mesurer la tension d'alimentation reçue par le compresseur (100) ou un déséquilibre de tension entre les enroulements de moteur du compresseur (100).
- 20
9. Module de protection de compresseur (200) selon l'une quelconque des revendications 1 à 8, dans lequel le premier moyen de connexion (205) fournit une connectivité pour permettre au moyen de traitement de signal (230) de commander le compresseur (100).
- 25
10. Module de protection de compresseur (200) selon la revendication 9, dans lequel la connectivité fournie par le premier moyen de connexion (205) permet au moyen de traitement de signal (230) de commander le compresseur (100) de manière à ce que le module de protection de compresseur (200) fournisse au moins une des fonctions de protection parmi : une fonction de protection de surchauffe, une fonction de protection de pression d'huile, une fonction de protection de température de décharge, une fonction de protection de blocage de rotor, une fonction de protection de basse tension, une fonction de protection de marche monophasée, une fonction de protection de déséquilibre de tension, et une commande de chauffage de carter.
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11. Module de protection de compresseur (200) selon l'une quelconque des revendications précédentes, dans lequel le second moyen de connexion (240)
- 35
- est adapté pour recevoir et faire fonctionner au moins un module d'extension (300) pour fournir au compresseur (100) au moins une des fonctions de protection en option parmi : une fonction de protection de surchauffe, une fonction de protection de pression d'huile, une fonction de protection de température de décharge, une fonction de protection de blocage de rotor, une fonction de protection de basse tension, une fonction de protection de marche monophasée, une fonction de protection de déséquilibre de tension, et une commande de chauffage de carter.
- 40
12. Module de protection de compresseur (200) selon l'une quelconque des revendications 6 à 11, dans lequel le premier et le second moyen de connexion (205, 240) sont adaptés pour permettre à au moins un module d'extension (300) d'utiliser le couplage entre le moyen de traitement de signal (230) et le compresseur (100) tel que fourni par le premier moyen de connexion (205) de manière à fournir ladite au moins une fonction de protection en option.
- 45
13. Module de protection de compresseur (200) selon l'une quelconque des revendications précédentes, dans lequel le second moyen de connexion (240) est adapté pour recevoir et faire fonctionner au moins un module d'extension (300) pour fournir, à titre de fonction en option, une liaison de communication vers un dispositif, de préférence dans lequel le dispositif est une unité de contrôleur, couplée au compresseur (100), à un ordinateur à distance ou à une unité de traitement de signal à distance, et de toute préférence dans lequel la liaison de communication est fournie via une liaison modbus ou de communication sans fil, une liaison sans fil Wi-Fi ou une liaison sans fil Bluetooth.
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14. Module d'extension plug-in (300) adapté pour être reçu et mis en fonctionnement par le second moyen de connexion (240) du module de protection de compresseur (200) selon l'une quelconque des revendications précédentes.
- 55
15. Système de protection de compresseur modulaire (400) comprenant un module de protection de compresseur (200) selon l'une quelconque des revendications 1 à 13 et le module d'extension (300) selon la revendication 14, dans lequel le module d'extension (300) est couplé au module de protection de compresseur (200).

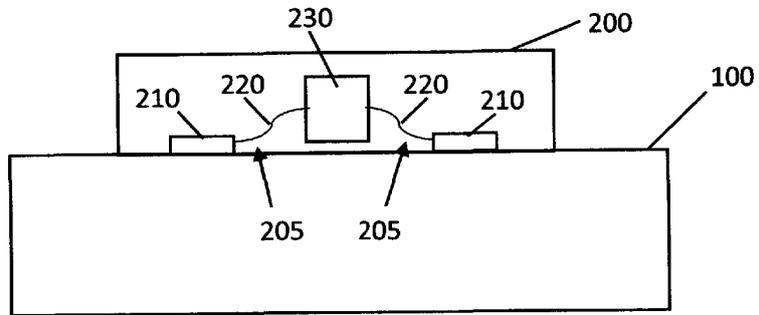


Fig. 1

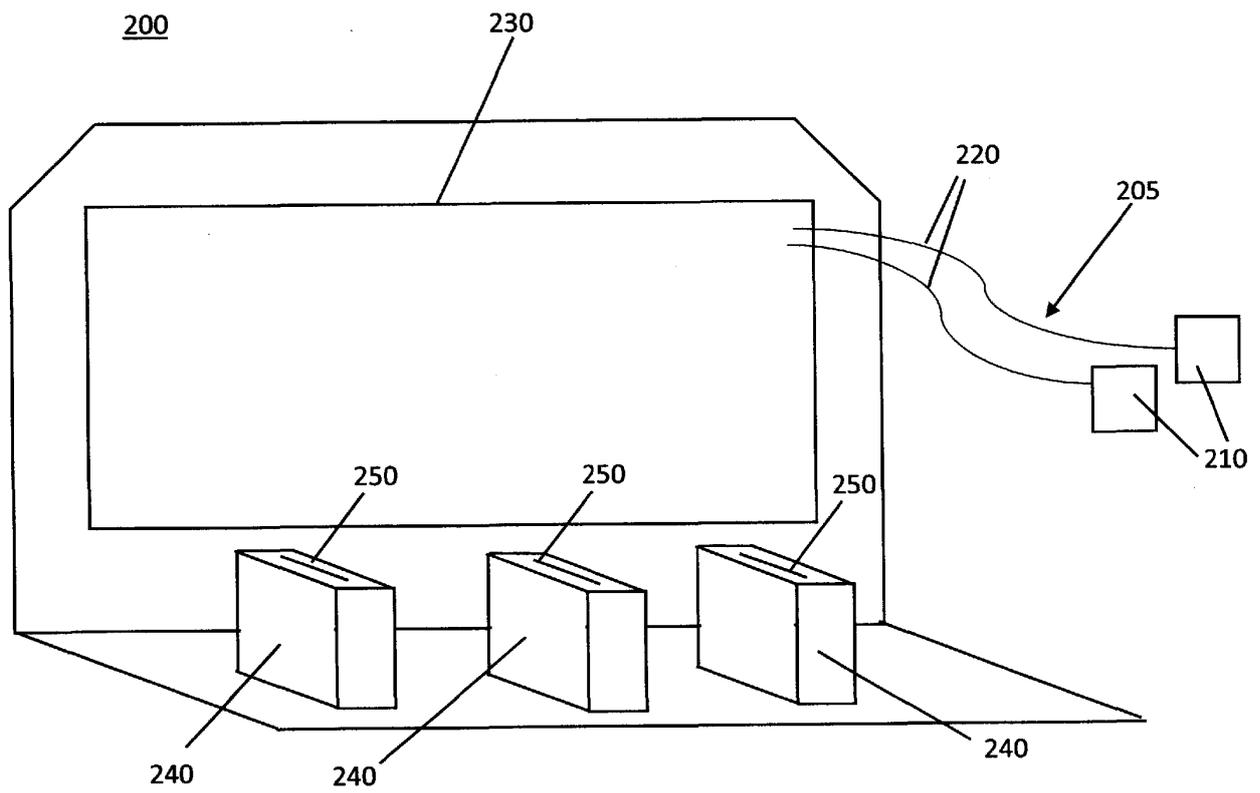


Fig. 2

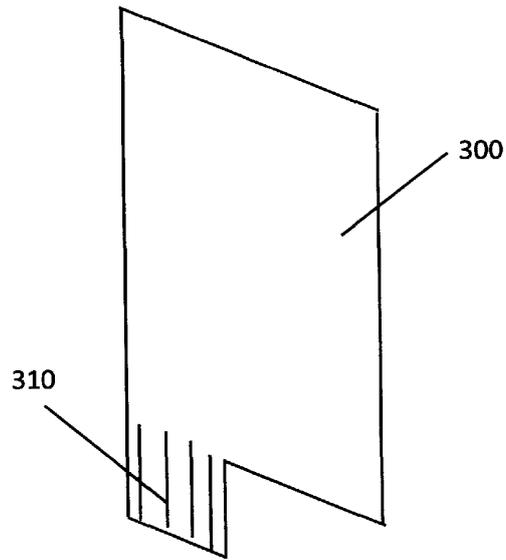


Fig. 3

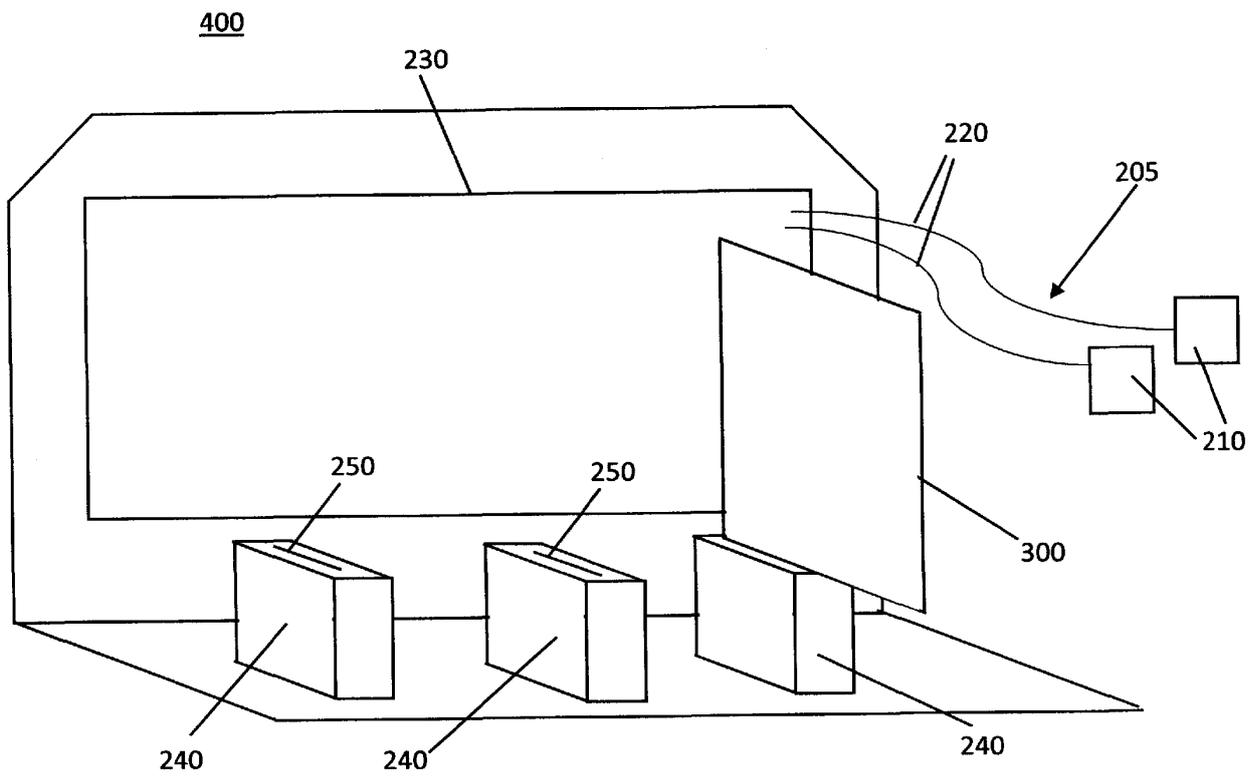


Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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