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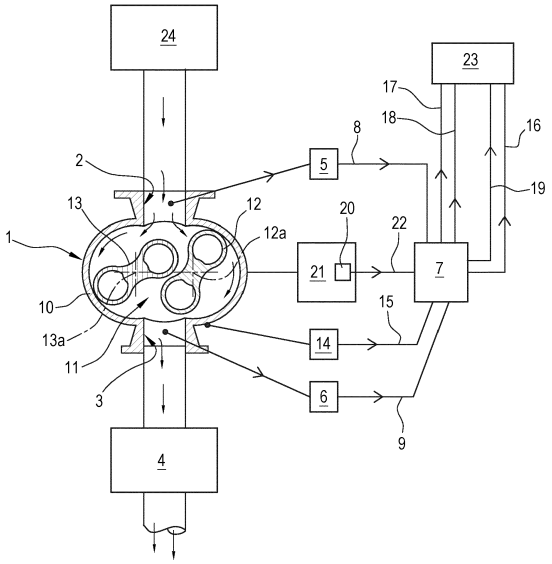
(54) **AUXILIARY VOLUMETRIC PUMP FOR GENERATING A VACUUM**

(57) An auxiliary volumetric pump for generating a vacuum comprising a casing (10), a rotary member (11) housed in the casing (10) and an electric motor (21) for powering the rotary member (11); the auxiliary pump (1) comprising an intake duct (2), located downstream of a user device (24), and a discharge duct (3) configured to define a delivery duct of a primary pump (4);
a device for detecting the pressure (5) of the fluid entering the auxiliary pump (1), designed for emitting a signal for detecting the pressure (8) of the fluid entering the auxiliary pump (1), is positioned in the intake duct (2); a device for detecting the pressure (6) of the fluid flowing out from the auxiliary pump (1), designed for emitting a signal for detecting the pressure (9) of the fluid flowing out of the auxiliary pump (1), is positioned in the discharge duct (3);
a control unit (7) is configured to receive and process the signal for detecting the pressure (8, 9) of the fluid entering and flowing out from the auxiliary pump (1) and determining the pressure of the fluid in the intake duct (2) and in the discharge duct (3) and the pressure difference between the pressure value in the intake duct (2) and in the discharge duct (3);
a control unit (7) is configured for controlling the frequency of rotation and the absorption of the electric motor (21) by the rotary member (11) as a function of the pressure difference between the pressure value in the intake duct (2) and in the discharge duct (3), if less than a pre-set permissible pressure difference.

FIG. 1



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Description

[0001] This invention relates to an auxiliary volumetric pump for generating a vacuum.

[0002] The term volumetric auxiliary pump means a "booster" pump, generally called a "roots" pump or a rotary lobes pump, positioned upstream of a primary pump, for example of the rotary blade type, for generating a vacuum in systems in which it is necessary to manage high fluid flow rates and to speed up the emptying time of the system.

[0003] Currently, the most commonly used system for guaranteeing the correct operation of an auxiliary volumetric pump is determined by the control of the maximum current absorption value, as a function of the rotation speed of the pump and the operating pressure.

[0004] However, the control on the absorption of the electric current does not protect the pump against faults or malfunctions caused, for example, by abnormal pressure conditions, at the inlet and/or at the outlet of the pump. In this context, the need has been felt of making an auxiliary pump for generating a vacuum comprising a casing, a rotary member housed in the casing and an electric motor for powering the rotary member.

[0005] The auxiliary pump comprises an intake duct, located downstream of a user device, and a discharge duct configured to define a delivery duct of a primary pump.

[0006] A device for detecting the pressure of the fluid entering the auxiliary pump, designed for emitting a signal for detecting the pressure of the fluid entering the auxiliary pump, is positioned in the intake duct.

[0007] A device for detecting the pressure of the fluid leaving the auxiliary pump, designed for emitting a signal for detecting the pressure of the fluid leaving the auxiliary pump, is positioned in the discharge duct.

[0008] A control unit is configured to receive and process the signal for detecting the pressure of the fluid entering and flowing out from the auxiliary pump and determining the pressure of the fluid in the intake duct and in the discharge duct and the pressure difference between the pressure value in the intake duct and in the discharge duct.

[0009] The control unit is configured for controlling the frequency of rotation and the absorption of the electric motor by the rotary member as a function of the pressure difference between the pressure value in the intake duct and in the discharge duct, if less than a pre-set permissible pressure difference.

[0010] Advantageously, this operating mode protects the electric motor of the auxiliary pump against malfunctions or faults since the current absorption is determined by the pressure difference between the pressure value in the intake duct and in the discharge duct, below the threshold value declared by the manufacturer of the auxiliary pump.

[0011] Further features and advantages of the invention are more apparent in the detailed description below, with reference to a preferred, non-limiting, embodiment of a volumetric auxiliary pump for generating a vacuum illustrated in a schematic view in Figure 1 which schematically illustrates a vacuum generating system.

[0012] Thenumeral 1 denotes an auxiliary volumetric pump for generating the vacuum according to the invention.

[0013] The auxiliary pump 1 comprises an intake duct 2 and a discharge duct 3. The intake duct 2 is located downstream of a user device 24, with reference to the direction of flow of the fluid.

[0014] The discharge duct 3 is configured to define a delivery duct of a primary pump 4.

[0015] The primary pump 4 is positioned downstream of the auxiliary pump 1, with reference to the direction of flow of the fluid.

[0016] A device for detecting the pressure 5 of the fluid entering the auxiliary pump 1 , designed for emitting a signal for detecting the pressure 8 of the fluid entering the auxiliary pump 1, is positioned in the intake duct 2.

[0017] A device for detecting the pressure 6 of the fluid flowing out from the auxiliary pump 1, designed for emitting a signal for detecting the pressure 9 of the fluid flowing out of the auxiliary pump 1, is positioned in the discharge duct 3.

[0018] A control unit 7 is configured for receiving and processing the signal for measuring the pressure 8 of the fluid entering the auxiliary pump 1 and determining the pressure of the fluid in the intake duct 2.

[0019] The control unit 7 is configured for receiving and processing the signal for measuring the pressure 9 of the fluid flowing out from the auxiliary pump 1 and determining the pressure of the fluid in the discharge duct 3.

[0020] The control unit 7 is configured to receive and process the signals for detecting the pressure 8, 9 of the fluid entering and flowing out and determining the pressure difference between the pressure value in the intake duct 2 and in the discharge duct 3.

[0021] The control unit 7 is configured for controlling the frequency of rotation and the absorption of the electric motor 21 by the rotary member 11 as a function of the pressure difference between the pressure value in the intake duct and in the discharge duct, if less than a preset permissible pressure difference.

[0022] The control unit 7 is configured for comparing the value of the pressure of the fluid in the discharge duct 3 with a threshold pressure value.

[0023] If the control unit 7 determines that the value of the pressure in the discharge duct 3 is greater than the threshold pressure value for a set period of time, the control unit 7 is configured to emit a first alarm signal 16.

[0024] This malfunction condition, that is to say, a pressure in the discharge duct 3 between the auxiliary pump 1 and the primary pump 4, may occur, for example, if the primary pump 4 is subject to a malfunction, the primary pump 4 switched off.

[0025] The control unit 7 is configured for comparing the value of the pressure of the fluid in the discharge duct

3 with a control pressure value.

[0026] If the control unit 7 determines that the pressure value in the discharge duct 3 is less than the control pressure value, the control unit 7 does not take any action.

[0027] If the control unit 7 determines that the pressure value in the discharge duct 3 is greater than the control pressure value, the control unit 7 is configured for storing the value of the pressure determined by means of the signal for measuring the pressure 9 of the fluid flowing out from the auxiliary pump 1.

[0028] The control unit 7 is configured for continuously measuring the pressure values determined by means of the respective signals for measuring the pressure 9 of the fluid flowing out from the auxiliary pump 1.

[0029] The control unit 7 is configured to determine whether or not the new pressure values are within a range of pressure values defined by the pressure value stored in a respective time interval.

[0030] If the control unit 7 determines that the pressure values are within said range of pressure values, according to a respective time interval, the control unit 7 is configured to send a second alarm signal 17.

[0031] If the control unit 7 determines that the new pressure value is not within the range of pressure values, the control unit 7 is configured for storing the new pressure value and, after a predetermined period of time, the control unit 7 is configured for measuring a new pressure value determined by the detection signal of the pressure 9 of the fluid flowing out from the auxiliary pump 1 and determining again if the new pressure value is within said range of pressure values defined by the value of the last pressure value stored.

[0032] This sequence of operations is repeated until the pressure value, in the respective time interval, is shown to be within said range of pressure values and the control unit 7 sends a second alarm signal 17.

[0033] The auxiliary pump 1 comprises a device for measuring the frequency 20 of the electric motor and is configured for emitting a signal for measuring the frequency 22 of the electric motor 21.

[0034] If the control unit 7 determines that the value of the frequency of the electric motor 21 is less than the pre-set minimum frequency value for a pre-set period of time, the control unit 7 is configured to emit a third alarm signal 18.

[0035] The minimum frequency set is the frequency necessary to guarantee the circulation of lubricating liquid in the auxiliary pump 1.

[0036] This malfunction condition, that is to say, a minimum frequency which continues over time, may occur, for example, when the ratio of the flow rate between auxiliary pump 1 and primary pump 4 is too high, over-absorbing, the primary pump 4 switched off.

[0037] The auxiliary pump 1 comprises a casing 10 and a rotary member 11 housed in the casing 10.

[0038] An electric motor 21 powers the rotary member 11.

[0039] In the example illustrated, the rotary member 11 comprises at least a first lobe 12, rotating about its own axis 12a of rotation, and a second lobe 13, rotating about its own axis 13a of rotation.

[0040] The first lobe 12 and the second lobe 13 rotate in a synchronous fashion about the respective axes of rotation 12a, 13a for conveying the fluid from the intake duct 2 to the discharge duct 3.

[0041] A device 14 for measuring the temperature is positioned on the casing 10. More specifically, the device 14 for measuring the temperature is positioned on the casing 10 in a zone close to the discharge duct 3.

[0042] The temperature measuring device 14 is configured to measure the temperature of the casing 10 and to emit a warning signal 15 indicating that the temperature has been exceeded a maximum permitted temperature value.

[0043] For example, the temperature measuring device 14 comprises an electrical circuit equipped with a switch whose opening or closing is determined by the temperature of the casing 10 exceeding a maximum permitted temperature value.

[0044] The control unit 7 is configured to receive the warning signal 15 of the temperature measuring device 14 and, upon receiving it, to emit a fourth alarm signal 19.

[0045] This condition of malfunction, that is to say, an over-temperature of the auxiliary pump 1, may occur, for example, if the ambient temperature in which the auxiliary pump 1 is positioned is high, the level or viscosity of the oil is high, the clearances of the rotary member 11 are too high, the suction filter of the auxiliary pump 1 is dirty or due to overloading of the auxiliary pump 1.

[0046] A display device 23 is configured to receive the first, second, third and fourth alarm signals 16, 17, 18, 19 emitted by the control unit 7 and make it visible to an operator.

[0047] Preferably, the display device 23 makes available the alarm signals by means of a warning light.

[0048] Lastly, it should be noted that, in order to protect the auxiliary pump 1 from malfunctions or faults, the control unit 7 is configured for controlling the switching off of the auxiliary pump 1, that is to say, for controlling the interruption of the electric motor 21 for powering the rotary member 11 upon the emission of at least one of the above-mentioned alarm signals 16, 17, 18, 19.

Claims

1. An auxiliary volumetric pump for generating a vacuum comprising a casing (10), a rotary member (11) housed in the casing (10) and an electric motor (21) for powering the rotary member (11); the auxiliary pump (1) comprising an intake duct (2), located downstream of a user device (24), and a discharge duct (3) configured to define a delivery duct of a primary pump (4);
   a device for detecting the pressure (5) of the fluid entering the auxiliary pump (1), designed for emitting

a signal for detecting the pressure (8) of the fluid entering the auxiliary pump (1), is positioned in the intake duct (2);
a device for detecting the pressure (6) of the fluid flowing out from the auxiliary pump (1), designed for emitting a signal for detecting the pressure (9) of the fluid flowing out of the auxiliary pump (1), is positioned in the discharge duct (3);
a control unit (7) is configured to receive and process the signal for detecting the pressure (8, 9) of the fluid entering and flowing out from the auxiliary pump (1) and determining the pressure of the fluid in the intake duct (2) and in the discharge duct (3) and the pressure difference between the pressure value in the intake duct (2) and in the discharge duct (3);
the control unit (7) is configured for controlling the frequency of rotation and the absorption of the electric motor (21) by the rotary member (11) as a function of the pressure difference between the pressure value in the intake duct (2) and in the discharge duct (3), if less than a pre-set permissible pressure difference.

2. The pump according to independent claim 1, **characterised in that** the control unit (7) is configured for comparing the value of the pressure of the fluid in the discharge duct (3) with a pre-set threshold pressure value; the control unit (7) being configured to determine whether the value of the pressure in the discharge duct (3) is greater than the threshold pressure value set for a set period of time and, if this is the case, to emit a first alarm signal (16).

3. The pump according to claim 1 or 2, **characterised in that** the control unit (7) is configured for continuously comparing each value of the pressure of the fluid detected in the discharge duct (3) with a pre-set control pressure value; the control unit (7) being configured to determine whether the value of the pressure in the discharge duct (3) is less than a pre-set control pressure value and, if the value of the pressure in the discharge duct (3) is greater than the control pressure value, the control unit (7) being configured to store this pressure value and, after a predetermined period of time, the control unit (7) being configured to determine if a new pressure value measured in the discharge duct (3) is within or not a range of pressure values defined by the previous pressure value stored; if the new pressure value is within the range of pressure values, the control unit (7) being configured to send a second alarm signal (17); if the new pressure value is not within the range of pressure values, the control unit (7) being configured to repeat the sequence of operations until a new pressure value is within the range of pressure values.

4. The pump according to any one of the preceding claims, **characterised in that** it comprises a device for measuring the frequency (20) of the electric motor, designed for emitting a signal for measuring the frequency (22) of the electric motor (21); the control unit (7) is configured to determine whether the value of the frequency of the electric motor (21) is less than the pre-set minimum frequency value for a pre-set period of time and, if this is the case, to emit a third alarm signal (18).

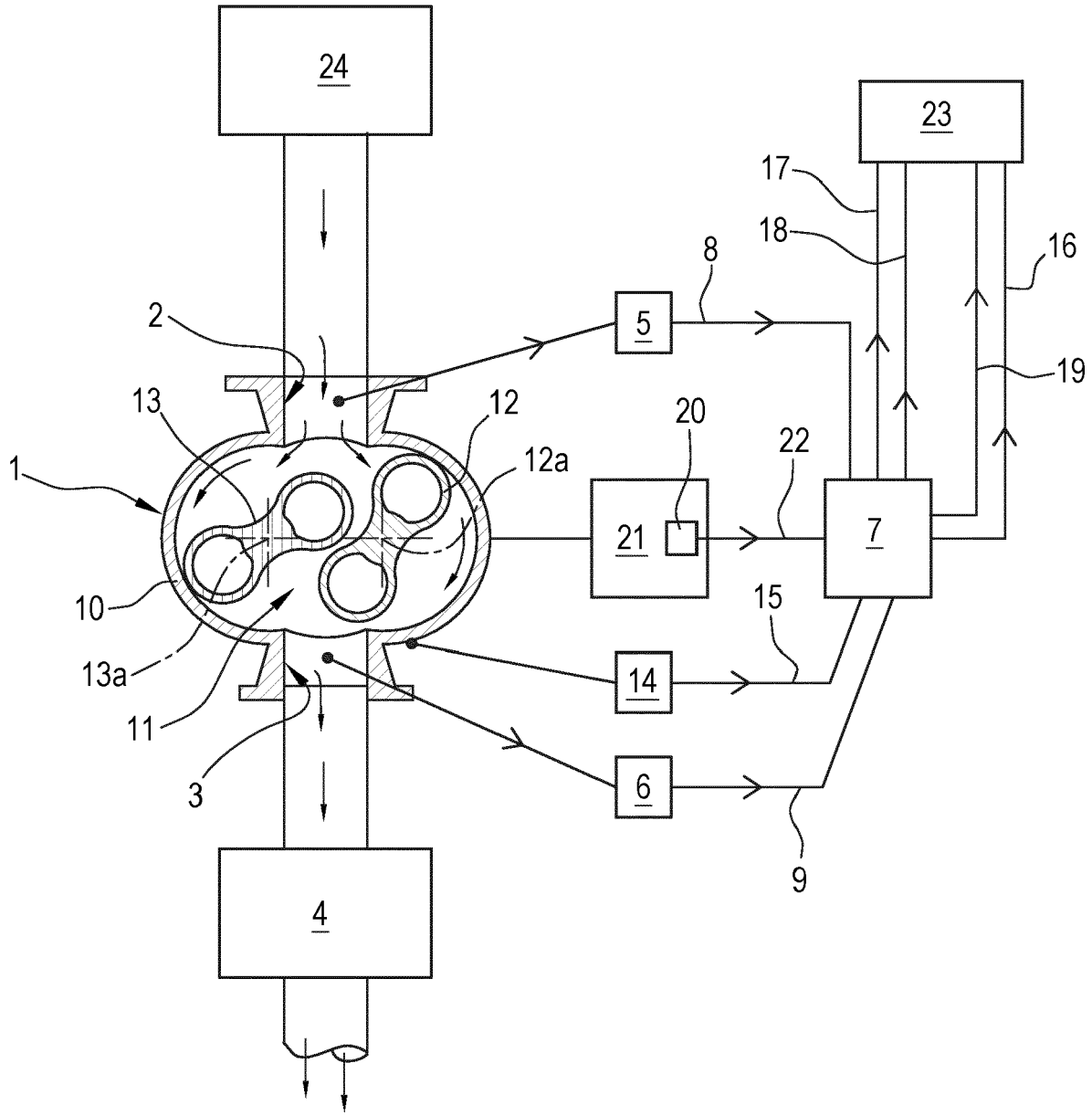
5. The pump according to any one of the preceding claims, **characterised in that** it comprises a device for measuring the temperature (14) positioned on the surface of the casing (10), in particular in an area of the casing (10) close to the discharge duct (3) configured for measuring the temperature of the casing (10) and for emitting a warning signal (15) that the temperature has exceeded a maximum permitted temperature value; the control unit (7) being configured to receive the warning signal (15) of the temperature measuring device (14) and, upon receiving it, to emit a fourth alarm signal (19).

6. The pump according to any one of the preceding claims, **characterised in that** it comprises a display device (23) configured to receive the first, second, third and fourth alarm signals (16, 17, 18, 19) emitted by the control unit (7) and make it visible to an operator; preferably, the display device (23) makes available the alarm signals (16, 17, 18, 19) by means of a warning light.

7. The pump according to any one of the preceding claims, **characterised in that** the control unit (7) is configured to control the switching off of the auxiliary pump (1), in particular for controlling the interruption of the electric motor (21) powering the rotary member (11), upon the emitting of at least one of the first, second, third and fourth alarm signals (16, 17, 18, 19).

8. A plant for generating a vacuum comprising the auxiliary pump according to any one of claims 1 to 7 and a primary pump (4) located downstream of the auxiliary pump (1), with reference to the direction of flow of the fluid; the intake duct (2) of the auxiliary pump (1) being located downstream of a user device (24), with reference to the direction of flow of the fluid.

FIG. 1



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EUROPEAN SEARCH REPORT

Application Number
EP 19 21 6999

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2018/010970 A1 (PFEIFFER VACUUM [FR]) 18 January 2018 (2018-01-18) * figure 1 * * page 8, line 18 - line 26 * * page 9, line 9 - line 14 *	1-8	INV. F04C28/06 F04C28/08 F04C18/12 F04C25/02
A	US 2017/298935 A1 (MÜLLER DIDIER [CH] ET AL) 19 October 2017 (2017-10-19) * figures * * abstract *	1-8	
A	JP 2007 100562 A (SHINKO SEIKI) 19 April 2007 (2007-04-19) * figures * * abstract *	1-8	
A	EP 0 401 399 A1 (LEYBOLD AG [DE]) 12 December 1990 (1990-12-12) * figure 1 * * abstract *	1-8	

TECHNICAL FIELDS SEARCHED (IPC)

F04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 January 2020	Durante, Andrea

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23-01-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2018010970 A1	18-01-2018	CN 109477485 A	15-03-2019
		EP 3485168 A1	22-05-2019
		FR 3054005 A1	19-01-2018
		KR 20190022880 A	06-03-2019
		TW 201804083 A	01-02-2018
		WO 2018010970 A1	18-01-2018
US 2017298935 A1	19-10-2017	AU 2014406724 A1	13-04-2017
		BR 112017005927 A2	19-12-2017
		CA 2961977 A1	31-03-2016
		CN 107002680 A	01-08-2017
		EP 3198148 A1	02-08-2017
		JP 2017531125 A	19-10-2017
		KR 20170063839 A	08-06-2017
		RU 2670640 C1	24-10-2018
		TW 201623801 A	01-07-2016
		US 2017298935 A1	19-10-2017
		WO 2016045753 A1	31-03-2016
JP 2007100562 A	19-04-2007	JP 4745779 B2	10-08-2011
		JP 2007100562 A	19-04-2007
EP 0401399 A1	12-12-1990	DE 58907121 D1	07-04-1994
		EP 0401399 A1	12-12-1990
		US 5066202 A	19-11-1991

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