



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.05.2014 Bulletin 2014/21

(51) Int Cl.:
A47L 15/42^(2006.01) A47L 15/00^(2006.01)

(21) Application number: **13192913.5**

(22) Date of filing: **14.11.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

- **Himmelsbach, Björn S.**
Glenview, IL Illinois 60026 (US)
- **Plewnia, Thomas**
Glenview, IL Illinois 60026 (US)
- **Carrington, Kevin J.**
Glenview, IL Illinois 60026 (US)
- **Piotrowski, Stanislaw**
Glenview, IL Illinois 60026 (US)

(30) Priority: **20.11.2012 US 201261728556 P**

(71) Applicant: **Premark FEG L.L.C.**
Glenview, IL 60026 (US)

(74) Representative: **Trinks, Ole**
Meissner, Bolte & Partner GbR
Depotstrasse 5 1/2
86199 Augsburg (DE)

(72) Inventors:
• **Watson, William T.**
Glenview, IL Illinois 60026 (US)

(54) **Warewash Machine Pump Motor Failure Sensing System And Related Method**

(57) This present invention relates to a method and system of monitoring a pump (1) in a warewash machine. The sensing system is capable of monitoring signals from mechanical liquid pumps used on a warewash machine. The sensed phenomenon may be directly related to the mechanical vibration of the pump. The sig-

nals obtained through such monitoring are processed in a manner that allows some major failure modes of a pump to be detected prior to complete failure of the pump so that the pump can be replaced at a convenient time prior to an unplanned loss of use of the warewash machine.

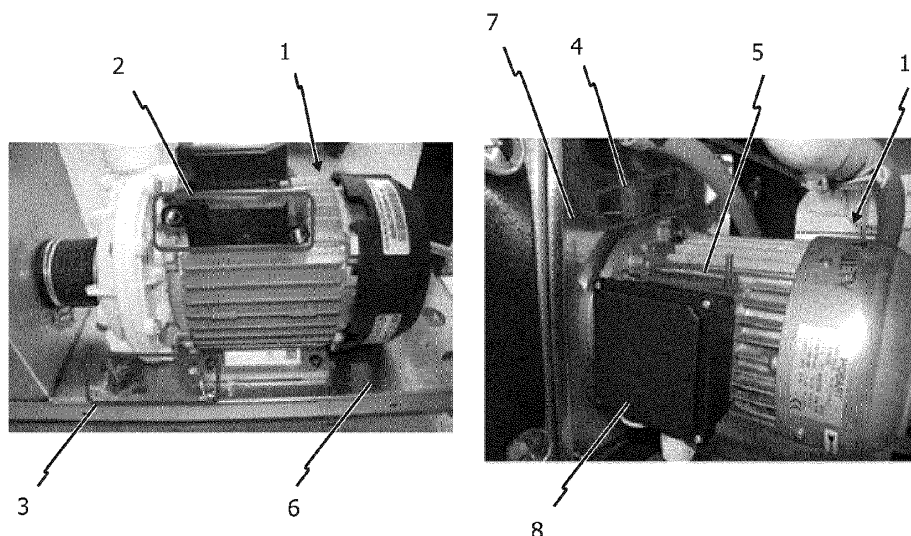


Fig. 1

Description

TECHNICAL FIELD

[0001] This application relates generally to commercial warewash machines and, more specifically, to a sensing system and method for monitoring and detection potential failure of one or more pumps in such a warewash machine.

BACKGROUND

[0002] On a batch-type or box-type warewasher or dishwasher (e.g., a hood machine or an undercounter machine), wash arms are typically located on the top and bottom of the washing chamber to wash wares located in a dish rack by directing a washing solution out of nozzles located on the arms. The sprayed washing solution is typically a recirculated solution that, once sprayed, falls and collects in a sump below the chamber, is drawn from the sump through a strainer by a pump and is pushed by the pump along a flow path into the wash arms and then out through the nozzles. One or more rotatable rinse arms may also be provided for spraying fresh rinse liquid and, in some cases, the rinse liquid delivery system includes its own associated pump.

[0003] In a flow-through warewasher (e.g., a continuous-type warewasher), wares are moved through a chamber (e.g., via a conveyor that moves racks of wares or via a conveyor with flights that hold wares) with multiple spray zones (e.g., a pre-wash zone, a wash zone, a post-wash or pre-rinse zone and a final rinse zone, each having respective nozzles) as they are cleaned. Each wash zone typically includes its own recirculation system having a tank and a recirculation line with a pump to feed liquid from the tank to one or more spray arms with nozzles (e.g., upper and lower arms) in the zone. Spray in the final rinse zone may be controlled by line pressure or, alternatively, another pump.

[0004] Regardless of machine type, due to high volume use, over time, the pumps may eventually fail, requiring replacement. When a pump fails, the warewash machine is temporarily out of commission, placing a serious strain on the commercial establishment (e.g., a cafeteria, restaurant, catering facility or other type dining and/or cooking facility) to effectively clean wares (e.g., dishes, cutlery, pots, pans and glasses) in a timely manner. What is needed is a system and method to reduce machine downtime caused by pump failures.

SUMMARY

[0005] This application encompasses a sensing system that is capable of monitoring sensed signals from mechanical liquid pumps used on a warewash machine. The sensed phenomenon may be directly related to the mechanical vibration of the pump. The signals obtained through such monitoring are processed in a manner that

allows some major failure modes of a pump to be detected prior to complete failure of the pump so that the pump can be replaced at a convenient time prior to an unplanned loss of use of the warewash machine.

[0006] The concept of monitoring machinery, such as rotating motors or pumps, for vibration in order to detect its failure is well established. Often an accelerometer or velocity sensor is mounted to the machine and provides a single-valued real-time output signal indicative of the vibration magnitude over a range of frequencies, where increased vibration may be an indication of upcoming mechanical failure. Typically, this sensor band-passes the vibration signal to provide an indication of vibration using primarily signal frequency components from about 400 to 1000Hz. Often the sensor will only have a single sensing axis that should be mounted so that this sensitive axis is aligned with the direction anticipated for greatest vibration. For a pump or rotating motor, this axis is usually along a radial direction outward from the main rotating shaft. Usually the sensing system monitors the vibrating machinery continuously when it is operational. The sensing system may be preset to provide an alert when the total vibration signal exceeds some preset level or the signal may simply be sent to some monitoring and control system that can interpret the signal.

[0007] Our warewash machine system in its most complete embodiment includes one or more sensors capable of detecting mechanical vibrations (e.g., sensor may include at least a vibration transducer, processor, memory, analog-to-digital converter, and a digital communication circuit), a housing for the sensor(s), electrical connections between the sensor(s) and a power source, an external processor with nonvolatile memory in communication with the sensor(s), a controller that can control the power to warewash pumps/motors, and sensors and/or logic that recognize the state of the warewash liquid drain and fill for a sump or tank.

[0008] The sensing system may be capable of measuring the total magnitude and direction of the acceleration, or vibration signal. For example, a tri-axial micro-electro-mechanical system (MEMS) accelerometer may be used to obtain acceleration along three orthogonal axes. In such an implementation that measures the total magnitude of the vibration signal, the sensor does not need to be mounted in line with an expected primary vibration axis. This makes sensor placement more flexible in terms of position and orientation and also means that the accuracy of the mounting placement is much less important. For example, the sensor may not need to be mounted directly on the pump or motor at all. In a warewasher, the pump or motor is often mounted to a water tank (made of thin walled material, such as stainless steel sheet) or to a relatively thin plate (also often made of stainless steel). Much of the vibrations or vibrational energy in the pump or motor will be transferred through the mounting surfaces and fasteners into the tank wall or mounting plate. It is possible to mount the sensor on the tank wall or mounting plate, preferably near a mounting

surface or fastener, and sense the pump/motor vibration levels indicative of pump condition and potential failure. The omnidirectional sensing allows the sensor to sense the total magnitude of vibration superimposed on the mounting surface, along many directions, when the vibrational energy is transferred to that surface. This sensing enables the system to still derive a measure of the total vibration energy produced by the pump/motor. Mounting the sensor on the tank wall of mounting plate (i) will often be less expensive and easier than modifying the pump/motor to allow for sensor placement and (ii) allows the sensor to remain mounted in place if the pump must be replaced. One easy way to mount the sensor would be to weld, or otherwise affix, threaded studs to the tank wall or mounting plate so the sensor housing can be placed on these studs and appropriate nuts added to complete the mechanical attachment. Figure 1 shows some potential mounting arrangements for a sensor. In particular, Figure 1 shows a pump 1 with a sensor mounted on the pump motor case with two threaded studs at a first location 2. In addition, Figure 1 shows second, third and fourth potential locations for mounting the sensor. In a second potential mounting location 3, the sensor is mounted on a pump mounting plate 6 by means of two threaded studs. In a third potential sensor mounting location 4, the sensor is mounted on the tank of the dishwasher near the pump mating surface 7 by means of two threaded studs. In another potential sensor mounting location 5, the sensor could be mounted on the respective pump motor case 8 by means of two threaded studs.

[0009] In a warewasher, many of the pumps are pumping a highly variable liquid. The primary component is usually tap water, but the liquid will often also contain detergents and food soils of varying composition and concentration. As the motor pumps this liquid the vibration experienced by the pump can vary greatly due to the chemical and mechanical properties of this liquid. Some conditions can cause foaming or cavitation of the liquid in or near the pump causing very different vibration levels and frequencies than are experienced by pumping clean water, for instance. The vibration signals may sometimes be difficult to differentiate from those expected from imminent pump failure and the exact condition of the liquid is usually unknown after the machine is placed into operation. In order to overcome this problem, the system and method may be implemented can monitor when the warewasher is drained of used/soiled liquid and when it is refilled with clean water. Such a drain and refill may typically occur at times such as (i) the end of the day when the machine is shut down, (ii) the start of the day when the machine is turned on, (iii) after a predefined number of hours of operation or (iv) upon detecting an unacceptably high soiling of water using a soil detection sensor. The system/method can analyze or acquire vibration sensing information to be used for pump failure detection after the machine has been drained and refilled with fresh water (e.g., upon system startup). In this manner our system will avoid potential false positive detec-

tions of a failing pump that might be triggered by analyzing the vibration levels when liquid is highly soiled or foamed..

[0010] As noted above, a warewasher often has more than one pump or other motors installed. The typical machine configuration does not effectively isolate vibrations between the pumps and therefore the vibration signature at each pump may be affected by some partial superposition of vibrations generated by any other running pumps or motors. In one embodiment, the system and method determines or otherwise recognizes the ON/OFF status of all pumps and motors and/or other vibration generating equipment on the machine. In this manner, the system/method can be operated to assure that the vibration monitoring and analysis for any given pump is achieved in a consistent manner (i.e., under the same overall machine operating conditions) to reduce the likelihood that some variation in machine operating condition affects the vibration analysis.

[0011] For example, in one implementation the system has one sensor dedicated to each pump (although in some machines it may be possible to use one sensor to monitor more than one pump). The system may choose to only analyze or acquire vibration sensing information to be used for pump failure detection of a given pump only when the given pump under evaluation is ON (e.g., when all other pumps in the machine are turned OFF). In this scenario, each pump in the machine may be turned on, one-at-a-time, during startup, after the liquid has been drained and replaced with clean water, and vibration sensing information will be used from the sensor associated with the particular pump that is ON to assess its condition. Each single pump evaluation may only require a small time period (e.g., a few seconds), but to improve the consistency and accuracy of the evaluation the pump vibration signal associated with each pump may be monitored for about 1 minute or longer. In the single pump evaluation type arrangement, each pump vibration sensor may have an associated baseline vibration against which future readings are analyzed or compared, with the baseline likewise having being defined and stored when only that one pump was ON and operating.

[0012] In another implementation, the system/method may evaluate or at least screen all pumps at the same time. This initial screening could reduce machine startup time, assuming that no pump appears to have elevated vibration levels. In this scenario, all pumps might be started and operated simultaneously, with their respective vibration signals simultaneously collected for some time period. If any of the pumps shows potentially elevated vibration levels, then the controller could choose to evaluate that pump more carefully by operating it alone. In this implementation, the baseline vibration level for each pump for the purpose of the screening may likewise be defined when all of the pumps are ON and operating. Moreover, each pump may have two associated baseline vibration levels, one for the initial screening (determined when all pumps were operating) and one for more fo-

cused single pump screening (determined when only that one pump was operating).

[0013] New/different pumps of the same type and model will generally not have identical vibration signatures. Variations in the pumps due to tolerances in the shaft, bearings, electric motor, assembly process, and other mechanical variations will sometimes lead to significant variations in the vibration levels when, for example, a new pump is installed on a warewash machine to replace an old pump. In order to account for this variation, the system/method may record the initial sensed vibration levels after new pump installation and store that information as a new baseline vibration for the pump. These initial/baseline levels are then compared with future vibration levels, looking for changes (increases) in the vibration levels in order to detect imminent pump failure. The absolute vibration level for indication of potential pump failure should not, in most cases, be preset prior to pump installation, but instead can be tailored to each pump based upon its baseline vibration level when newly installed (at the time of original warewash assembly or after pump replacement in the field). Tailoring the pump failure detection algorithm thresholds to each pump as newly installed on the warewash machine provides a more reliable and potentially earlier detection of a potential imminent failure.

[0014] As mentioned above, in one embodiment the vibration sensor is based upon a tri-axial MEMS accelerometer. However, it is noted that other types of vibrations sensors could be used to monitor vibration in the system. These sensors could include, but are not limited to, microphones (sensing acoustic pressure variations), nanoelectromechanical system accelerometers, optical accelerometers, electrodynamic velocity sensors, laser vibrometers, piezoelectric or piezoresistive type accelerometers. As mentioned above, depending upon the distance between motors to be monitored and the coupling of the vibration waves to potential sensor locations, it is possible that a single sensor could be located in a position such that it could effectively monitor the vibration level of more than one pump/motor. For example, a single microphone could be positioned to detect sounds generated multiple pumps, one-at-a-time, to infer the magnitude of the vibration exhibited by that pump. Sensing technologies that measure vibration of the surface to which they are mounted should use a reliable and mechanical stable linkage (machine structure) that could transmit appropriate vibration signals while maintaining a consistent transmission coefficient over the frequencies of interest. In another example, a single vibration sensor could be positioned at a location intermediate two pumps (e.g., where two pumps are mounted on the same plate the sensor could likewise be mounted on the plate). In this arrangement the single sensor could report vibration levels for a first of the pumps when only the first pump is operating and could report vibration levels for a second of the pumps when only the second pump is operating.

[0015] In one embodiment, the sensor can be set by

software to immediately change its sensing range to any one of $\pm 2g$, $\pm 4g$, $\pm 8g$, or $\pm 16g$. The number of bits providing the resolution of the system is constant, such that choosing a smaller sensing range provides finer absolute resolution of the sensed signals. For instance, the minimum resolution of the $\pm 2g$ range given an 8-bit analog to digital converter will be about 0.0156g, while the resolution of the $\pm 4g$ sensing range will be about 0.0313g. Finer resolution usually allows for the detection of smaller changes in the vibration signal, especially at higher frequencies where the vibration signal may be smaller. Choosing a larger range allows larger vibration signals to be measured accurately without experiencing significant instances where the physical signal exceeds the maximum range of the sensor, often known as signal clipping. The sensing system may be configured to continuously monitor the sensed vibration levels, and adjust the sensor to a nearly optimal acceleration sensing range in real time. When the sensed acceleration magnitude exceeds a specified percentage of the current sensing range, then the maximum range of the sensor is dynamically changed by increasing to the next wider available range. When the sensed acceleration magnitude falls below some predetermined percentage of the current maximum sensing range for several predetermined number of sensing time intervals, then the maximum range of the sensor is dynamically changed by decreasing to the next narrower available range. In the preceding discussion, the sensing time interval could vary widely, but might be on the order of 0.5s and the predetermined number of sensing time intervals used to make a change in the sensing range could also vary widely, but might be on the order of 10 intervals for a total of 5 seconds. The accelerometer should be sampled at a rate high enough to enable some reconstruction of the amplitude of the vibration signal at frequencies up to about 1000Hz. A minimum sampling rate of about 5kHz on all three axes should be sufficient to achieve excellent pump failure detection, but is not required. At a 5kHz sampling rate, if more than about 3 to 5% of the samples (about 75-125 samples in 0.5s) are equal to or greater than the current maximum range, then the system would begin to consider a dynamic range change to the next wider range. If the maximum sensed vibration along the most responsive axis were below about 30-40% of the maximum current sensing range, then the system might begin to consider a dynamic range change to the next narrower range. Some additional hysteresis algorithms might be employed to prevent the system from dynamically changing the sensing range back and forth between two ranges.

[0016] The sensor may measure vibration in each of the x, y, and z directions at a rate of at least 5kHz but need not use this raw data to evaluate the pump's condition. Instead, for each sample a representative magnitude may be calculated and at the end of a predetermined time period of, for example, 0.5 seconds, the average of those magnitudes is taken. This provides a simple way to capture a representation of the vibration magnitude of

the pump without having to calculate the actual magnitude of the vibration, which is much more computationally intensive and could require more powerful devices to be able to process real-time. Using this method for evaluating the pump condition has further benefits in that a single value represents the pump's condition. This is in contrast to a curve shape, specific vibration frequency, time in between peaks or other possible classification methods. Benefits of using a single value to classify the pump condition include that it requires very little memory storage for significant record keeping of pump historical data and requires little computing bandwidth to compare with another vibration sample.

[0017] When a motor is first turned on, there is often a large but very short duration time interval during which the vibration level is elevated (e.g. due to inductive spike or air induced cavitation). The system/method may be implemented to ignore this initial spike in vibration level when calculating the vibration level. For example, any vibration data during the first few seconds of pump operation may simply be ignored.

[0018] The system/method may be implemented such that pump vibration can be monitored at any particular time when power is available, and therefore the system/method can also be used to detect if each pump is actually ON or OFF. While more precise evaluation of the pump vibration level may not be possible at all times, the system will generally be capable of confirming whether a give pump is generally rotating or not, even with any combination of other motors/pumps ON.

[0019] The sensor and associated electronics should be protected from mechanical damage and from exposure to water or chemicals in the machine that might affect the function. In one embodiment, a plastic housing, in conjunction with a potting compound, should provide those protection functions along with allowing the sensor to be rigidly attached to the warewash machine. To avoid the use of fasteners the PCB may be glued to and/or potted against a flat surface 10 within the housing. Where the PCB uses through-hole components (e.g., a large LED that protrudes through the housing at LED hole 13) and connections, the portion of the board with these features are co-located. This enables a housing configuration with a large flat area for PCB mounting undercut by a small trough region 12 where through-hole connections can be made without interference with the flat mounting (see Figure 2). As can further be derived from Figures 2a and 2b, the housing 11 may additionally include means 14 for strain relief of the electrical cable 15. The means 14 may be constructed as an S-shaped channel. This PCB undercut region in the housing will fill with potting material during sensor assembly.

[0020] Where the housing is made by plastic injection molding, where uniform cooling is partially achieved by uniform part wall thickness, the outside of the housing at the PCB undercut region is elevated to maintain more uniform wall thickness in this area. Uniform cooling leads to a part that experiences less warping or mechanical

tolerance variations in important parameters, such as flatness of the mounting surface.

[0021] To accommodate various types of warewashing machines the sensor may be designed to accept a wide voltage supply range of, for example, 10-30VDC.

[0022] The sensor may be configured such that data and parameters can be stored on board the sensor in non-volatile memory. Data may be stored in a peripheral memory chip (e.g., not in the CPU itself) and is saved as it becomes available, having no static location for the most recent received data. This allows data to easily be retrieved via an "address" that is in reference to the most recently stored data, in contrast to an absolute address or an address in reference to the first piece of stored data.

[0023] Calibration values and other important sensor configurations may be stored within the MCU flash for immediate access and static addressing. In this way communication with the peripheral memory chip is not required for sensor start-up and initialization, eliminating initialization errors due to communication glitches.

[0024] Sensor configurations may be programmed and saved in non-volatile memory via a communication bus, such as Modbus. Bus messages may be variable in length, according to the type of command issued. These commands can be automated in nature, or issued by a person using the human machine interface of the warewash controller to generate a command through the communication bus. This allows for system auto-correcting of measurement settings as well as manual configuration, all without needing to program the sensor with new code, yet enabling retention of the altered settings even with power removed from the device.

[0025] The sensors may have an auto-addressing scheme to allow self-configuration of the sensors' address upon installation onto a machine, so that each may be talked to individually by the machine's controller. Each sensor will be manufactured with the same default bus address (e.g., address 01). During production assembly of the machine each sensor could be re-addressed with a predetermined address according to the pump upon which it will be mounted using a programmer explicitly for this setup purpose. When replacing a sensor in the field, the technician must swap out the sensor and initiate a replace sensor process with the machine controller. The machine controller will then identify which addresses are currently in use by the sensors on the bus. Based on the information received, the controller will then assign a unique address to the newly installed sensor according to which non-default address is available. For instance, all sensors could have a default address of 01. If, in a particular machine, the controller logic is configured to expect the sensors associated with its installed pumps to be addressed 10, 11, 12, 13, and 14. Assume sensor 11 is removed and replaced with a new sensor, then when the technician initiates a replace sensor logic process of controller, the controller will identify the sensors on the bus as having addresses 01, 10, 12, 13, 14. The controller will then know to automatically assign the sensor with

address 01 to address 11, automatically linking the newly installed sensor to the same pump that the replaced sensor was being used to monitor. If more than one sensor must be replaced, then the technician will need to replace one sensor, initiate the replace sensor process with the controller, and then select which of the 2 or more possible missing sensors have been replaced. This process would be repeated until all sensors are installed and re-addressed. Sensor addresses may be re-written in non-volatile memory when changed such that even when power has been removed from the device it will retain its unique address.

[0026] The sensor can perform self diagnostics and attempts to indicate faults to both the machine controller via Modbus and the user via, for example, an LED. Self diagnostics may include but are not limited to an accelerometer element deflection, a check of parameters fetched from memory, bias voltage of the MCU and peripheral ICs.

[0027] When the system/method determines that a pump failure is imminent, the system/method can (i) trigger an operator alert via a machine interface (e.g., simple light or buzzer or more advanced message on a display screen) or (ii) may automatically send a message to a service entity (e.g., e-mail, text message, etc.). By replacing the pump before it fails, downtime is significantly reduced.

[0028] By way of example, U.S. Patent No. 8,042,557 (cover page attached) shows one example of a flow-through type warewasher in which the system and method could be used to monitor one or more of pumps 22, 44, 48, 64 or any other pump used in the machine. U.S. Patent No. 7,892,359 (cover page attached) shows one example of a batch-type warewasher in which the system and method could be used to monitor one or more of pumps 10, 30, 20, 66, 220 or any other pump used in the machine.

[0029] It is to be clearly understood that the above description is intended by way of illustration and example only, is not intended to be taken by way of limitation, and that other changes and modifications are possible.

Claims

1. A method of monitoring a pump in a warewash machine, the pump arranged for delivering liquid to one or more nozzles for spraying on wares, the method comprising:

- utilizing a tri-axial sensor mounted on the machine to detect pump vibrations,
- determining a total magnitude of vibration during pump operation for purpose of analysis of potential failure of the pump.

2. The method of claim 1 including determining both total magnitude and direction of vibration during

pump operation for purpose of analysis of potential failure of the pump.

3. The method of claim 1 or 2 wherein the sensor is not mounted directly to the pump.

4. The method of claim 1 or 2 wherein the sensor is mounted on one of (i) a tank or sump wall to which the pump is mounted or (ii) a plate to which the pump is mounted, and wherein a set of threaded studs are affixed to one of (i) the wall or (ii) the plate, and the tri-axial sensor is positioned on a PCB within a plastic housing having mount openings through which the studs pass, the housing of the sensor thereby mounted to the wall or plate.

5. The method of claim 1, monitoring multiple pumps in a warewash machine, where each pump is operable to move a liquid within the machine for spraying of the liquid on wares in the machine, the method comprising:

- utilizing one or more sensors to provide an output or outputs indicative of vibration level of each pump;
- for each pump:

analyzing vibration level that is indicated by the pump only when the pump is considered to be moving clean/fresh liquid so as to factor out vibration variations that might be caused by soiled liquid, and or

- for each pump:

analyzing vibration level that is indicated by the pump only when that pump is operating and all other pumps are not operating so as to factor out vibration variations that might be caused by operation of the other pumps, and or

- for each pump:

analyzing vibration level that is indicated by the pump only after the pump has been operating for at least a predetermined time period so as to factor out vibration variations that might be caused by inductive spikes or cavitation that tends to occur upon pump start up.

6. The method of claim 5 including:

detecting vibration level indicated by each of the pumps in a sequential manner after a machine drain and refill operation.

7. The method of claim 5 including:

performing a screening operation with all pumps operating and during which vibration level data for each of the pumps is detected and analyzed.

5

8. The method of claim 1 comprising:

- utilizing a sensor to provide an output indicative of vibration level of the pump;
- utilizing a stored baseline vibration level for the pump, where the baseline was determined during a defined set of machine operating conditions; and

10

- comparing vibration level that is subsequently indicated by the pump only during the defined set of operating conditions to the baseline vibration level in order to evaluate potential pump failure,

15

- wherein the stored baseline vibration level is determined (i) during machine testing after manufacture and before machine installation at an operating site or (ii) after a specified number of runs or time of operation at an operating site or (iii) after pump change-out that occurs at an operating site of the machine.

20

25

9. The method of claim 1 monitoring first and second pumps in a warewash machine, where each pump is operable to move a liquid within the machine for spraying of the liquid on wares in the machine, the method comprising:

30

- providing one sensor to monitor vibration level of the first and second pumps;
- when the first pump is operating and the second pump is not operating, utilizing the one sensor to evaluate vibration of the first pump; and
- when the second pump is operating and the first pump is not operating, utilizing the one sensor to evaluate vibration of the second pump.

35

40

10. The method of claim 9 wherein the one sensor is mounted at a location intermediate the first pump and the second pump, and or wherein the first pump and the second pump are mounted to a common plate, the one sensor also mounted to the common plate.

45

11. The method of claim 1,

50

- utilizing a sensor for providing an output indicative of vibration level of the pump, the sensor having a set vibration sensing range;
- upon detection that the sensor output indicates vibration that meets one or more specific criteria, automatically changing the vibration sensing range of the sensor.

55

12. The method of claim 11 including:

- upon detection that the sensor output indicates vibration that satisfies high vibration criteria relative to the set sensing range, automatically increasing the vibration sensing range of the sensor, or

- upon detection that the sensor output indicates vibration that satisfies low vibration criteria relative to the set sensing range, automatically decreasing the vibration sensing range of the sensor.

13. The method of claim 1,

- utilizing a sensor arrangement that includes a vibration sensor, a microcontroller and peripheral memory mounted on a board within a housing;

- storing vibration data on the peripheral memory chip without any static location for most recently stored data.

14. The method of claim 13 including:

- storing sensor calibration and configuration data within memory of the microcontroller such that upon sensor start-up and initialization communication with the peripheral memory chip is not required.

15. The method of claim 1 monitoring multiple pumps in a warewash machine, each of the pumps arranged for delivering liquid to one or more nozzles for spraying on wares, the method comprising:

- utilizing multiple like sensors, each sensor initialized with a common default bus address;
- during machine manufacture, for each sensor on a communication bus of the machine, changing the default bus address to a unique bus address;

- upon subsequent sensor replacement in the machine, evaluating the bus addresses of sensors connected to the bus to identify a missing unique bus address of the removed sensor and a present default bus address of the replacement sensor, and automatically changing the default bus address of the replacement sensor to the missing unique bus address.

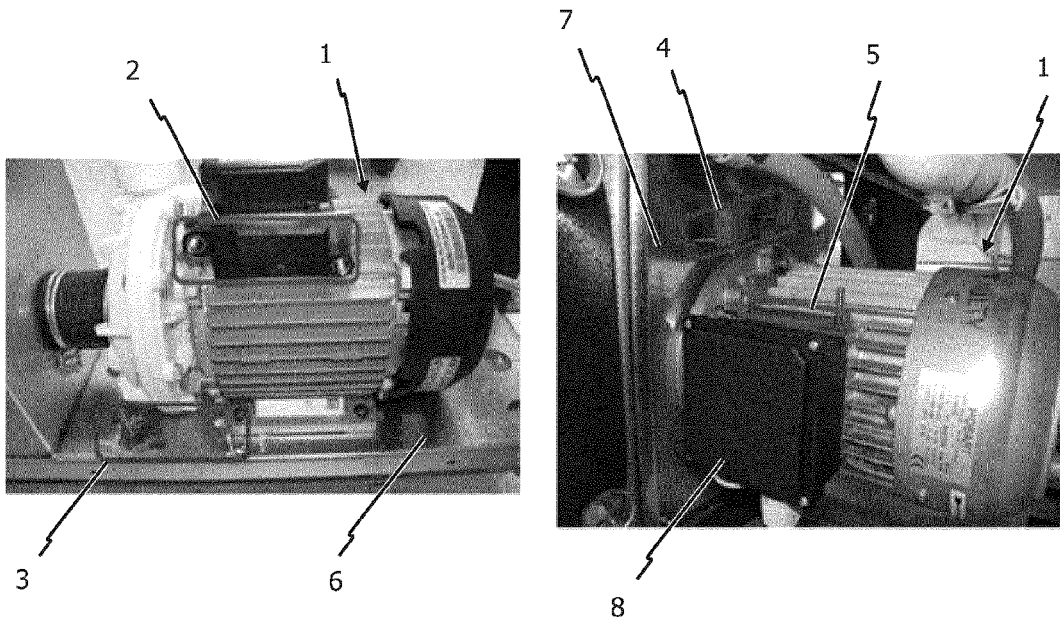


Fig. 1

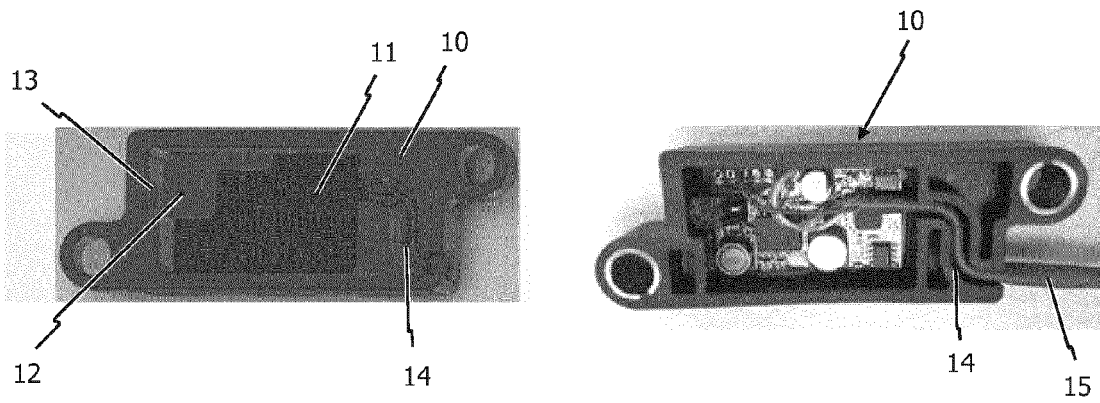


Fig. 2a

Fig. 2b



EUROPEAN SEARCH REPORT

Application Number
EP 13 19 2913

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	EP 0 321 295 A2 (WESTINGHOUSE ELECTRIC CORP [US]) 21 June 1989 (1989-06-21) * the whole document *	1-15	INV. A47L15/42 A47L15/00
A	DE 196 18 498 A1 (AMP GMBH [DE]) 13 November 1997 (1997-11-13) * the whole document *	1-15	
A	US 2009/056773 A1 (SON RO MON [KR] ET AL) 5 March 2009 (2009-03-05) * the whole document *	1-15	
A	US 4 909 076 A (BUSCH DIETER [DE] ET AL) 20 March 1990 (1990-03-20) * the whole document *	1-15	
A	DE 198 28 871 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 30 December 1999 (1999-12-30) * the whole document *	1-15	
A	DE 100 65 677 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 4 July 2002 (2002-07-04) * the whole document *	1-15	TECHNICAL FIELDS SEARCHED (IPC) A47L
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 January 2014	Examiner Jezierski, Krzysztof
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

2
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 19 2913

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

20-01-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0321295 A2	21-06-1989	EP 0321295 A2	21-06-1989
		JP H01200081 A	11-08-1989
		US 4913625 A	03-04-1990
DE 19618498 A1	13-11-1997	NONE	
US 2009056773 A1	05-03-2009	CN 101176641 A	14-05-2008
		KR 20090022855 A	04-03-2009
		US 2009056773 A1	05-03-2009
US 4909076 A	20-03-1990	DE 3725754 A1	16-02-1989
		JP S6453091 A	01-03-1989
		US 4909076 A	20-03-1990
DE 19828871 A1	30-12-1999	DE 19828871 A1	30-12-1999
		IT MI991403 A1	27-12-2000
DE 10065677 A1	04-07-2002	NONE	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 8042557 B [0028]
- US 7892359 B [0028]