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(54) **WAREWASH MACHINE SYSTEM AND METHOD FOR DETECTING CLOGGED WASH ARM**

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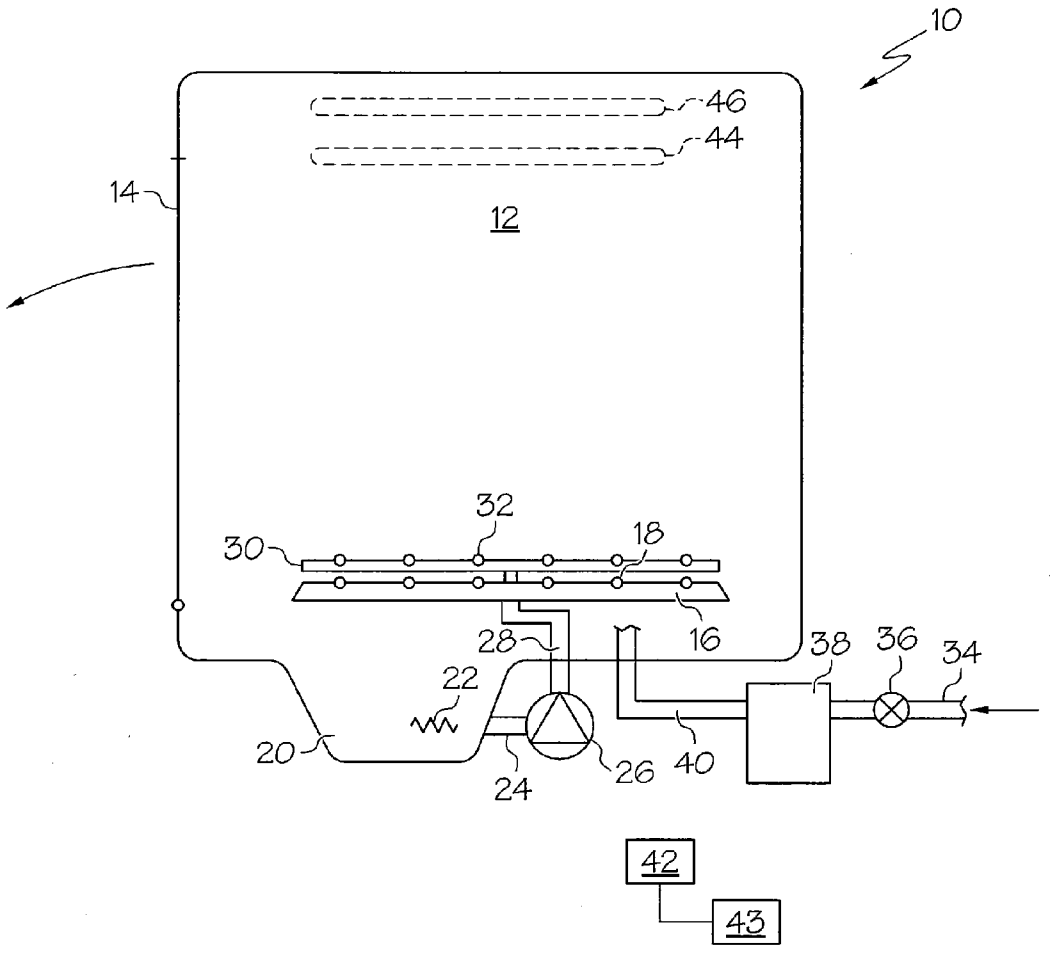
USPC ..... **134/18**; 134/56 R

(57) **ABSTRACT**

A method of detecting a clogged or partially clogged wash arm in a warewash machine involves the steps of: monitoring a rotational speed of the wash arm during a washing step of aware cleaning cycle or operation; and comparing the monitored rotation speed to a set threshold speed and, if the monitored rotational speed falls below the set threshold speed, triggering an operator alert to advise the machine operator to check the wash arm. An advantageous sensor arrangement associated with a wash arm manifold is also provided.



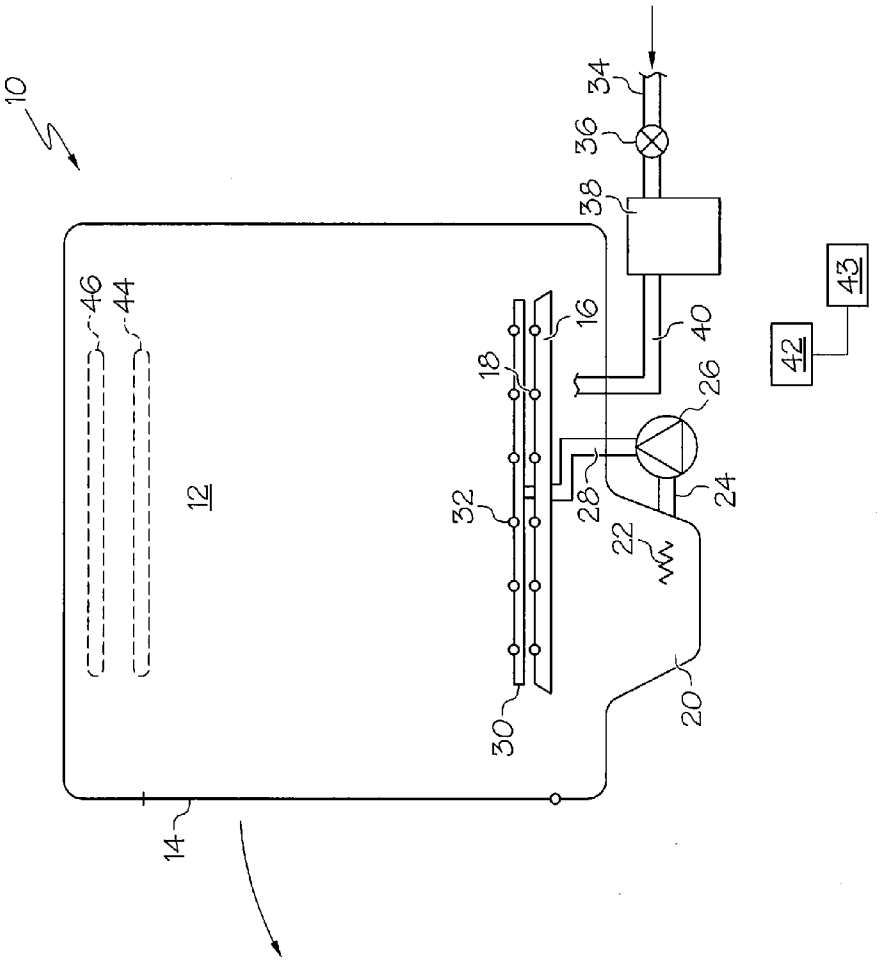


FIG. 1

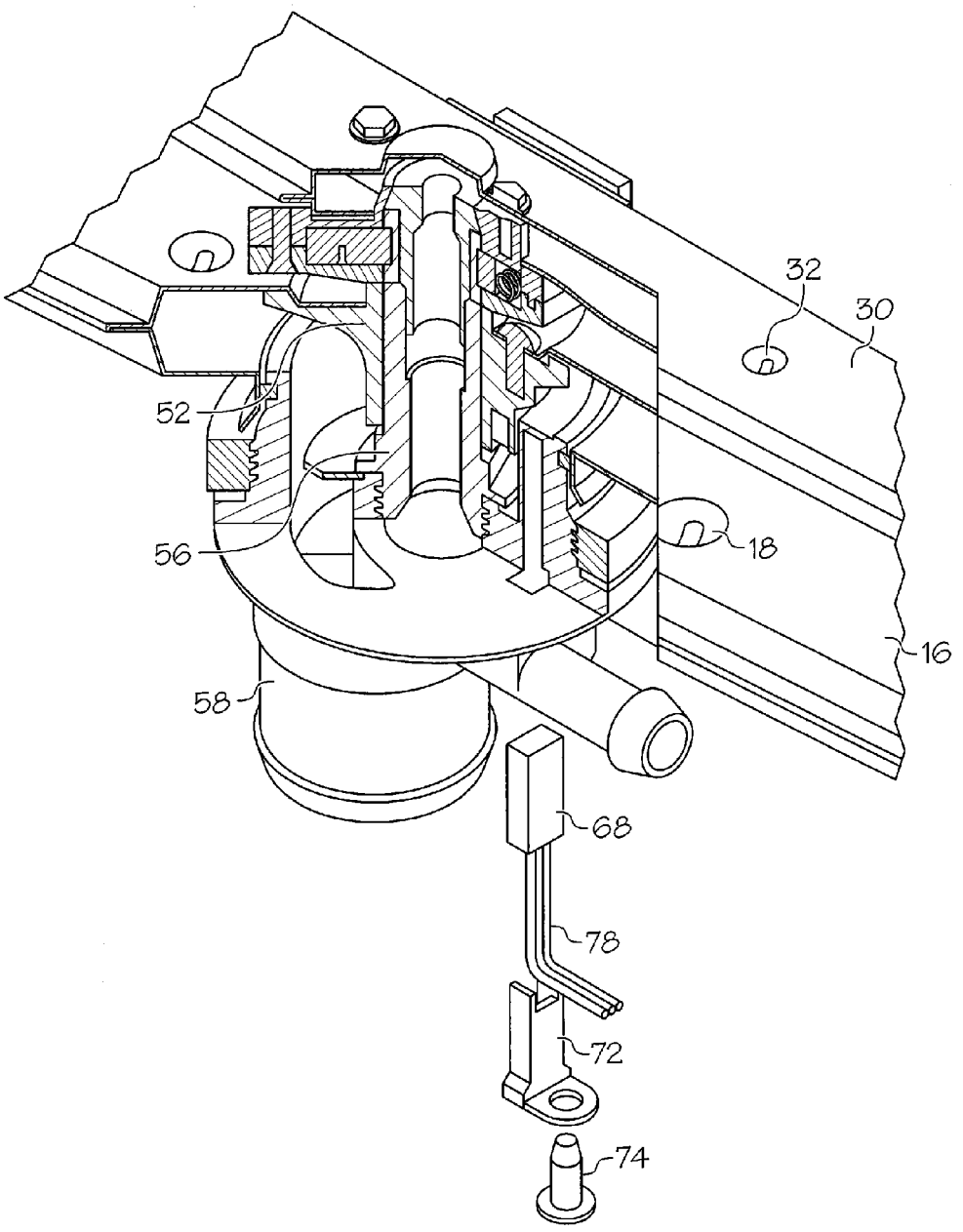


FIG. 2

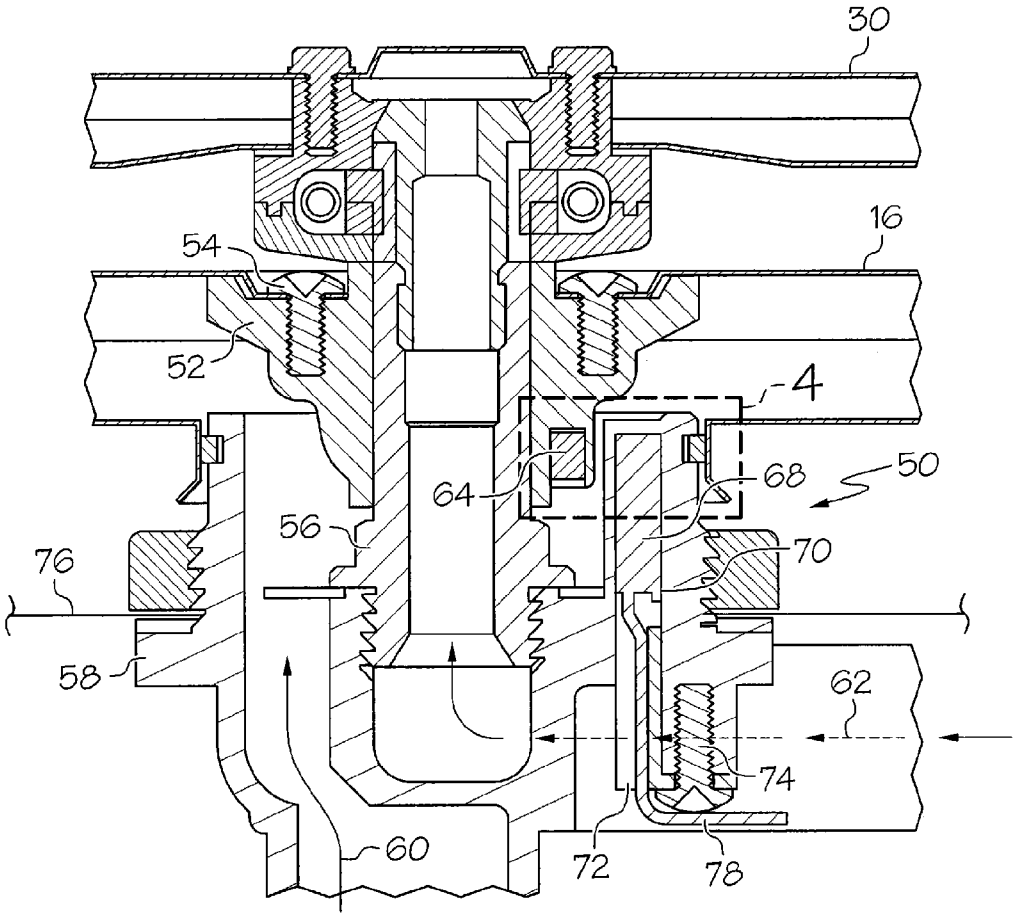


FIG. 3

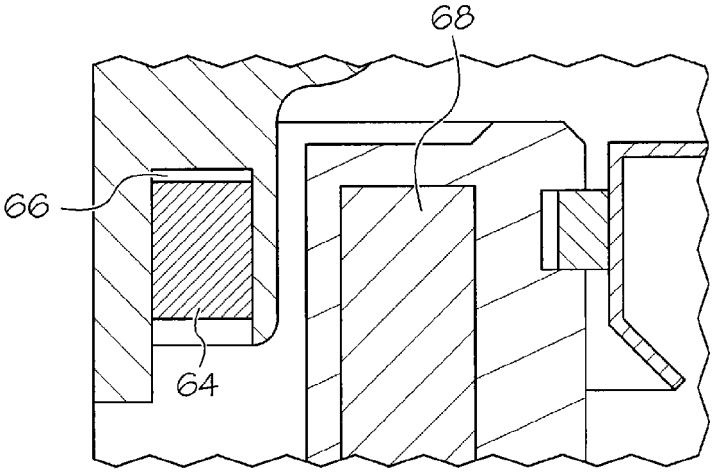


FIG. 4

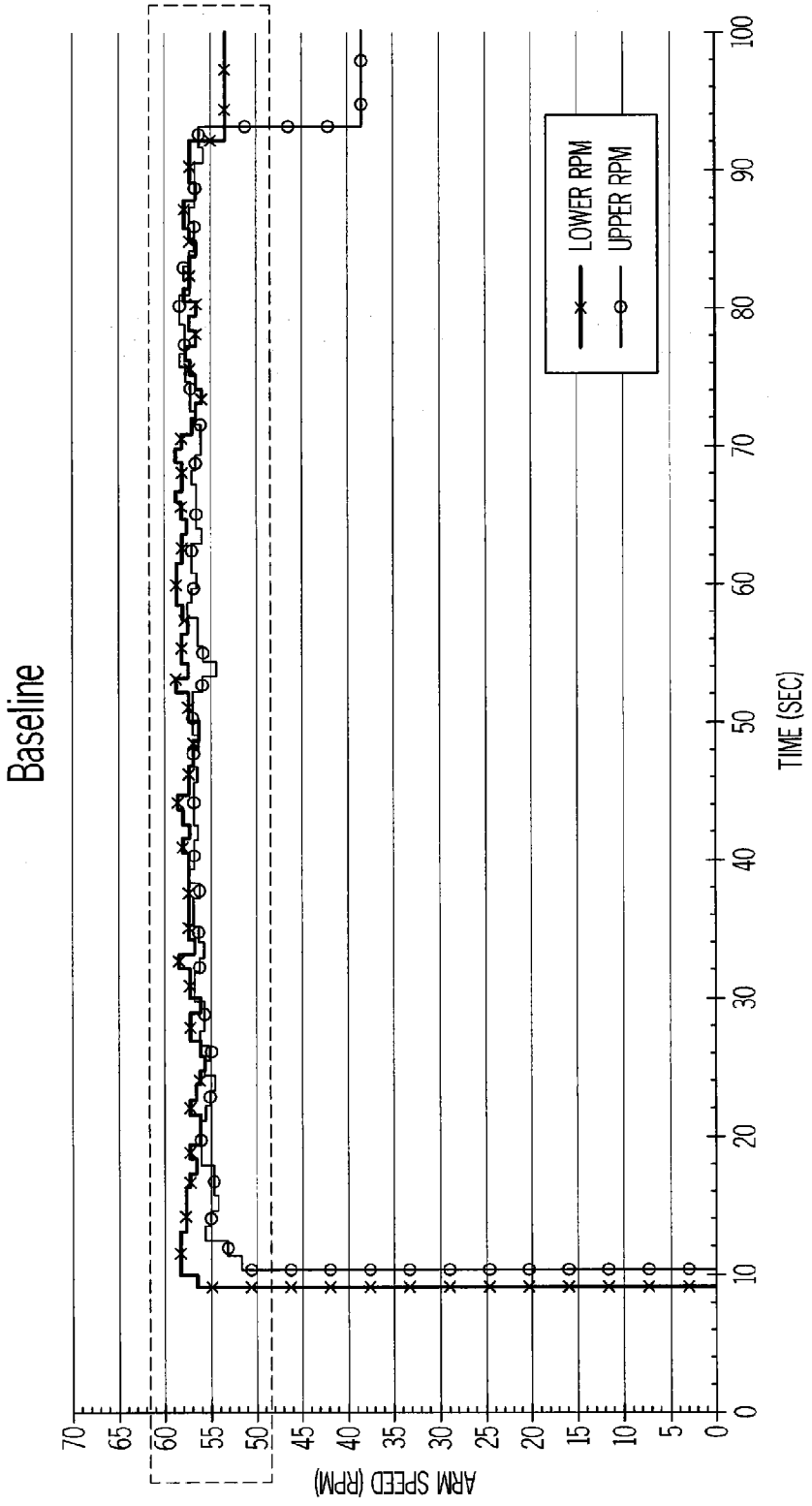

Baseline
ARM SPEED (RPM)
TIME (SEC)
LOWER RPM
UPPER RPM
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

FIG. 5

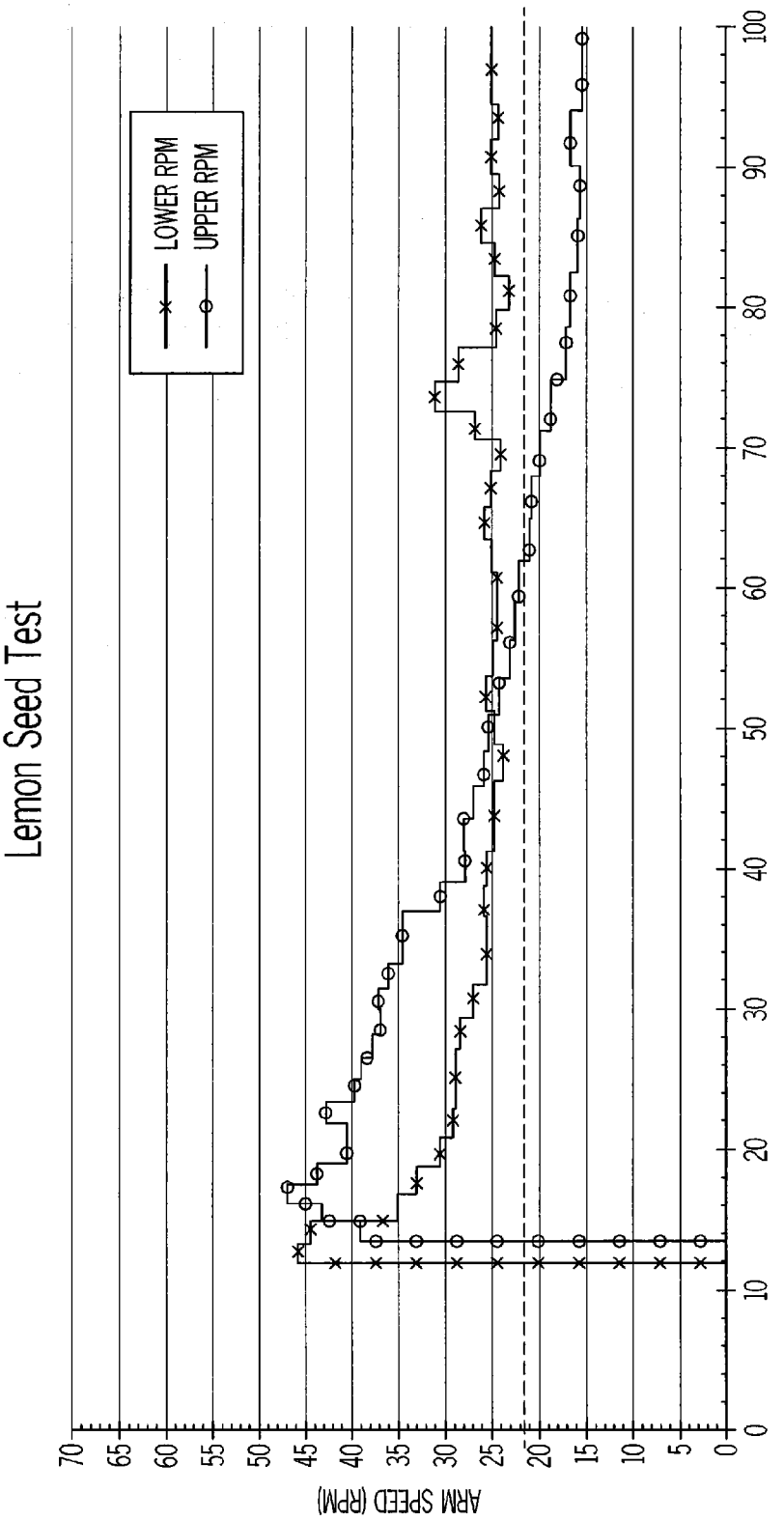

Lemon Seed Test
LOWER RPM
UPPER RPM
ARM SPEED (RPM)
TIME (SEC)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
0
10
20
30
40
50
60
70
80
90
100

FIG. 6

WAREWASH MACHINE SYSTEM AND METHOD FOR DETECTING CLOGGED WASH ARM

CROSS-REFERENCES

[0001] This application claims the benefit of U.S. Provisional Application Ser. No. 61/691,571, filed Aug. 21, 2012, which is incorporated herein by reference.

TECHNICAL FIELD

[0002] This application relates generally to the field of warewasher machines with rotation wash arms and, more specifically, to a system and method for anticipating adverse clogging of the rotating wash arm of such a warewash machine.

BACKGROUND

[0003] On a stationary warewasher or dishwasher (e.g., a batch-type or box-type dishwasher), wash arms located on the top and/or bottom of the washing chamber 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. These nozzles are arranged and oriented to both rotate the arms and to spray liquid onto the wares throughout the rack. Certain nozzles may be arranged for the sole purpose of providing jets to turn the arm. The wash arm nozzles are sized, located and balanced to provide desired washing performance. If debris such as citrus seeds, broken glass, paper napkin pieces, etc. gets passed through the wash system strainers and into the wash arms, wash performance can be affected. Nozzles can get clogged and either plug completely or become choked causing the flow out of the nozzle to be reduced and erratic, spraying in different directions. The wash arm hub can become choked as well. When the wash arms become clogged, the cleaning operation is adversely affected.

[0004] Various systems for monitoring wash arms have been suggested in the past. For example, U.S. Patent Publication No. 2008/0186170 describes the use of a detection device that detects rotation and/or presence of a spray arm in a dishwasher. In one implementation the detection device emits electromagnetic radiation and the spray arm includes a RFID transponder element that responds to a querying signal from the detection device. DE Patent Publication No. 101 21 083 describes a dishwashing machine with a sensor to detect the rotation of a spray arm. According to the background section of the above-noted U.S. Patent Publication No. 2008/0186170, DE 101 21 083 describes a permanent magnet at the tip of a spray arm and a Hall sensor arranged in the machine to detect the passing of the permanent magnet so as to determine rotation speed and position of the spray arm. U.S. Pat. No. 5,681,401 describes the use of a microphone wash arm sensor (e.g., acoustic sensor) in a dishwasher to determine the rotational speed of the wash arm by detecting the sound caused by the impingement stream of liquid form the wash arm. French Patent Publication No. 2 663 833 describes a dishwasher having a sensor that detects motion of the spray arm. The sensor operates by detecting the spray from the spray arm as it impinges upon a membrane associated with the sensor. The English language abstract for DE 40208098 states that a permanent magnet could be located at the end of a spray arm to work on the magnetic field of a contact switch, or the end of the arm could be metal that would be detected by a Hall sensor. U.S. Pat. No. 6,675,818 teaches the use of a radar sensor in a dishwasher that can be used to detect, among other things, whether a spray arm is rotating. U.S. Pat. No. 7,250,087 relates to detecting clogged nozzles utilizing specific sound analyzing techniques.

[0005] Notwithstanding the above-mentioned prior art, improved techniques for monitoring rotating wash arms are sought. What is needed is a wash arm detecting system that can predict wash arm clogging in advance of the machine reaching a state of excessively poor cleaning conditions.

SUMMARY

[0006] In one aspect, a method is provided for automated operation a warewash machine that includes a chamber for receiving wares to be washed, a wash arm mounted for rotation within the chamber and including multiple nozzles for spraying wash liquid. The method involves: delivering a recirculated wash liquid to the wash arm for spraying during a ware cleaning operation; monitoring rotational speed of the wash arm during the delivering step; comparing the monitored rotational speed to a set threshold speed that is greater than zero speed; and if the monitored rotational speed falls below the set threshold speed, triggering an operator alert to advise the machine operator to check the wash arm.

[0007] In one implementation of the method of the preceding paragraph, the set threshold speed corresponds to a speed above which wares are adequately cleaned and below which wares are not adequately cleaned as determined by prior testing.

[0008] In one implementation of the method of either of the two preceding paragraphs, the monitoring step is carried out utilizing a magnet located on a rotatable hub member to which the wash arm is mounted and a magnetic detector mounted in a manifold that feeds water to the wash arm.

[0009] In one implementation of the method of the preceding paragraph, the manifold includes a first portion internal of the chamber and a second portion external of the chamber, and the magnetic detector is mounted into the manifold through a slot or opening that is accessed via the second portion and that extends up into the first portion.

[0010] In one implementation of the method of the any one of the four preceding paragraphs, a controller of the machine is configured such that the operator alert is only communicated after the ware cleaning operation is completed.

[0011] In one implementation of the method of the any one of the five preceding paragraphs, the machine includes multiple wash arms and the operator alert identifies a specific one of the wash arms that should be checked.

[0012] In one implementation of the method of the any one of the six preceding paragraphs, the machine includes multiple wash arms that are monitored, and each wash arm has a corresponding set threshold speed stored in memory of a controller of the machine.

[0013] In another aspect, a warewash machine includes a chamber for receiving wares to be washed, the chamber accessible via a door. A wash arm is located in the chamber, the wash arm mounted to a rotatable hub member. The wash arm includes multiple nozzles for spraying recirculated wash liquid, and the rotatable hub member includes a trigger element thereon. A manifold delivers wash liquid to the wash

arm. The manifold includes a detector positioned for detecting the trigger element as it rotates past the detector. A controller is connected with the detector to monitor wash arm rotational speed. The controller is configured to responsively identify a clogged or potentially clogged condition of the wash arm.

[0014] In one implementation of the warewash machine of the preceding paragraph, the trigger element is a magnet and the detector is a magnetic detector. In an alternative implementation, the trigger element is an RF element and the detector is an RF detector.

[0015] In one implementation, the manifold includes a first portion internal of the chamber and a second portion external of the chamber, and the detector is mounted into the manifold through a slot or opening that is accessed via the second portion and that extends up into the first portion.

[0016] In one implementation of the machine according to any one of the three preceding paragraphs, the controller is configured to compare the monitored rotational speed to a set threshold speed and, if the monitored rotational speed falls below the set threshold speed, to trigger an operator alert to advise the machine operator to check the wash arm.

[0017] In one implementation of the machine of the preceding paragraph, the set threshold speed corresponds to a speed above which wares are adequately cleaned and below which wares are not adequately cleaned.

[0018] In one implementation of the machine of either of the two preceding paragraphs, the controller is configured such that the operator alert is only delivered after a ware cleaning cycle is completed so to limit the likelihood that the machine operator will stop the machine during the ware cleaning cycle.

[0019] The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. **1** is schematic depiction of a batch-type warewasher;

[0021] FIG. **2** is partially exploded view of a manifold, wash arm and rinse arm configuration;

[0022] FIG. **3** is a partial cross-section of the configuration of FIG. **2**;

[0023] FIG. **4** is an enlarged view of the designated area of FIG. **3**;

[0024] FIG. **5** is a graph showing baseline speed determination for wash arms; and

[0025] FIG. **6** is a graph showing speed degradation experienced by clogged wash arms.

DETAILED DESCRIPTION

[0026] Referring to FIG. **1**, a schematic depiction of a batch-type warewasher **10** is shown, and includes a chamber **12** in which wares are placed for cleaning via opening of a pivoting access door **14**. At the bottom of the chamber **12**, a rotatable wash arm **16** is provided and includes multiple nozzles **18** that eject wash liquid during a cleaning operation. The wash liquid contacts the wares for cleaning and then falls back down into a collection sump **20** that may include a heater element **22**. A recirculation path is provided via piping **24**, pump **26** and piping **28** to move the wash liquid back to the wash arm **16**. A rotatable rinse arm **30** with nozzles **32** is also shown, to which fresh rinsing liquid may be fed via a rinse line made up of fresh water input line **34**, valve **36**, boiler **38** and line **40**. A controller **42** is also shown, which may typically be programmed to carry out one or more selectable ware cleaning cycles that generally each include at least a washing step (e.g., that may run for 30 -150 seconds, followed by a rinsing step (e.g., that may run for 7-30 seconds), though many other variations are possible. Although the illustrated machine **10** includes only lower arms, such machines may also include upper wash and rinse arms shown schematically as **44** and **46**. Such machines may also include other features, such as blowers for a drying step at the end of a ware cleaning cycle. Machines with hood type doors, as opposed to the illustrated pivoting door, are also known.

[0027] The present system is used to sense when a rotating wash arm (e.g., **16**) has become, or is becoming, clogged with debris and notifies the user of this situation. The system can also notify the user if the rotating wash arm stops due to an obstruction. The system utilizes a sensor that measures the rotational speed of the wash arm and logic (e.g., programmed in controller **42**) that analyzes the speed measurements to determine when the speed characteristics of the wash arm have changed enough, due to wash arm fouling, to impact washing performance. The system may also sense when a wash arm has stopped, either due to fouling or an obstruction, which also impacts washing performance.

[0028] Referring now to FIGS. **2-4**, a magnet and detector arrangement **50** is shown. As best seen in the cross-section of FIG. **3**, the wash arm **16** is secured to a hub member **52** (e.g., via fasteners **54**). The hub member **52** is rotatably positioned on a tube **56** that feeds water to the above rinse arm and has a lower end threadedly connected to a manifold **58**. The manifold **58** is secured to a wall **76** of the chamber (e.g., with an upper portion of the manifold positioned within the chamber and a lower portion of the manifold external of the chamber). The manifold **58** has a flow path **60** that delivers wash liquid to the wash arm **16** and a flow path **62** that delivers fresh rinse liquid to the tube **56** and on to the rinse arm **30**. A magnet **64** is embedded in the hub member **52** and rotates with the hub member. The hub member may be of a plastic material that is overmolded onto the magnet **64**. Alternatively, the hub member **64** may be molded with a slot **66** for the magnet, the magnet later inserted in the slot **66** and then a sealant material (e.g., the same or similar plastic or a different material) applied to hold the magnet in placed. A magnetic detector **68** (e.g., a reed switch or Hall effect sensor) is mounted in the manifold in a position to detect the magnet passing thereby during rotation of the hub member **52**. Notably, the manifold **58**, which may be of plastic material, is configured with a slot **70** for receiving the detector **68**. In the illustrated embodiment, a detector mount bracket **72** and fastener **74** are used to hold the detector **68** in place, with the entire assembly being insertable into the slot **70** from the underside of the manifold **58**. In this regard, access to the slot **70** is provided from below the wall **76** that defines the chamber so that the detector assembly can be readily accessed from below the chamber and so that the detector **68** and its leads **78** remain outside of the area where any water travels or is sprayed, preventing fouling and/or corrosion etc. In the case of an upper arm, such access would be from above the upper wall of the chamber. In some instances, existing machines could be modified to include the wash arm detecting system by swapping out the existing manifold and arm assembly of the machine for the new manifold **58** with detector and hub member **52** with

magnet **64**, along with any necessary updating of the program logic of the controller of the existing machine.

[0029] Testing has shown that as the wash arm nozzles get plugged, the rotational speed of the wash arm will be reduced. When the arm is plugged enough to cause a noticeable reduction in washing performance, the rotational speed of the wash arm is well below the typical speed range for a clean wash arm. The system described here monitors the rotational speed of the wash arms and if the speed reduces to a threshold where testing has shown that washing performance will be affected, the user is notified that there is a clogging issue with the wash arm that needs to be addressed. In certain implementations, the system could also differentiate between a slowed wash arm or a stopped wash arm, which could be due to an obstruction, such a piece of ware falling out of the rack.

[0030] Referring now to FIG. **5**, a baseline speed for the wash arm(s) of a washing machine can be established by testing the machine when it is known to be clean. In the illustrated graph baseline speed for both a lower and upper wash arm of one machine example are determined to generally be in a range 80 of about 50-60 RPM. In other machine examples, the baseline speed could vary (e.g., such as anywhere between about 25-75 RPM depending upon the machine). Referring to FIG. **6**, subsequent testing was conducted utilizing lemon seeds in the system, and the impact of the plugging of nozzles with the seeds is readily apparent by the illustrated degradation of the wash arm speed. Repeated testing of the system in various states of wash arm nozzle plugging, corresponding wash arm RPM and resulting cleaning effectiveness can be used to identify a threshold low performance wash arm speed limit 82 below which the cleaning effectiveness of the machine becomes unacceptable. Although the foregoing description primarily discusses clogging or plugging of the wash arm nozzles that limits flow through the nozzles, it is contemplated that the detecting system and method is applicable to other types of wash arm clogging or plugging, such as clogging or plugging of a flow path within the wash arm or that feeds the wash arm or clogging or plugging of the bearing area of the arm that acts to hinder rotation of the arm.

[0031] The controller **42** is programmed to utilize the defined threshold speed 82 during washing operations and alert the operator via a user interface **43** (see FIG. **1**) that the wash arm or arms need cleaning. Where the machine includes multiple wash arms, the alert may focus the machine operator on the specific wash arm that needs to be checked. In one implementation the interface **43** may be a display on which a verbal message may be provided to clean the upper and/or lower wash arms. In another implementation the interface **43** may include a simpler light annunciator (e.g., one light for the upper wash arm and one light for the lower wash arm) and/or audible annunciator that alerts the operator. Regardless of the implementation, in one embodiment it is desired to wait until the end of the washing cycle to alert the operator so that the current washing cycle completes without interruption. In such an embodiment, the alert is only delivered after the current washing cycle is completed (e.g., immediately after completion or some time later, such as before the next washing cycle is initiated). In machines with multiple wash arms, the threshold speed may be the same for both wash arms or may be different as between the wash arms.

[0032] 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. For example, while a magnet and magnetic detector are primarily described, an RF element could be used on the hub and an RF detector mounted in the manifold. Likewise, other trigger element and detector combinations could be used. Moreover, although rotating wash arms are primarily used in stationary-type machines as in the described embodiment above, it is recognized that the detection systems and methods could be implemented in versions of continuous-type machines (e.g., a machine having an elongated chamber with multiple spray zones through which wares are moved via a ware conveying system) that might incorporate one or more rotating wash arms.

What is claimed is:

1. A method of automated operation of a warewash machine that includes a chamber for receiving wares to be washed, a wash arm mounted for rotation within the chamber and including multiple nozzles for spraying wash liquid, the method including:

delivering a recirculated wash liquid to the wash arm for spraying during a ware cleaning operation;

monitoring rotational speed of the wash arm during the delivering step;

comparing the monitored rotational speed to a set threshold speed that is greater than zero speed; and

if the monitored rotational speed falls below the set threshold speed, triggering an operator alert to advise the machine operator to check the wash arm.

2. The method of claim **1** wherein the set threshold speed corresponds to a speed above which wares are adequately cleaned and below which wares are not adequately cleaned as determined by prior testing.

3. The method of claim **1** wherein the monitoring step is carried out utilizing a magnet located on a rotatable hub member to which the wash arm is mounted and a magnetic detector mounted in a manifold that feeds water to the wash arm.

4. The method of claim **3** wherein the manifold includes a first portion internal of the chamber and a second portion external of the chamber, and the magnetic detector is mounted into the manifold through a slot or opening that is accessed via the second portion and that extends up into the first portion.

5. The method of claim **1** wherein a controller of the machine is configured such that the operator alert is only communicated after the ware cleaning operation is completed.

6. The method of claim **1** wherein the machine includes multiple wash arms and the operator alert identifies a specific one of the wash arms that should be checked.

7. The method of claim **1** wherein the machine includes multiple wash arms that are monitored, and each wash arm has a corresponding set threshold speed stored in memory of a controller of the machine.

8. A warewash machine, comprising:

a chamber for receiving wares to be washed, the chamber accessible via a door;

a wash arm in the chamber, the wash arm mounted to a rotatable hub member, the wash arm including multiple nozzles for spraying recirculated wash liquid, the rotatable hub member including a trigger element thereon;

a manifold for delivering wash liquid to the wash arm, the manifold including a detector positioned for detecting the trigger element as it rotates past the detector;

a controller connected with the detector to monitor wash arm rotational speed, the controller configured to responsively identify a clogged or potentially clogged condition of the wash arm.

9. The warewash machine of claim **8** wherein the trigger element is an RF element and the detector is an RF detector.

10. The warewash machine of claim **8** wherein the trigger element is a magnet and the detector is a magnetic detector.

11. The warewash machine of claim **10** wherein the manifold includes a first portion internal of the chamber and a second portion external of the chamber, and the magnetic detector is mounted into the manifold through a slot or opening that is accessed via the second portion and that extends up into the first portion.

12. The warewash machine of claim **8** wherein the controller is configured to compare the monitored rotational speed to a set threshold speed and, if the monitored rotational speed falls below the set threshold speed, to trigger an operator alert to advise the machine operator to check the wash arm.

13. The warewash machine of claim **12** wherein the set threshold speed corresponds to a speed above which wares are adequately cleaned and below which wares are not adequately cleaned.

14. The warewash machine of claim **12** wherein the controller is configured such that the operator alert is only delivered after a ware cleaning cycle is completed so to limit the likelihood that the machine operator will stop the machine during the ware cleaning cycle.

15. A warewash machine, comprising:

a chamber for receiving wares to be washed, the chamber accessible via a door;

a wash arm in the chamber, the wash arm mounted to a rotatable hub member, the wash arm including multiple nozzles for spraying recirculated wash liquid, the rotatable hub member including a trigger element thereon;

a manifold for delivering wash liquid to the wash arm, the manifold including a detector positioned for detecting the trigger element as it rotates past the detector, wherein the manifold includes a first portion internal of the chamber and a second portion external of the chamber, and the detector is mounted into the manifold through a slot or opening that is accessed via the second portion and that extends up into the first portion so that the detector can be accessed and/or replaced from external of the chamber;

a controller connected with the detector to monitor wash arm rotational speed.

16. The warewash machine of claim **12** wherein the trigger element is an RF element and the detector is an RF detector.

17. The warewash machine of claim **12** wherein the trigger element is a magnet and the detector is a magnetic detector.

19. The warewash machine of claim **12** wherein the controller is configured to compare the monitored rotational speed to a set threshold speed and, if the monitored rotational speed falls below the set threshold speed, to trigger an operator alert to advise the machine operator to check the wash arm.

20. The warewash machine of claim **19** wherein:

the set threshold speed corresponds to a speed above which wares are adequately cleaned and below which wares are not adequately cleaned; and

the controller is configured such that the operator alert is only delivered after a ware cleaning cycle is completed so to limit the likelihood that the machine operator will stop the machine during the ware cleaning cycle.

* * * * *