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(54) **METHOD FOR AUTOMATICALLY EVALUATING THE PRESENCE OF FOAM IN A DISHWASHING MACHINE**

(57) The present disclosure relates to a method for automatically evaluating the presence of foam in a dishwashing machine (1) provided with optical devices (8), the method comprising the steps of: acquiring (11) a first digital image (11A) representative of a first condition of the washing fluid collection zone (2'') of the dishwashing machine (1); digitally processing (12) the first digital image (11A) so as to obtain a first processed image (11B) which identifies the value of a first volume of fluid contained in the washing fluid collection zone (2''); acquiring (13) a second digital image (13A) representative of a second condition of the washing fluid collection zone (2'') after a predefined time interval from the performance of the step of acquiring (11) a first digital image (11A); digitally processing (14) the second digital image (13A) so as to obtain a second processed image (13B) that identifies a value of a second volume of fluid contained in the washing fluid collection zone (2''); comparing (15) the value of the first volume of fluid with the value of the second volume of fluid for calculating a value of fluid volume variation (DV); generating a foam presence signal (Sig) indicative of the presence of foam in the washing fluid collection zone (2''), when the value of fluid volume variation (DV) exceeds a predefined threshold value; modifying the cleaning parameters of the cleaning program (P) of the dishwashing machine (1) when the foam presence signal is generated.

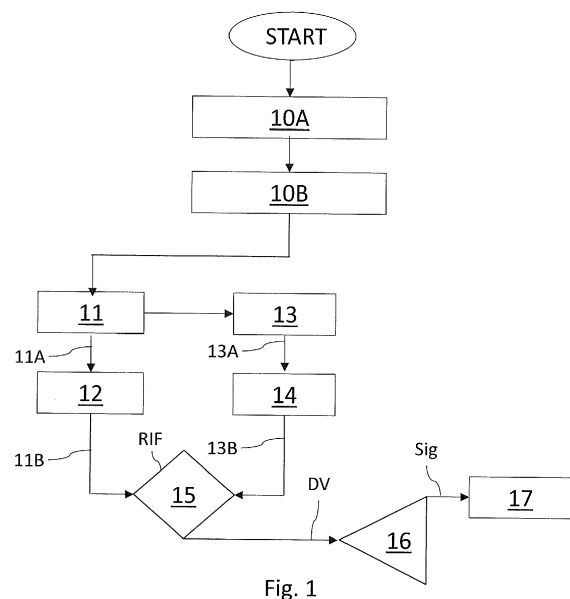


Fig. 1

## Description

### Field of application

**[0001]** The present description relates to a method for automatically evaluating the presence of foam in a dishwashing machine, according to the preamble of claim 1.

**[0002]** The present description also relates to a dishwashing machine configured to implement the method for automatically evaluating the presence of foam in a dishwashing machine, according to the preamble of claim 11.

**[0003]** The present description also relates to a system composed of a dishwashing machine and a portable device that can be gripped by a user and configured to implement the method for automatically evaluating the presence of foam in a dishwashing machine, according to the preamble of claim 14.

### Description of the prior art

**[0004]** Dishwashing machines are known in the state of the art that are provided with optical devices such as photo cameras, television cameras or video cameras arranged in a fixed or movable position with respect to the washing tank to check the weight of the dishes or the degree of cleanliness of the dishes.

**[0005]** For example, documents WO 2016008699 A1 and US 2012/0138092 A1 illustrate such dishwashing machines. Furthermore, document US 2005/028850 A1 describes a method for automatically evaluating the presence of foam in a dishwashing machine comprising a washing zone provided with an area intended for the collection of the washing fluid.

**[0006]** The use of a dishwasher as identified above envisages the loading of dishes into a washing zone thereof by the user and the use of a washing detergent.

**[0007]** Such detergent is usually positioned inside a dispenser which is provided with an appropriate door that opens automatically once the user has closed the door of the dishwasher and has started the pre-chosen wash program.

**[0008]** Among the various detergents currently available on the market, the following can be identified:

- powder detergent;
- liquid detergent;
- gel detergent;
- TABS;
- rinse aid, used to promote the drying of the dishes.

### Problem of the prior art

**[0009]** The types of detergent specified above have different chemical/physical characteristics with different chemical agents and variable solubility.

**[0010]** Current dishwasher wash programs that comprise the steps of loading water, heating, intensity and

duration of the washing and drying are calibrated by hypothesizing the use of a detergent having average characteristics. This implies that a specific type of detergent is used, and presupposes that the dishes inserted in the dishwasher do not contain any trace of other types of detergents or products able to generate foam in the dishwasher.

**[0011]** However, it is possible that during use a series of undesired conditions arise that could promote the formation of foam inside the washing zone of the dishwashing machine. For example, some conditions that could cause the formation of foam during the washing cycle of the dishwasher are:

- use of an unsuitable detergent,
- leaks and/or spills of rinse aid after loading the doser,
- washing of dishes that are already clean that contain residues of detergent, and
- use of a higher quantity of detergent than the maximum level indicated.

**[0012]** The presence of foam inside the washing zone of the dishwashing machine can cause an increase in noise during the operation of the wash pump.

**[0013]** Additionally, the presence of foam can alter the normal performance of the washing cycle leading to deterioration of the washing performance.

**[0014]** Furthermore, in the event of the formation of foam in the washing zone, there is a concrete risk that, at the end of washing, there are residues of detergent on the dishes.

**[0015]** It is necessary to highlight that, in the event of the formation of an excessive amount of foam inside the washing zone, problems may arise in the operation of the dishwashing machine with a consequent risk of the product breaking down.

### SUMMARY OF THE INVENTION

**[0016]** The object of the invention in question is to overcome the drawbacks of the prior art.

**[0017]** A further object of the invention is that of realising a method, a dishwashing machine and a system for evaluating the presence of foam in a dishwashing machine so as to prevent the problems of the prior art described above.

**[0018]** Such objects are reached through a method, a dishwashing machine and a system for automatically evaluating the presence of foam in a dishwashing machine according to the following claims 1, 11 and 14, respectively.

### Advantages of the invention

**[0019]** Thanks to an embodiment of the present invention, it is possible to realize a method and related dishwashing machine and a dishwashing machine system and device that is portable by hand by a user that allows:

- any increase in noise of the dishwashing machine to be prevented,
- the washing performance to be optimized, and
- the cleanliness of the plates both from dirt and detergent to be guaranteed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0020]** The characteristics and advantages of the present disclosure will become clear from the following detailed description of a possible practical embodiment, illustrated by way of non-limiting example in the set of drawings, wherein:

- Figure 1 shows a flow diagram of the method according to the present invention;
- Figure 2 shows a schematic representation of the quadrant of a digitalized image obtained according to a step of the method of the present invention;
- Figure 3 shows a front perspective view of a dishwashing machine of the built-in type, without finishing panels, configured to perform the method of Figure 1;
- Figure 4 shows a rear perspective view of the dishwashing machine of Figure 2 without some of the components thereof and the dishes;
- Figure 5 shows a schematic lateral view of the dishwashing machine of figure 3;
- Figure 6 shows a flow diagram of the system according to the present invention.

#### DETAILED DESCRIPTION

**[0021]** Even when not explicitly highlighted, the individual characteristics described with reference to the specific embodiments must be considered as accessories and/or exchangeable with other characteristics, described with reference to other embodiments.

**[0022]** With reference to the appended figures 3, 4 and 5, 1 indicates a dishwashing machine, e.g. of the type built-in to a kitchen unit, free from finishing panels for better understanding of the internal volumes.

**[0023]** Such dishwashing machine 1 comprises a washing zone 2 and a door 3 that is associable in closure with the washing zone 2.

**[0024]** The dishwashing machine 1 identifies a base 1A, usually dedicated to housing the necessary mechanisms/devices for the performance of the main operations of the machine 1.

**[0025]** The washing zone 2 defines the volume inside which the dishes S are arranged.

**[0026]** In particular, the washing zone 2 is defined by a plurality of walls such as the base wall 2A, the side walls 2B and 2C, the top 2D and the bottom wall 2E and identifies an upper portion 2' and a lower portion 2".

**[0027]** The term upper/lower must be interpreted in light of the correct installation and condition of use of the dishwashing machine 1. In such scenario, the term upper

relates to the more distant part from the base 1A while the term lower relates to the more proximal part to the base 1A.

**[0028]** The door 3 can be activated by hand by the user and/or with an electrical servomechanism and has the aim of hermetically closing the washing zone 2 so as to prevent any losses of washing liquid during the performance of the cleaning program.

**[0029]** In the following description the term S means for example a plate, cutlery, a glass, a saucepan, etc..

**[0030]** The impellers 5A, 5B are of the type known *per se* and therefore shall not be described. It is worth highlighting here that there may be one or, preferably, two impellers 5A, 5B arranged in the washing zone 2. In particular, the lower impeller 5A is placed in the lower zone 2' in proximity to the base 1A and the upper impeller 5B in the upper zone 2", preferably in the lower part of the upper zone 2".

**[0031]** The lower zone 2' of the washing zone 2, when the dishwasher 1 is in use, identifies the collection zone of the washing fluid 2"". In particular, such washing fluid collection zone 2"" is interposed between the lower impeller 5A and the base wall 2A. With reference to figure 5, the washing fluid collection zone 2"" is configured as a washing water collection tank, first clean as it is sucked from the water mains network at the start of the cleaning cycle, and subsequently contaminated by the residues of detergent and dirt once the washing cycle has finished.

**[0032]** In the lower zone 2' and/or in the upper zone 2" a respective dish holder basket 21 is arranged which has the function of housing the various dishes S, according to techniques known in the art and therefore not described.

**[0033]** The term dish holder basket 21 means any device and/or accessory dedicated to the positioning thereof and therefore suitable for supporting the dishes S.

**[0034]** Such basket and/or accessories must be compatible with the dimensions of the washing zone 2 of the dishwashing machine 1.

**[0035]** The dishwashing machine 1 comprises a dispenser 6 conformed so as to define a suitable volume for housing the products or detergents necessary for cleaning objects, in particular dishes S.

**[0036]** Such dispenser 6 may comprise one or more compartments each intended to receive a specific washing product.

**[0037]** According to one aspect, the dispenser 6 comprises a door 7 that is configured to pass between a closed position and a free access position to the internal volume of the dispenser 6.

**[0038]** For example, in the closed position of the door 7 products are prevented from being able to exit from their respective compartments while in the open position of the door 7, such washing products can exit, once the door 3 is in its closed position and a wash program P has been selected with which to wash the dishes S.

**[0039]** In other words, the passage of the door 7 between the closed position and the open position is con-

trolled mechanically and/or electrically by the control unit 4 following the closure of the door 3 of the dishwashing machine 1.

**[0040]** According to one aspect, also with reference to Figures 3 and 4, the dispenser 6 is located on the door 3, in particular on the side facing towards the washing zone 2, at a predefined height. More in particular, the dispenser 6 is housed inside the thickness of the door 3.

**[0041]** The dishwashing machine 1 comprises a control unit 4, e.g. arranged in the thickness of the door 3 provided with a mother plate on which the usual electrical and electronic devices are housed which may include a CPU, a series of I/O ports for receiving and emitting data in a memory bank, the latter having a dedicated portion for permanently storing at least one cleaning program.

**[0042]** The cleaning program P is the result of one or a combination of more than one of the following parameters:

- duration of the washing step;
- pressure of the wash pump;
- temperature of the washing and drying steps;
- litres of water loaded.

**[0043]** The program P may also comprise other parameters that are not described here for description simplicity purposes.

**[0044]** The control unit 4 is a unit configured to control and monitor the operating functions of the dishwashing machine 1.

**[0045]** In one embodiment of the present invention, it is envisaged that in the memory of the control unit 4 a database is also permanently stored in which through appropriate parameters information is stored on the operating data collected by the sensors present inside the dishwashing machine. Various sensors will be described below intended to collect parameters within the dishwashing machine during the operation thereof, such as for example optical devices.

**[0046]** In order to allow the implementation of the selected cleaning program, the dishwashing machine 1 comprises a pump, e.g. arranged in the base 1A, which can be connected, according to techniques known to a person skilled in the art and therefore not described, with a mains water inlet.

**[0047]** Such pump is controlled by the control unit 4 and has the task of making water flow into the impellers 5A, 5B arranged inside the washing zone.

**[0048]** The dishwashing machine 1 comprises one or more optical devices 8 able to acquire digital images of the washing zone 2.

**[0049]** According to a preferred aspect of the invention, the optical devices 8 are arranged so that their optics are facing towards the washing fluid collection zone 2" which, as already mentioned before, is interposed between the lower impeller 5A and the base wall 2A.

**[0050]** In particular, each wall 2A, 2B, 2C, 2D and/or 2E of the washing zone 2 can each house, within their

thickness, one or more of the aforesaid optical devices 8.

**[0051]** For that purpose a seat 2F is provided for each optical device 8.

**[0052]** The seat 2F defines a suitable volume for housing the respective optical device and, preferably, to cover the optics of the optical device, a covering panel 8A is provided which is transparent to light.

**[0053]** Such covering panel 8A is, for example, made of glass or plastic or materials having similar technical properties.

**[0054]** The covering panel 8A is preferably arranged so as to be substantially flush or slightly projecting from the surface of the wall 2A, 2B, 2C, 2D or 2E.

**[0055]** According to a preferred embodiment illustrated schematically in figure 5, the optical devices 8 are housed inside respective seats 2F obtained in the body of the dishwashing machine 1 at the washing fluid collection zone 2". Preferably, the washing fluid collection zone 2" is configured like a collection tank for the washing liquid which has a bottom wall F and a side wall LT (or various side walls) that define a container for collecting liquids.

**[0056]** With particular reference to figure 5, the seat 2F, in which one or more respective optical devices 8 are housed, is obtained in the thickness of the side wall LT of the washing fluid collection zone 2", so that the optical device 8 is able to transversally scan the washing fluid collection zone 2", e.g. to acquire images of a predefined quadrant Q. Coherently, the covering panel 8A is substantially arranged flush with the side wall LT of the washing fluid collection zone 2". Alternatively, according to an example not shown in detail in the appended figures, the seat 2F can be obtained in the thickness of the top 2D of the dishwashing machine 1.

**[0057]** All the electrical and electronic elements necessary for the operation of the optical device 8 are arranged in each seat 2F. Such arrangement is advantageous considering that it allows the optical device 8 to frame the washing fluid collection zone 2" during the entire washing cycle.

**[0058]** For example, still with reference to Figures 2 and 5, it can be noted that the optical device 8 has an optical field of view that allows the images of the washing fluid collection zone 2" that fall within such field of view, i.e. in a predefined quadrant Q, to be acquired.

**[0059]** The purpose of the optical devices 8 used in the dishwashing machine 1 is that of acquiring 2D images that are fixed and/or in sequence, at predetermined capture speeds, such as for example a single photogram, or a burst of images, or an uninterrupted flow of images of the washing fluid collection zone 2".

**[0060]** In particular, the optical devices 8 acquire the images of the washing liquid seen transversally from the side wall LT of the washing fluid collection zone 2", so as to display and clearly identify at least the line of the level reached by the surface of the washing liquid.

**[0061]** It is worth highlighting that the aforesaid optical devices 8 preferably acquire the images of the washing fluid collection zone 2" throughout the whole washing

cycle, at pre-established time intervals or with a pre-defined acquisition frequency.

**[0062]** Such optical devices 8 are in signal communication with the control unit 4 through its I/O ports in order to send the data acquired to the control unit 4.

**[0063]** Such optical devices 8, for example, are embodied in a photo camera and/or a video camera. Such devices are known in the sector and therefore will not be described in detail in the present description.

**[0064]** In the present description it is however worth highlighting that the photo camera and/or video camera, which can be used in the dishwashing machine 1 are preferably able to acquire images with lower acquisition times than a tenth of a second and adhere to the technical specifications according to which their operation is guaranteed also in the presence of water, i.e. the photo camera and/or video camera comply with the standard IP x(1-8).

**[0065]** Alternatively, or in combination with such technical specifications, it is envisaged that the seat 2F, within which the optical devices 8 are arranged, is configured so as to be hermetic to water, e.g. using sealing techniques.

**[0066]** The dishwashing machine 1 comprises a user interface 9, i.e. the command and control interface through which the user can control and manage the operations and functions of the dishwashing machine itself.

**[0067]** For that purpose, the user interface 9 is in signal communication with the control unit 4 through its I/O ports in order to receive the data processed by the CPU of the control unit 4 itself.

**[0068]** In one embodiment, the user interface 9 is a screen 23 integrated into the dishwashing machine 1 so that it can be visible to a user during its normal use and/or with the addition of a buzzer (not shown in the figure).

**[0069]** According to one aspect, with reference to figures 3 and 4, the user interface 9 is integrated into the door 3 so that the screen faces the washing zone 2 externally.

**[0070]** It is worth highlighting that the screen 23 of the user interface 9 is configured to display luminous indications, text messages and/or single or continuous images. In particular, the images that can be displayed on the screen may be images of the washing zone 2 and of the related objects provided there acquired by the optical devices 8.

**[0071]** In particular, the screen may be of the touch type.

**[0072]** In another embodiment, the user interface 9 comprises one or more analog buttons and/or a combination of analog/digital controls and/or a combination of analog/digital controls and a screen, the latter for example of the touch type.

**[0073]** The buzzer of the user interface 9 has the aim of reporting any operating conditions or situations to the user through an acoustic signal.

**[0074]** In one embodiment, the dishwashing machine 1 comprises a radio transceiver device which is config-

ured to create a signal communication with a wired and/or wireless network. For example, the wireless network may be a network based on an internet protocol through a WI-FI connection or a WPAN: (Wireless Personal Area Network) based on Bluetooth protocol.

**[0075]** In this hypothesis, the user interface 9 also comprises a portable device (i.e. transportable or graspable by a hand of a user) 22 such as, for example, a smartphone, a tablet, a pc or similar instruments.

**[0076]** In other words, the user interface 9 comprises both the usual control interface of the dishwashing machine 1 and the screen of the transportable device 22.

**[0077]** In particular, the portable device 22 comprises its own radio transceiver device which is configured to establish a signal communication with the radio transceiver of the dishwashing machine 1.

**[0078]** According to one aspect, the portable device 22 as well as being able to communicate with the control unit 4 of the dishwashing machine 1 can also connect through the internet, e.g. through GSM infrastructure, with one or more remote servers 24 in order to perform the archiving, saving and/or processing operations of data on the images acquired by the optical devices 8.

**[0079]** In other words, the portable device 22 is suitable to connect both directly with the dishwashing machine 1 and with the internet through the GSM infrastructure. In such scenario, therefore, a system 25 is configured comprising the dishwashing machine 1, the portable device 22 in signal communication between them through GSM network, WI-FI connection and/or a WPAN network.

**[0080]** It is worth highlighting that the screen of the portable device 22 is configured to display luminous indications, text messages and/or images acquired from the optical devices 8.

**[0081]** In one embodiment of the present invention, if the user interface 9 also comprises the portable device 22 then it is envisaged that the database may be stored at least partially, preferably completely, in the memory of the portable device 22, in a mass memory of the server and/or, in distributed mode, between the memory of the dishwashing machine 1, of the portable device 22 and of the server 23.

**[0082]** According to one aspect, the control unit 4 is in signal communication with the user interface 9 (whether it is in the form of the actual screen only of the dishwashing machine 1 or that of the screen of the portable device 22) in order to be able to signal through the user interface 9 the presence of foam in the dishwasher 1 and/or the modifications made to one or more of said cleaning parameters of the cleaning program P.

**[0083]** The term one or more of said cleaning parameters of the cleaning program P means in the present description any change to the parameters of the program P following the identification of the presence of foam in the dishwashing machine.

**[0084]** With reference now to Figure 1, the method for automatically evaluating the presence of foam in a dishwashing machine 1, preferably comprises a step 10A of

supplying detergent into the dispenser 6, i.e. it envisages that the user positions in the compartment of the dispenser 6 the detergent selected by him/her.

**[0085]** Preferably, the method comprises a step 10B of automatically filling the washing fluid collection zone 2''' with clean water sucked from the water supply network connected to the dishwashing machine 1.

**[0086]** It is worth highlighting that the steps of the method described herein below, the acquisition and processing steps, may be performed either directly by the CPU of the control unit 4 or, more preferably, by the CPU of the portable device of the user also through internet connection with the CPU of remote servers used for the analysis and processing of the data.

**[0087]** Once the door 7 of the dispenser 6 has been brought into the closed position, the program P has been selected through the interface 9 and the door 3 of the dishwashing machine 1 has been brought into the closed position, the method comprises the step 11 of acquiring a first digital image 11A representative of a first condition of the washing fluid collection zone 2'''.

**[0088]** Such acquisition step 11 is performed through the optical device(s) 8 provided inside the washing zone 2. For that purpose, the control unit 4 monitors the acquisition step by controlling the optical device(s) 8.

**[0089]** The method also comprises the step of digitally processing 12 the first digital image 11A so as to obtain a first processed image 11B, in which the first processed image 11B identifies a value of a first volume of fluid contained in the washing fluid collection zone 2'''. It is necessary to specify that the first processed image 11B identifies a value representative of the first volume of fluid contained in the washing fluid collection zone 2''', i.e. of the volume of fluid present in the washing fluid collection zone 2'''. Obviously, the volume of fluid may comprise both the volume occupied by a liquid fluid such as water, and that occupied by a fluid in the at least partially gaseous state, such as in the case of foam.

**[0090]** The method comprises a step of acquiring 13 a second digital image 13A representative of a second condition of the washing fluid collection zone 2''' after a predefined time interval from the performance of the step of acquiring 11 a first digital image 11A. Preferably, the step of acquiring 13 a second digital image 13A is performed after the release of the detergent into the washing fluid collection zone 2''' and/or after activation of the washing pump at regular time intervals, preferably at intervals of a minute or more.

**[0091]** The method further comprises the step of digitally processing 14 the second digital image 13A so as to obtain a first processed image 13B, in which the second processed image 13B identifies a value of a second volume of fluid contained in a washing fluid collection zone 2'''. Also in this case it is necessary to specify that the second processed image 11B identifies a value representative of the second volume of fluid contained in the washing fluid collection zone 2''', i.e. of the volume of fluid present in the washing fluid collection zone 2'''. Obvious-

ly, the volume of fluid comprises both the volume occupied by a liquid fluid such as water, and that occupied by a fluid in the at least partially gaseous state, such as in the case of foam.

**[0092]** The method comprises the step of comparing 15 the first processed image 11B with the second processed digital image 13B, i.e. the value of the first volume of fluid with the value of the second volume of fluid, to calculate a value of fluid volume variation DV between the first condition and the second condition of said washing fluid collection zone 2'''.

**[0093]** Additionally, the method comprises a step of generating 16 a foam presence signal Sig indicative of the presence of foam in the washing fluid collection zone 2''', when the value of fluid volume variation DV exceeds a predefined threshold value.

**[0094]** The method also comprises the step of modifying 17 the cleaning parameters of the cleaning program P of the dishwashing machine 1 when the foam presence signal Sig is generated.

**[0095]** According to a preferred solution of the invention, the first digital image 11A is representative of a first condition of the washing fluid collection zone 2''' before the activation of the wash pump. In particular, the image 11A is acquired, alternatively, before the filling step 10B of the washing fluid collection zone 2''' with clean water, or after such step when the washing fluid collection zone 2''' is filled with clean water (in both cases, before the activation of the wash pump). Preferably, the method comprises a step of automatically activating the wash pump. Furthermore, the second digital image 13A is representative of a second condition of the washing fluid collection zone 2''' after a predefined time interval following the wash pump activation step.

**[0096]** According to an embodiment of the invention described above, the method comprises the step of automatically filling 10B the washing fluid collection zone 2''' with clean water. In that case, the first digital image 11A is preferably representative of a first condition of the washing fluid collection zone 2''' in which the washing fluid collection zone 2''' contains clean water. Furthermore, the second digital image 13A is representative of a second condition of the washing fluid collection zone 2''' after a predefined time interval following the step of filling the washing fluid collection zone 2'''. According to an alternative form to the previous one, the method also comprises a step of automatically releasing a detergent into the washing fluid collection zone 2'''. In this case, the second digital image 13A is representative of a second condition of the washing fluid collection zone 2''' after a predefined time interval following the performance of the step of automatically releasing a detergent into the washing fluid collection zone 2'''.

**[0097]** According to a preferred embodiment of the invention, the first processed image 11B identifies a first level line L1 of the first volume of fluid contained in a washing fluid collection zone 2'''. Likewise, the second processed image 13B identifies a second level line L2 of

the second volume of fluid contained in the washing fluid collection zone 2". With particular reference to figures 3 and 5, it is worth highlighting that the level lines L1, L2 are the lines that define the surface of the fluid contained in the washing fluid collection zone 2", transversally observing the volume of fluid through an optical device 8 arranged in the side wall LT of the washing fluid collection zone 2". The level lines L1, L2 are not necessarily perfectly horizontal, an expected condition in the case of clean or foam-free water, but can have an irregular trend with peaks and troughs in the case of the presence of foam on the surface of the liquid. Preferably, the step of comparing 15 the first volume of fluid with the second volume of fluid comprises the sub-step of comparing the first level line L1 with the second level line L2 for calculating the value of fluid volume variation DV between the first condition and the second condition of the washing fluid collection zone 2".

**[0098]** According to an alternative solution or that can be combined with the previous one, the first processed image 11B identifies a first surface S1 representative of the space occupied by the first volume of fluid in a predefined quadrant Q of the washing fluid collection zone 2". The quadrant Q is configured like a grille and, as already mentioned, its outlines are predefined and determined by the scanning capacity of the optical devices 8 that acquire transverse images of the fluid contained in the washing fluid collection zone 2". The second processed image 13B identifies a second surface S2 representative of the space occupied by the second volume of fluid in the predefined quadrant Q of the washing fluid collection zone 2". The step of comparing 15 the first volume of fluid with the second volume of fluid comprises the sub-step of comparing the first surface S1 with the second surface S2 for calculating the value of fluid volume variation DV between the first condition and the second condition of the washing fluid collection zone 2". Advantageously, it is possible to split the acquired image into a grille and store the first digital image 11A, so as to split the space of the quadrant Q into predefined units in order to compare each segment for determining the fluid volume variations in the space of the area analysed.

**[0099]** It is necessary to specify that, in both of the alternative/combinable solutions described above, i.e. analysis of the levels lines L1, L2 or of the surfaces S1, S2 in the quadrant Q (see figures 2 and 5), these parameters may be related to the volume of the fluid containment tank of the washing fluid collection zone 2", so as to be able to calculate on a case-by-case basis the volume of fluid contained in the washing fluid collection zone.

**[0100]** According to a preferred embodiment, the method envisages iteratively repeating, during a washing cycle, the step of:

- acquiring 13 a second digital image 13A representative of the second condition of the washing fluid collection zone 2" after a predefined time interval

from the performance of the step of acquiring 11 a first digital image 11A, preferably at time intervals greater than or equal to 1 min;

- digitally processing 14 the second digital image 13A so as to obtain the second processed image 13B;
- comparing 15 the first volume of fluid with the second volume of fluid for calculating the value of fluid volume variation DV between the first condition and the second condition of the washing fluid collection zone 2";
- generating 16 a foam presence signal Sig in the washing fluid collection zone 2" when the value of fluid volume variation DV exceeds a predefined threshold value;
- modifying 17 the cleaning parameters of the cleaning program P of the dishwashing machine 1 when the foam presence signal Sig is generated.

**[0101]** According to a preferred solution, the method comprises the step of providing a reference digital image RIF representative of a reference condition of the washing fluid collection zone 2". In particular, the reference digital image RIF identifies a reference fluid volume contained in the washing fluid collection zone 2". The comparison step 15 comprises the sub-step of comparing the reference digital image RIF with the first processed image 11B, i.e. the value of the reference fluid volume with the value of the first volume of fluid for calculating a value of fluid volume variation DV between the reference condition and the first condition of the washing fluid collection zone 2". Preferably, the reference digital image RIF relates to a condition of the reference fluid collection zone 2" that may be empty or filled with clean water. It is worth highlighting that the reference image is known to the dishwashing machine manufacturer and can be stored in the database.

**[0102]** According to a preferred embodiment, the method comprises one or more of the steps for modifying the cleaning parameters of the cleaning program P of the dishwashing machine 1 when the foam presence signal is generated:

- reducing the pressure of the wash pump;
- heating the washing fluid to raise the temperature of the fluid contained in the washing fluid collection zone (2");
- unloading the washing fluid and automatically filling the washing fluid collection zone (2") with clean water.

**[0103]** According to a preferred embodiment, the method comprises the step of signalling through the user interface 9 the presence of foam when the foam presence signal is generated and/or the modifications made to one or more of the cleaning program cleaning parameters P.

**[0104]** Advantageously, the method of the present invention allows the presence of foam in the dishwashing machine 1 to be detected.

[0105] Also advantageously, the method allows one or more of the cleaning parameters of the cleaning program P to be modified as a function of the possible presence of foam.

[0106] In particular, the cleaning parameters of the cleaning program that may be modified based on the amount of foam detected and at the time of the cycle in which it is detected are one or a combination of more than one of the following parameters:

- duration of the washing step;
- pressure of the wash pump;
- temperature of the washing and drying steps;
- litres of water loaded.

[0107] According to a preferred step, the method comprises a step of signalling through the user interface the presence of foam and/or the modifications made to one or more of the cleaning parameters of the cleaning program P so as to promptly inform the user of the variations made.

[0108] As has been seen, thanks to the method and the dishwashing machine 1 it is possible to signal through the user interface 9 the identification of a change in operating status of the machine itself in order to be able to restore the correct installation conditions of the object. This reduces the need to perform a dedicated wash for some dishes and/or to repeat the washing cycle with consequent water, detergent and energy consumptions.

[0109] According to one embodiment, the method can be performed as follows:

- one or more television cameras are arranged so as to be able to view the zone included between the lower impeller 5A used to distribute the washing fluid and the lower part 2A of the dishwasher tank (washing fluid collection zone 2'') where the water sucked for washing is collected;
- the television camera(s) connected to the control device of the product and/or to a remote device, acquire the image in the condition prior to the activation of the wash pump (reference image, tank full of clean water);
- following the activation of the wash pump, the system proceeds to acquire the image at intervals greater than or equal to 1 minute;
- through the analysis of the images and the space occupied by the washing fluid, using an image processing system (e.g. dishwasher control board and/or a remotely connected device), it is possible to discriminate the presence of foam by analysing the comparison of the spaces with the reference image.

[0110] It is necessary to specify that in conditions of absence of foam, the second processed image 13B will not have any variation of the image compared to that of the first processed image 11B. In the presence of foam,

instead, the space will be occupied by foam and therefore the "foam presence" condition will be identified.

[0111] According to a further preferred embodiment of the invention, it is possible to generate a foam reset signal in the event that, following the modification of the program and the washing parameters, all or almost all of the foam previously detected has been removed, obtaining a negative fluid quantity variation value. Furthermore, in the same way, it is possible to generate a foam absence signal when the value of the fluid quantity variation is equal to zero.

[0112] Obviously, a person skilled in the art, for the purpose of satisfying contingent and specific requirements, can make numerous modifications to the variants described above, all therefore contained within the scope of protection as defined in the following claims.

## Claims

1. Method for automatically evaluating the presence of foam in a dishwashing machine (1) comprising a washing zone (2) provided with a washing fluid collection zone (2''), said method **being characterized in that it comprises the steps of:**

- acquiring (11) a first digital image (11A) representative of a first condition of said washing fluid collection zone (2''),
- digitally processing (12) said first digital image (11A) so as to obtain a first processed image (11B), in which said first processed image (11B) identifies a value of a first volume of fluid contained in said washing fluid collection zone (2''),
- acquiring (13) a second digital image (13A) representative of a second condition of said washing fluid collection zone (2'') after a predefined time interval from the performance of said step of acquiring (11) a first digital image (11A),
- digitally processing (14) said second digital image (13A) so as to obtain a second processed image (13B), in which said second processed image (13B) identifies a value of a second volume of fluid contained in said washing fluid collection zone (2''),
- comparing (15) said value of said first volume of fluid with the value of said second volume of fluid for calculating a value of fluid volume variation (DV) between said first condition and said second condition of said washing fluid collection zone (2''),
- generating (16) a foam presence signal (Sig) indicative of the presence of foam in said washing fluid collection zone (2''), when the value of said fluid volume variation (DV) exceeds a predefined threshold value,
- modifying (17) the cleaning parameters of the cleaning program (P) of said dishwashing machine.



chine (1) when said foam presence signal (Sig) is generated.

2. Method according to claim 1, wherein:

- said dishwashing machine (1) comprises a wash pump,
- said first digital image (11A) is representative of a first condition of said washing fluid collection zone (2'') before the activation of said wash pump,
- said method comprises a step of automatically activating said wash pump,
- said second digital image (13A) is representative of a second condition of said washing fluid collection zone (2'') after a predefined time interval following said activation step of said wash pump.

3. Method according to claim 1, comprising the step of:

- automatically filling (10B) said washing fluid collection zone (2'') with clean water, wherein
- said first digital image (11A) is representative of a first condition of said washing fluid collection zone (2'') in which said washing fluid collection zone (2'') contains clean water,
- said second digital image (13A) is representative of a second condition of said washing fluid collection zone (2'') after a predefined time interval following said step of filling said washing fluid collection zone (2'').

4. Method according to claim 1, comprising the step of:

- automatically filling (10B) said washing fluid collection zone (2'') with clean water, said first digital image (11A) being representative of a first condition of said washing fluid collection zone (2'') in which said washing fluid collection zone (2'') contains clean water,
- said method comprising a step of automatically releasing a detergent into said washing fluid collection zone (2''), said second digital image (13A) being representative of a second condition of said washing fluid collection zone (2'') after a predefined time interval following the performance of said step of automatically releasing a detergent into said washing fluid collection zone (2'').

5. Method according to any one of the preceding claims, wherein:

- said washing fluid collection zone (2'') is interposed between the lower impeller (5A) and the base wall (2A) of said washing zone (2),
- said first processed image (11B) identifies a

first level line (L1) of said first volume of fluid contained in said washing fluid collection zone (2'').

- said second processed image (13B) identifies a second level line (L2) of said second volume of fluid contained in said washing fluid collection zone (2'').

- said step of comparing (15) said first volume of fluid with said second volume of fluid comprises the sub-step of comparing said first level line (L1) with said second level line (L2) for calculating said value of fluid volume variation (DV) between said first condition and said second condition of said washing fluid collection zone (2'').

6. Method according to any one of claims 1 to 4, wherein:

- said washing fluid collection zone (2'') is interposed between the lower impeller (5A) and the base wall (2A) of said washing zone (2),

- said first processed image (11B) identifies a first surface (S1) representative of the space occupied by said first volume of fluid in a predefined quadrant (Q) of said washing fluid collection zone (2''), said quadrant (Q) being configured like a grille,

- said second processed image (13B) identifies a second surface (S2) representative of the space occupied by said second volume of fluid in said predefined quadrant (Q) of said washing fluid collection zone (2''),

- said step of comparing (15) said first volume of fluid with said second volume of fluid comprises the sub-step of comparing said first surface (S1) with said second surface (S2) for calculating said value of fluid volume variation (DV) between said first condition and said second condition of said washing fluid collection zone (2'').

7. Method according to any one of the preceding claims, wherein said method envisages iteratively repeating, during a washing cycle, the step of:

- acquiring (13) a second digital image (13A) representative of said second condition of said washing fluid collection zone (2'') after a predefined time interval from the performance of said step of acquiring (11) a first digital image (11A),
- digitally processing (14) said second digital image (13A) so as to obtain said second processed image (13B),
- comparing (15) said first volume of fluid with said second volume of fluid for calculating said value of fluid volume variation (DV) between said first condition and said second condition of said washing fluid collection zone (2''),
- generating (16) a foam presence signal (Sig)

- in said washing fluid collection zone (2'') when the value of said fluid volume variation (DV) exceeds a predefined threshold value;
- modifying (17) the cleaning parameters of the cleaning program (P) of said dishwashing machine (1) when said foam presence signal (Sig) is generated.
8. Method according to any one of the preceding claims, comprising the step of:
- providing a reference digital image (RIF) representative of a reference condition of said washing fluid collection zone (2''), said reference digital image (RIF) identifying a reference volume of fluid contained in said washing fluid collection zone (2''), wherein:
  - said comparison step (15) comprises the sub-step of comparing said reference volume of fluid with said first volume of fluid for calculating a value of fluid volume variation (DV) between said reference condition and said first condition of said washing fluid collection zone (2'').
9. Method according to any one of the preceding claims, comprising one or more of the following steps for modifying the cleaning parameters of the cleaning program (P) of said dishwashing machine (1) when said foam presence signal is generated:
- reducing the pressure of said wash pump;
  - heating the washing fluid to raise the temperature of the fluid contained in said washing fluid collection zone (2'');
  - unloading the washing fluid and automatically filling said washing fluid collection zone (2'') with clean water.
10. Method according to claim 9, wherein said dishwasher (1) comprises a user interface (9), the method comprising the step of signalling through said user interface (9) the presence of foam when said foam presence signal is generated and/or the modifications made to one or more of said cleaning parameters of said cleaning program (P).
11. Dishwashing machine (1) comprising a pump that can be connected to a mains water inlet for taking clean water from the network, one or more impellers (5A,5B) in fluid communication with such pump, a washing zone (2) provided with a washing fluid collection zone (2'') interposed between the lower impeller (5A) and the base wall (2A) of said washing zone (2), and a door (3) that can be associated in closure with said washing zone (2), a control unit (4) having a memory in one portion of which a cleaning program (P) is stored, a dispenser (6) configured to release a detergent into said washing fluid collection
- zone (2''), and one or more resistive means for varying the temperature of the mains water, one or more optical devices (8) able to acquire digital images (11, 16) of said washing fluid collection zone (2'') and a user interface (9), said one or more optical devices (8) and said user interface (9) being in signal communication with said control unit (4), **characterized in that it** comprises a program resident in another portion of said memory structured to perform the method according to any one of the preceding claims from 1 to 10.
12. Dishwashing machine according to claim 11, wherein said user interface (9) is a screen integrated into said dishwashing machine, said screen (23) being configured to display said foam presence signal and/or the modifications made to one or more of said cleaning parameters of said cleaning program (P) through luminous type indications, text messages and/or images.
13. Dishwashing machine according to claim 11, wherein said dishwashing machine comprises a radio transceiver apparatus and said user interface (9) is a portable device having its own radio transceiver apparatus configured to establish a signal communication with said radio transceiver apparatus of said dishwashing machine (1) so as to receive data representative of said foam presence signal and/or of the modifications made to one or more of said cleaning parameters of said cleaning program through luminous type indications, messages and/or images.
14. System for automatically evaluating the presence of foam in a dishwashing machine (1) comprising:
- a dishwashing machine comprising a pump that can be connected to a mains water inlet for taking clean water from the network, one or more impellers (5A,5B) in fluid communication with such pump, a washing zone (2) provided with a washing fluid collection zone (2'') interposed between the lower impeller (5A) and the base wall (2A) of said washing zone (2), and a door (3) that can be associated in closure with said washing zone (2), a control unit (4) having a memory in one portion of which a cleaning program (P) is stored, a dispenser (6) for dispensing a detergent and one or more resistive means for varying the temperature of the mains water, one or more optical devices (8) able to acquire digital images of said washing fluid collection zone (2'') and a user interface (9), said one or more optical devices (8) and user interface (9) being in signal communication with said control unit (4) like said pump and a radio transceiver apparatus;
  - a portable device (22) that can be grasped by a hand of a user, having its own radio transceiver

apparatus configured to establish a signal communication with said radio transceiver apparatus of said dishwashing machine, a screen configured to display luminous type indications, messages and/or images and a memory,

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**characterized in that it comprises** a program resident in a portion of said portable device memory (22) that can be grasped by a user, said program being structured to perform the method according to any one of the preceding claims from 1 to 10 so as to display, on said interface (9) and/or on said screen of said mobile device graspable by a user, said foam presence signal and/or the modifications made to one or more of said cleaning parameters of said cleaning program through luminous type indications, text messages and/or images.

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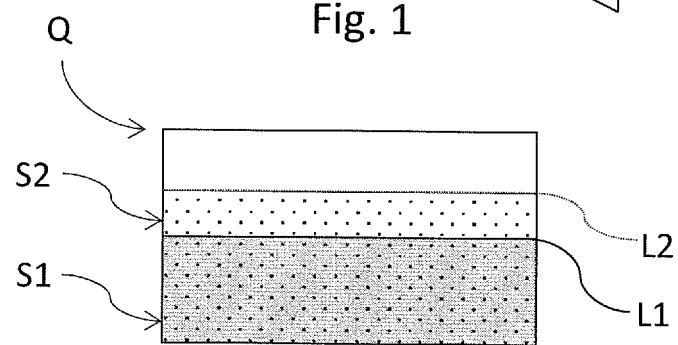
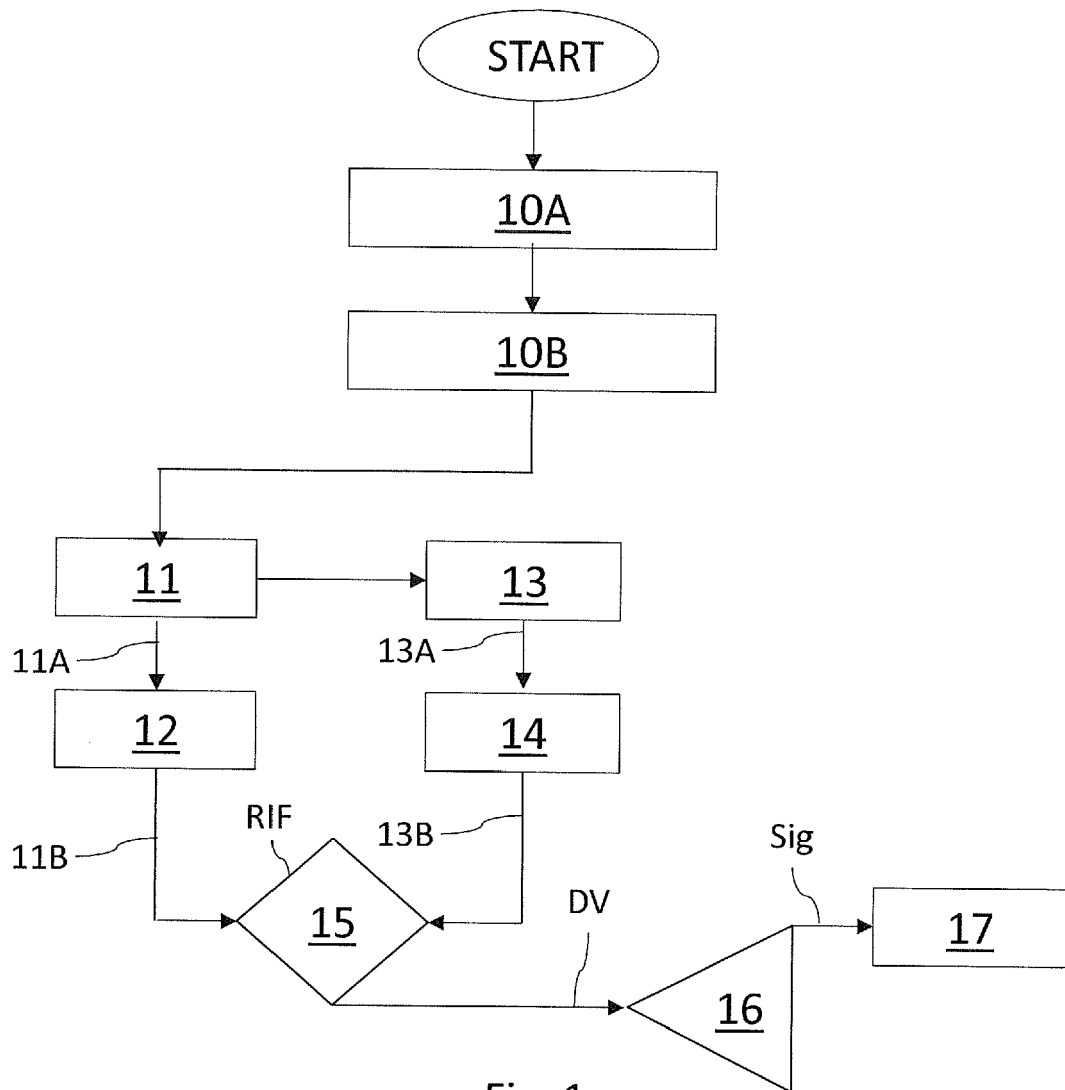
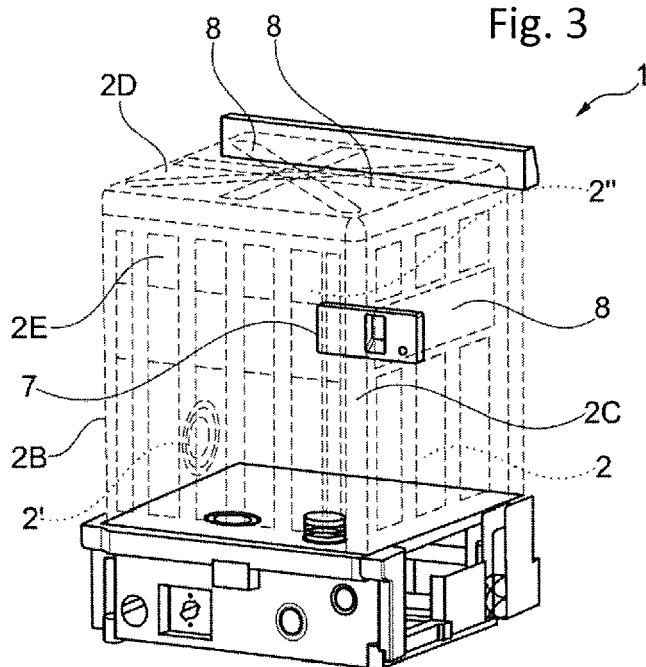
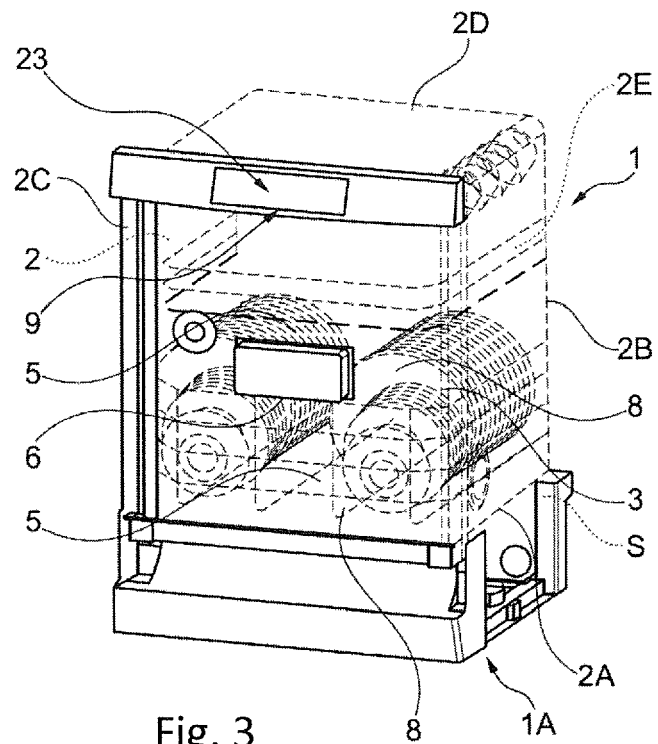


Fig. 2



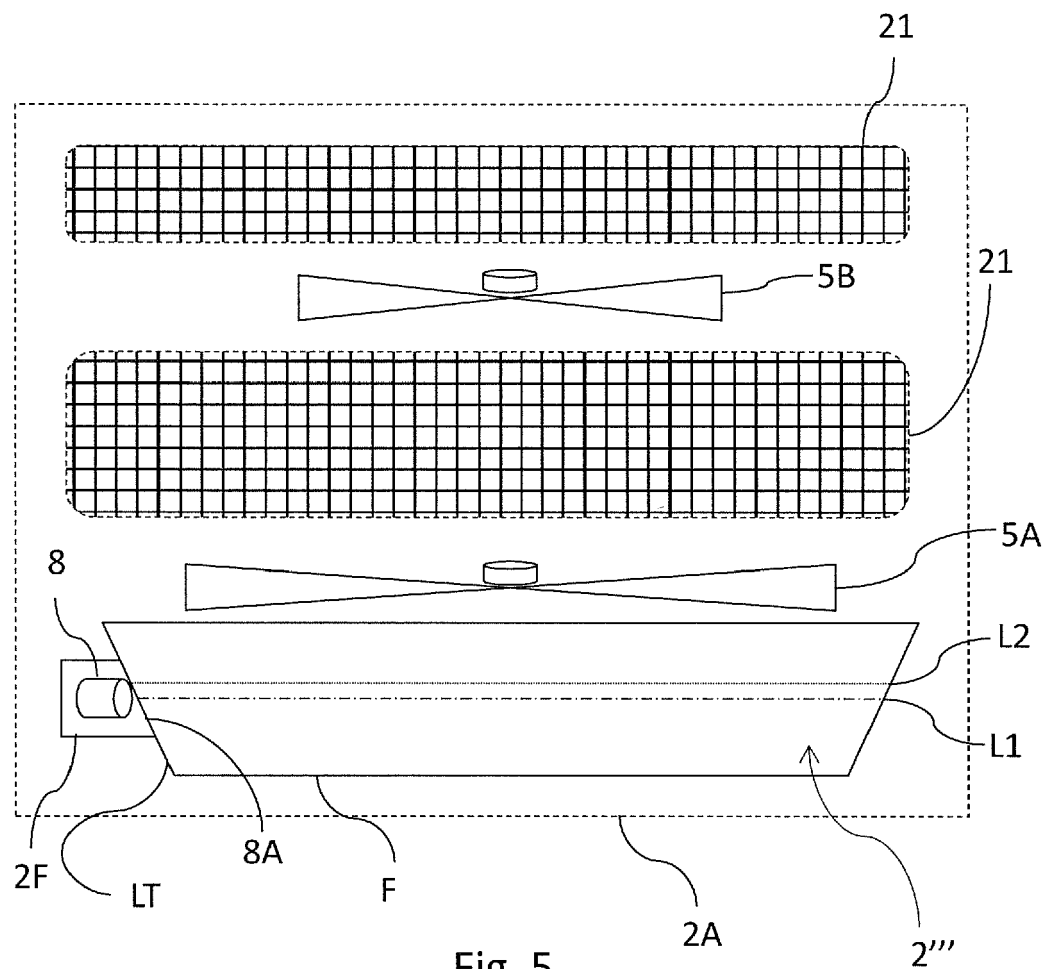


Fig. 5

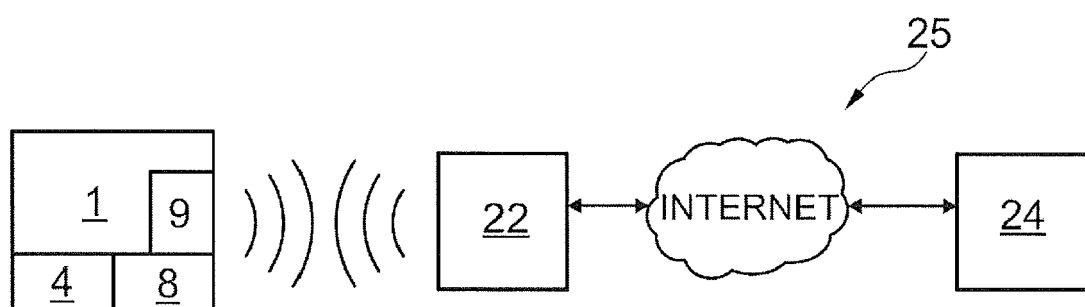


Fig. 6



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Application Number  
EP 19 15 2611

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Place of search <b>Munich</b>		Date of completion of the search <b>19 June 2019</b>	Examiner <b>Weinberg, Ekkehard</b>
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