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(54) **Laundry dryer and method of operating a laundry dryer**

(57) The present application in particular relates to a laundry dryer (1) and method of operating a laundry dryer. In particular, a laundry dryer (1) comprising a condensate tank unit (3) adapted to receive condensate fluid generated during laundry drying operation is provided. The laundry dryer further comprises a filling level unit adapted to determine a filling level of the condensate tank (3). The filling level unit comprises at least one strain gauge sensor unit (11) for determining at least a fraction of the condensate tank weight as a parameter for determining the filling level.

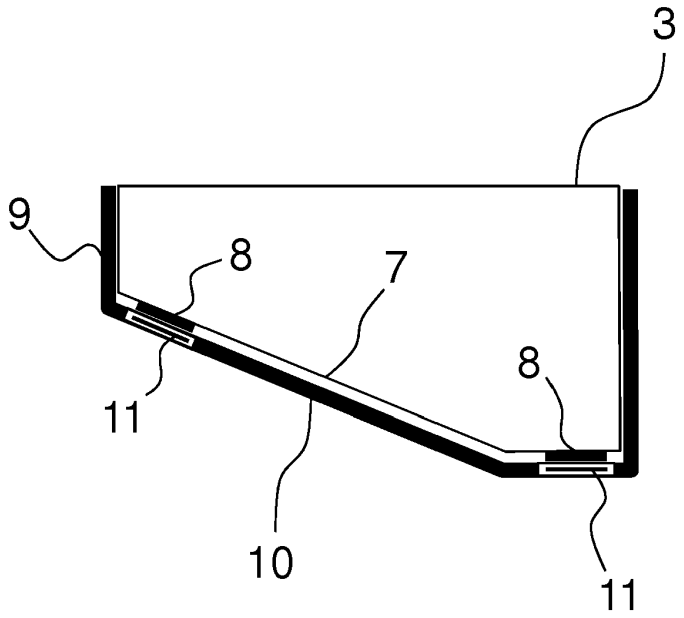

Fig. 3

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Description

[0001] The present application in particular is directed to a laundry dryer comprising a condensate tank and means to determine or detect a filled state of the condensate tank. Further, the present application is directed to a method of operating a laundry dryer.

[0002] Laundry dryers comprising a condensate tank and means at least adapted to determine or assess a filled state of the condensate tank are known for example from DE 38 42 778 A1, GB 1 390 901, EP 1 108 811 A1 and FR 2 696 196. The idea behind such laundry dryers is that in case of determining a filled state of the condensate tank, the operation of the laundry dryer can be stopped or blocked in order to prevent the condensate tank from overflowing. The means for assessing filling levels of the condensate tanks as described in the state of the art are comparatively complicated and liable to breakage or disruption.

[0003] It is an object of the invention to present a laundry dryer, i.e. tumble dryer, providing an alternative design for determining and/or assessing a certain filling level of the condensate tank. In particular, determining and/or assessing a certain filling level of the condensate tank shall be possible in a comparatively simple, robust and durable way. Further, under similar aspects, an enhanced method of operating a laundry dryer shall be provided. In particular an enhanced method of operating a laundry dryer shall be provided in which comprehensive information about the filling level may be presented to a user.

[0004] This object is solved by a laundry dryer according to claim 1 and according to claim 18, and a method of operating a laundry dryer according to claim 12 and according to claim 15. Preferred embodiments result from respective dependent claims.

[0005] According to claim 1, a laundry dryer, i.e. tumble dryer, is proposed, which laundry dryer comprises a condensate tank which is adapted to receive condensate fluid generated during laundry drying operations, i.e. in normal or ordinary operation of the laundry dryer.

[0006] The laundry dryer further comprises a filling level unit adapted to determine, assess, identify and/or calculate at least a filling level of the condensate tank. The filling level may be one of a fixed and/or predetermined filling level, such as the empty state and the fully filled state. The filling level, however, may also be any of a filling level in between the empty state and filled state. Further, the filling level may be a prospective filling level to be obtained in the course of operating the laundry dryer. The filling level as such may be determined and/or calculated in a continuous way, but may also be determined in or at specific events or timepoints during operation of the laundry dryer.

[0007] The filling level unit as proposed herein comprises at least one weight sensor unit, in particular a static weight sensor unit, in particular a strain gauge sensor unit. The weight sensor unit, in particular a static weight sensor unit, in particular strain gauge sensor unit is adapted and designed for sensing, determining and/or measuring at least a fraction of the condensate tank weight, in particular condensate liquid weight of condensate liquid contained or collected within the condensate tank. Determining the weight with a static weight sensor unit shall mean that the condensate tank is not required to move or be moved in order to determine its weight.

[0008] The term condensate tank weight in particular shall comprise the weight of the condensate tank as such and weight of condensate liquid contained in the condensate tank. The condensate tank weight may be and preferably is used as a parameter to determine and/or calculate the filling level, i.e. the overall filling level, of the condensate tank.

[0009] Determining at least a fraction of the condensate tank weight in particular shall comprise embodiments in which the overall weight of the condensate tank is determined. Under certain instances, in particular in dependence of configuration and geometry of the condensate tank and respective arrangements of the strain gauges, however, it may be that the strain gauge or strain gauges only allow determination of a fraction, such as or example a half or a fourth, of the condensate tank weight. In such cases, the overall condensate tank weight may be calculated or extracted by using additional information, such as geometry, arrangement and/or configuration, of the condensate tank, receiving housings or shafts for the condensate tank and/or strain gauges.

[0010] Each strain gauge sensor unit may comprise one or several strain gauge elements which, upon loads caused by the condensate tank, create signals representative of the load acting thereupon. From such signals, a value representative of at least a fraction of the condensate tank weight, or the condensate tank weight itself can be calculated or derived.

[0011] The values obtained from the strain gauge sensor unit can and preferably are used to calculate a filling level of the condensate tank. For calculating the filling level, the strain gauge sensor unit may be calibrated at least to an empty and a filled condenser tank situation. Values such as filling levels in between the empty and filled configuration may be derived and/or calculated by interpolation or other operations.

[0012] In any case, using the strain gauge technology, in particular using at least one strain gauge, for determining the filling level is a comparatively easy and robust way for determining actual, and as the case may be prospective, condensate tank filling levels. Further, the filling level unit as such can be implemented in a comparatively robust and easy construction, without requiring fine mechanical details generally prone to malfunction and damage.

[0013] In one embodiment, the condensate tank is adapted to be removably accommodated in a corresponding receiving housing or shaft. The receiving housing and condensate tank may be adapted such that the condensate tank can be inserted and removed in a sliding

operation, in particular motion. This in particular shall mean that the condensate tank may be or may be adapted to be slidably accommodated within a respective receiving housing.

[0014] The receiving housing and condensate tank may be implemented in a drawer type configuration, which in particular shall mean that the condensate tank is adapted to be drawn out and drawn in to the receiving housing in parallel to the horizontal direction, for example. In preferred variants, the drawer type condensate tank may be provided in or at a front face of the laundry dryer, in particular in or at a top or bottom section of the front face of the laundry dryer.

[0015] In a preferred embodiment, the at least one strain gauge sensor unit is installed in, at or on a supporting wall, i.e. a supporting wall of the laundry dryer, which supporting wall is adapted to support, bear or carry the condensate tank in the installed state or configuration. The installed state or configuration in particular shall mean that the condensate tank is accommodated within, in particular drawn into, the receiving housing.

[0016] Installing the strain gauge sensor unit, in particular one or several single strain gauges or strain gauge sensors, in, on or at a supporting wall fixed within the laundry dryer, in particular fixed in the laundry dryer housing, has the advantage that all electrical contacts may be mounted and installed in, on or at non-moveable parts. This greatly simplifies wiring related to the filling level unit. Further, operation of the condensate tank, in particular actions of removing or setting in the condensate tank from/in the receiving housing, can be greatly simplified.

[0017] In one embodiment of the laundry dryer, it is provided that the supporting wall is at least one of a bottom wall and side wall, in particular slanted side wall, of the receiving housing. Such walls in general are oriented horizontally and/or slightly slanted vis-à-vis horizontal direction, and therefore are advantageous for comparative exact assessments of the condensate tank weight. However, slanted walls may be used for space saving designs, in particular in order to adapt the shape of the receiving housing to the drying drum.

[0018] It is preferred that the at least one strain gauge sensor unit is arranged and mounted flush with the respective section of the supporting wall. This in particular is advantageous for avoiding twists or tilts during inserting and/or removing the condensate tank from the receiving housing, in particular if the supporting wall is used for sliding the condensate tank thereupon. However, it may also be conceivable that the at least one strain gauge sensor unit is placed recessed from a supporting face of the supporting wall, in particular within a recess provided in the supporting wall. Such a recess may be used to align, center and/or lock the condensate tank in the inserted state.

[0019] In one further embodiment, the condensate tank comprises, for each of the at least one strain gauge sensor units, an elevation, in particular a protrusion, projection, pin or leg. The elevation, in particular protrusion, projection, pin or leg, is/are arranged, adapted and implemented, in particular in geometry and size, such that a respective elevation and the like rests on a corresponding or respective strain gauge unit in the inserted or mounted state. The inserted or mounted state here in particular shall mean the state or condition in which the condensate tank is placed and/or rests aligned within the receiving housing.

[0020] In the inserted state the condensate tank will be connected or will cooperate with elements of a condenser provided for removing moisture from air cycled trough wet laundry, for example, and adapted to guide condensed water into the condensate tank.

[0021] In particular with the embodiment proposing to place or mount the strain gauge sensor units in, at or on the supporting face, it is preferred that the elevations are provided at a lower side of the condensate tank, facing the supporting wall in the inserted or mounted state.

[0022] Using elevations and/or other similar elements as mentioned above, adapted to rest on respective strain gauge sensor units, or strain gauge sensors, has the advantage that the weight, in particular full weight, of the condensate tank can be applied to the strain gauge sensor unit in a precise and defined way. Hence, comparatively exact determination of the weight and therefore filling level of the condensate tank is possible.

[0023] In the embodiment proposing elevations, in particular protrusions, projections, pins or legs, it is, with respect to accuracy, preferred that the condensate tank has at least three, preferably four, elevations provided at a bottom side of the condensate tank. In particular in this case, but also in different configurations, it is possible that all the weight of the condensate tank can be applied to respective strain gauge sensor units. The elevations preferably are provided at the condensate tank such that the condensate tank weight is equally distributed to all the elevations, in particular strain gauge sensor units. For example, if the condensate tank has a rectangular shaped base area, the elevations may be provided at respective four outer corners of the outer side of the condensate tank bottom wall. The condensate tank in this case may comprise four legs via which the condensate tank can rest on the supporting wall, in particular on respective strain gauge sensor units.

[0024] In one embodiment, the filling level unit further comprises a control unit adapted to control the laundry dryer in dependence of the filling level of the condensate tank. As an example, the control unit may disable and/or stop operation of the laundry dryer in case that the filling level, i.e. the filling level calculated or derived from the signals of the at least one strain gauge, reaches a preset threshold. In particular, operation of the laundry dryer may be stopped or blocked by the control unit in case that the condensate tank is full.

[0025] In a preferred embodiment, the control unit is adapted to consider at least one of an actual filling level, a prospective filling level of the condensate tank and at least one, in particular operational, parameter or value.

This in particular means that the control unit is adapted to control and/or influence operation of the laundry dryer in dependence of at least one of an actual filling level, a prospective filling level and at least one, in particular operational, parameter or value. The parameter or value may be derived from operational characteristics of the laundry dryer. However, also other parameters and values, in particular such as average humidity content of laundry, average filling levels of laundry dryer drums and the like, can be used to determine and/or calculate the actual and/or prospective filling level.

[0026] The actual filling level may, as already mentioned, be determined, in particular, calculated, from signals of the at least one strain gauge. Determining, in particular calculating, the actual filling level from signals, in particular actual signals, of the strain gauge may be performed by the control unit. The control unit may also be implemented to obtain and determine and/or calculate other operational parameters in connection with operating the laundry dryer in dependence of filling levels of the condensate tank.

[0027] A prospective filling level in connection with the present invention shall mean a filling level of the condensate tank to be achieved or arrived at in the course of operation of the laundry dryer, i.e. in the course of a subsequent drying sequence. In particular, a prospective filling level shall mean a future filling level relative to an actual situation, in particular filling level.

[0028] The prospective filling level may be calculated from at least one of the actual filling level, in particular strain gauge signals, parameters and/or values, and may in particular derived from operational details of the laundry dryer and other, in particular preset, values and parameters not necessarily related to operation of the laundry dryer. Respective values and/or parameters, not necessarily dependent on operation of the laundry dryer, are for example average humidity content of laundry to be put into a laundry dryer drum, average filling level of a laundry drum, and the like.

[0029] If for example, the control unit determines that the prospective filling level, calculated or estimated, for example at the beginning of a new operational drying cycle, or at any timepoint between start and end of an operational cycle, exceeds a maximum filling level, the control unit may output a warning and/or block or stop operation of the laundry dryer. In other words, if the control unit finds that the volume still available in the condensate tank is not enough to collect all humidity or condensed water supposedly to be extracted from laundry in course of completing a drying cycle, this information can be presented to the user, e.g. in form of a warning or message. The warning or message may be at least one of optical and acoustic, in particular indicating to a user that finishing an actual operational cycle will require emptying the condensate tank. Respective warnings and/or messages, in particular alarms, may be given to a user well before the condensate tank is full, so that the user can empty the condensate tank in time well before unwanted or undesired stops of the laundry dryer and respective drying cycles are required due to full condensate tank conditions. If the condensate tank is not emptied in due time, the control unit may stop or halt further operation of the laundry dryer.

[0030] The weight of laundry in the drying drum, humidity of respective laundry, air humidity at the drying drum outlet and/or a temperature difference across the condenser used to cool down and humidify the air coming from the drum outlet from laundry may be used as parameters for calculating respective prospective filling levels or filling conditions.

[0031] In case of a Heat Pump dryer, an evaporator is used to cool down and humidify the air coming from the drum outlet instead of an air to air heat exchanger condenser.

[0032] Note that other parameters and values can be used for calculating actual and/or prospective filling levels, such as for example the estimated laundry humidity, in particular the initial laundry humidity and/or the air temperature at the drum outlet and/or a temperature difference across the drum. In particular, parameters and/or values as set out beforehand may be used to determine, in particular calculate, the actual filling level and/or the volume needed for completing a drying cycle, and respective information may be indicated to the user.

[0033] Note that calculating a filling level and/or prospective filling level may comprise calculating a residual volume of the condenser tank, in particular a prospective residual volume of the condenser tank, for example at the end of a drying cycle. In this connection, a residual volume is considered to be equivalent to a filling level. Hence and in analogy to the description given above, if the residual volume and/or prospective residual volume are too small for finishing a drying cycle, the control unit may issue a warning and/or stop or block operation of the laundry dryer, in particular in due time, i.e. well before the condenser tank is full.

[0034] In one embodiment, as at least in parts already discussed further above, the control unit is adapted to at least one of deactivate operation of the laundry dryer, output an optic, acoustic and/or haptic warning in the event that the filling level, in particular actual and/or prospective filling level, reaches a predetermined level. In particular, the control unit may be adapted to display at least one of an actual and prospective filling level on a display unit of the laundry dryer. The actual and/or prospective filling level may be visualized together with an indication of the maximum filling level or volume of the condensate tank. Similarly, respective residual volumes and total volumes of the condenser tank may be indicated to a user.

[0035] The control unit may in particular be adapted to submit by wireless and/or network based communication a message to a terminal equipment easily and freely accessible to the user. The terminal equipment may in particular be a computer and/or mobile phone and the like.

[0036] In one variant, the control unit may consider the

sum of the actual filling level and prospective condensate volume of a drying cycle. If the respective sum exceeds the maximal filling level and/or volume of the condensate tank, the control unit may issue a warning, in particular as described in more detail further above and below. It may also be, that the control unit stops, blocks or inhibits further operation of the laundry dryer.

[0037] In one further embodiment and as already indicated further above, the control unit may be adapted to determine and/or calculate the prospective filling level, based on at least one of operational parameters and/or conditions of the laundry dryer.

[0038] The, in particular actual, operational parameters and/or conditions may comprise an air temperature of air leaving a dryer drum in operation, which air temperature may be measured by a temperature sensor of the control unit. Further, the humidity of air leaving the dryer drum and/or a temperature difference across a condenser of the laundry dryer and/or a temperature difference across the treating chamber of the laundry dryer may be used and considered for determining and/or calculating the prospective filling level. For obtaining or measuring respective parameters and values, the laundry dryer may comprise corresponding temperature and/or humidity sensors.

[0039] According to claim 12, a method of operating a laundry dryer is provided. In case of claim 12, the laundry dryer is implemented according to at least one of the embodiments and/or variants as described above and further above.

[0040] In case of claim 15, the laundry dryer similarly comprises a condensate tank unit which is adapted to receive condensate fluid generated during laundry drying operation, and further comprises a filling level unit which is adapted to determine at least a filling level of the condensate tank. Determination of the filling level in the case of claim 15 may be done in any way, in particular as already known in the state of technology, by means a weight sensor (for example a scale or a spring) i.e. without the use of strain gauges. However, strain gauges as described further above may be used as well.

[0041] According to the method according to claim 12 or claim 15, a control unit of the laundry dryer is adapted and implemented to operate the laundry dryer in dependence of at least one of a residual volume and prospective filling level of the condensate tank of the laundry dryer. Using the residual volume and/or prospective filling level may contribute to enhanced and more convenient operation of the laundry dryer.

[0042] In particular in these methods, operation of the laundry dryer can be stopped and/or interrupted and/or interaction of a user may be requested in case that the residual volume of the condensate tank is lower and will not be sufficient to accommodate the liquid, in particular condensate water, generated in a subsequent drying cycle.

[0043] In an embodiment of either methods, it may be advantageous that determination of the residual volume and/or prospective filling level of the condensate tank is based on at least one of an actual filling level of the condensate tank, an average humidity of laundry to be dried, in particular an initial humidity, an average weight of laundry to be dried in a single drying cycle, in particular initial weight, a temperature and/or humidity of air leaving a drying chamber of the laundry dryer and/or a temperature and/or humidity gradient of air leaving a drying chamber and/or condenser of the laundry dryer. Any other suitable value and/or parameter may be used to determine and/or calculate the residual volume and/or prospective filling level of the condenser tank. In particular, using the prospective filling level can avoid unwanted and unpleasant situations in which operation of a drying cycle is first initiated and has to be suspended due to a filled configuration or situation of the condensate tank. In one further embodiment of either methods, the control unit in particular may be adapted such that in case that the residual volume of the condenser tank lies below and/or the prospective filling level exceeds a predefined volume or filling level of the condenser tank, respectively, the control unit will at least one of output a warning, block and/or stop operation of the laundry dryer. Such actions of the control unit are preferred for avoiding overflow conditions of the condenser tank.

[0044] In case that the residual volume of the condenser tank will not be sufficient to finish a drying cycle, the user may be prompted to empty the condensate tank. This in particular may greatly enhance operation of the laundry dryer, in particular laundry dryer cycles.

[0045] For calculating the prospective filling level and/or residual volume, a current filling level and/or residual volume of the condenser tank may be used. In particular, the current filling level and/or current residual volume may be calculated from a condensate tank weight. The condensate tank weight may according to the description above be determined and/or calculated from signals of at least one strain gauge unit adapted and arrange for at least partially measuring the weight of the condenser tank. Here, reference is made to the description further above.

[0046] Preferred embodiments of the invention will now be described in connection with the annexed figures, in which

Fig. 1 shows a schematic view of a laundry dryer,

Fig. 2 shows a perspective view of a condensate tank;

Fig. 3 shows a cross sectional view of a condensate tank accommodated in a respective receiving housing;

Fig. 4 shows a top view of a receiving housing adapted to accommodate the condensate tank;

Fig. 5 shows a side view of the condensate tank;

Fig. 6 shows a rear view of the condensate tank;

Fig. 7 shows schematically a wiring of the laundry dryer; and

Fig. 8 shows an exemplary operational flow chart of the laundry dryer.

[0047] Note that elements similar and/or equal in function will be designated by identic reference signs. Note that features shown any embodiment related to the figures may be implemented alone, in particular to the extent described further above.

[0048] Fig. 1 shows a schematic view of a laundry dryer 1. The laundry dryer 1 comprises a drying drum or chamber 2 adapted to accommodate laundry to be dried. During a drying cycle, air, in particular dry air, is conduced through the drying chamber 2 in order to absorb and remove humidity from laundry within the drying chamber 2. The humid air in general is then guided to a condenser for extracting humidity from air cycled through the laundry drying chamber 2.

[0049] Humidity, in particular and generally water, resulting from the condensing step in general is collected and/or conducted to a condensate tank 3 provided within the casing of the laundry dryer 1. In the configuration shown in Fig. 1, the condensate tank 3 is provided within an upper user service panel, easily accessible from a front side of the laundry dryer 1. Note that the condensate tank 3 may also be provided at a lower, in particular bottom, front site of the laundry dryer 1.

[0050] The condensate tank 3 in the present implementation is designed as a drawer type condensate tank accessible from the front side of the laundry dryer 1 and removable form a corresponding receiving housing in a horizontal drawing action. In other words, the condensate tank 3 is adapted to be pushed out and pushed in from a front end user face of the laundry dryer 1. Note that the condensate tank 3 may also be provided in a removable manner at a lower side of the front side of the laundry dryer 1. Further it shall be noted, that the invention in principle is independent from the position and location of the condensate tank 3 relative to the laundry dryer 1, in particular front side of the laundry dryer 1.

[0051] The front end side of the laundry dryer 1 accommodating the condensate tank 3 in the present case comprises several control and/or display elements adapted to provide control and/or display information of operational details of the laundry dryer 1 to a user.

[0052] Fig. 2 shows a perspective view of the condensate tank 3. At a front side, the condensate tank 3 comprises a front cover 4 or front panel with a handle 5 adapted to push the condensate tank 3 into and out of a receiving housing (not shown in Fig. 2). The condensate tank 3 has an elongated shape with a polygonal cross section. Note that the shape and cross section of the condensate tank 3 may be of any other design. In particular, the condensate tank 3 may have a cuboid, parallelepiped or other form.

[0053] The condensate tank 3 further comprises a discharge opening 6 adapted to discharge liquid, i.e. water, collected in the condensate tank 3 during laundry drying operations. The discharge opening 3 may also be used as an inlet opening for feeding condensate water from a condenser of the laundry dryer 1 into the condensate tank 3. The condensate tank 3 preferably is implemented, as shown in Fig. 2, as an essentially closed vessel having at least one inlet and/or outlet opening. The condensate tank 3 as such may be made from a plastic material or any other suitable material.

[0054] As indicated in Fig. 2 and described in more detail further below, the condensate tank 3 comprises at the outer side of the condensate tank bottom wall 7 several protrusions 8, or elevations, projecting from the condensate tank bottom wall 7 downwards. Downwards in this connection shall relate to the ordinary orientation of use of the condensate tank 3.

[0055] Fig. 3 shows a cross sectional view of the condensate tank 3 in a situation or condition in which the condensate tank 3 is inserted, i.e. drawn in, into a corresponding receiving housing 9 of the laundry dryer 1. The receiving housing 9 has a cross sectional shape essentially corresponding to that of the condensate tank 3.

[0056] The receiving housing 9 comprises a receiving housing bottom wall 10 on which the condensate tank 3, in particular on which the total weight of the condensate tank 3, rests in the inserted state. As the shape of the receiving housing bottom wall 10 essentially corresponds to the shape of the condensate tank 3, it is that only the protrusions 8 rest on the receiving housing bottom wall 10.

[0057] As the location of the protrusions 8 are fixed, the total weight of the condensate tank 3 is distributed and rests on respective and corresponding locations of the receiving housing bottom wall 10.

[0058] At the locations beneath the protrusions, i.e. at locations on which the protrusions rest in the inserted, i.e. drawn in, position or state of the condensate tank 3, the receiving housing 9, in more detail the receiving housing bottom wall 10, comprises means, in particular electronic based elements, adapted or implemented or suitable for determining, in particular measuring, the weight applied or exerted via the protrusions onto or to the receiving housing bottom wall 10.

[0059] The means for measuring respective weights in the present case are implemented as strain gauges 11, integrated into the receiving housing bottom wall 10 at locations on which the protrusions 8 rest in the inserted, i.e. drawn in position.

[0060] As all of the weight of the condensate tank 3 is and may advantageously be exerted on the strain gauges 11 via the protrusions 8, the total weight, i.e. the relative total weight, or a value or parameter correlating or representative of the weight or relative weight of the condensate tank 3 can be determined or calculated by respective signals of the strain gauges 11.

[0061] For determining and/or calculating the total weight of the condenser tank 3 or other related and/or corresponding values or parameters, a control unit, in particular a controller or microcontroller may be provided. The control unit may be connected to the strain gauges for receiving respective strain gauge signals and may be adapted to calculate and/or determine from the signals of the strain gauges the weight and/or a value or parameter corresponding to the weight of the condensate tank 3. A preferred parameter to be determined and/or calculated from the signals received from the strain gauges 11 is the actual and/or prospective filling level of the condensate tank 3 and/or an actual and/or prospective residual volume of the condenser tank 3. The filling level of the condensate tank 3 essentially closely relates to the weight of the condensate tank 3, as in general the overall volume of the condensate tank 3 and density of the condensate substance, i.e. water, to be collected within the condensate tank 3 are known. Similarly, the residual volume may be calculated from an actual and/or prospective weight of the condenser tank 3.

[0062] The filling level of the condensate tank 3 may be used for controlling operation of the laundry dryer 1, which will be described in more detail further below.

[0063] Operational control of the laundry dryer 1 by using the filling level of the condensate tank 3 may for example comprise locking and/or blocking operation of the laundry dryer in case that the condensate tank 3 is full, or filled to a preset maximum filling level. It is also possible, that a warning is presented to a user, indicating that the residual volume and/or space of the condensate tank 3 will not be sufficient to finish a current and/or subsequent drying cycle.

[0064] In a preferred embodiment and configuration the control unit is adapted and configured to determine and/or calculate from operational parameters of the laundry dryer a prospective filling level of the condensate tank 3. In this connection, a prospective filling level in particular shall mean a filling level of the condensate tank 3 to be achieved during further operating the laundry dryer 1, i.e. in operational cycles to be conducted by the laundry dryer 1.

[0065] For example, the control unit may be adapted to calculate at or before starting a new drying cycle a prospective filling level of the condensate tank 3. In case that the prospective filling level lies below a maximal filling level of the condensate tank 3, i.e. if the residual condensate tank volume is still sufficient to collect all condensate liquid generated during the subsequent drying cycle, operation of the laundry dryer 1 may be conducted without any interrupts.

[0066] If, however, the control unit determines or calculates that the residual volume of the condensate tank 3 is too small, i.e. insufficient, to collect all condensate liquid, i.e. water, to be generated during a successive drying cycle, the control unit may at least one of output a warning, stop and/or block further operation of the laundry dryer 1. The warning and/or operational control of the laundry dryer 1 in dependence of the filling level and/or residual volume of the condenser tank 3 is advantageous, as unwanted interruptions of drying cycles can be avoided.

[0067] Calculating the prospective filling level and/or residual volume of the condensate tank 3 may in particular involve parameters such as average humidity content of laundry to be put into a drying drum 2 of the laundry dryer 1, average weight of laundry put into a respective laundry dryer drum 2, humidity of air at a drying drum outlet of the laundry dryer 1, temperature difference across a condenser of the laundry dryer 1 and other values and parameters, in particular related to the amount of humidity to be extracted from laundry in a drying drum 2.

[0068] Calculating prospective filling levels and residual volumes of the condensate tank 3 and issuing respective warnings and messages to a user can avoid situations in which a drying cycle has to be interrupted and/or halted due to a filled condensate tank condition. This in particular enhances operability of the laundry dryer 1.

[0069] Fig. 4 shows a top view of the receiving housing 9. As can be seen from Fig. 4, the strain gauges 11 may be implemented elongate strips. The strips may extend in parallel to the lengthwise direction of the receiving housing 9, i.e. in parallel to the direction of movement carried out upon inserting or removing the condensate tank 3 in/from the receiving housing. The strain gauges 11 are distant from each other and in the present case are located at or near both longitudinal ends of the receiving housing 9. It shall be noted, that the strain gauges 11 may be differently distributed. Further, more than just four strain gauges 11 may be provided.

[0070] In concert with Fig. 5, showing a side view of the condensate tank 3, it becomes clear, that the protrusions 8 are located at corresponding sites at the condensate tank bottom wall 7. The orientation and location of the protrusions 8 is such, that the protrusions 8 will be positioned on or above the strain gauges 11.

[0071] Fig. 6 shows a back view of the condensate tank. Here, it can be seen, that one pair of the protrusions 8 is located on the lower horizontal section of the condensate tank bottom wall 7, whereas the other pair of protrusions is located in the slanted part of the condensate tank bottom wall 7. The direction of protrusion of the protrusions 8 preferably is selected such that the weight of the condensate tank 3 can be transferred optimally to and on the strain gauges 11. In the example in Fig. 6, the pair of protrusions 8 positioned on the lower horizontal section protrudes from the condensate tank bottom wall 7 essentially in normal direction, in the present case vertically downwards. The other pair of protrusions 8 protrudes horizontally outwards from the slanted section of the condensate tank bottom wall 7, such that respective fraction of the weight of the condensate tank 3 can be optimally transferred to the strain gauges 11. Note that in the case described beforehand, the strain gauges 11

may be oriented slightly different as depicted in Fig. 3. In general it shall be noted, that the direction of protrusion of the protrusions 8 and the location and orientation of the strain gauges 11 shall be selected such that over an as large range of filling levels as possible an optimal, exact and/or reliable determination of the weight of the condensate tank 3 is possible.

[0072] Fig. 7 schematically shows a wiring of several subunits of the laundry dryer 1. The control unit, indicated by CPU (central processing unit) is connected to the strain gauges 11 of the receiving housing 9 of the laundry dryer 1. Signals submitted from the strain gauges 11 to the CPU are used to calculate the actual total weight and/or actual filling level and/or residual volume of the condensate tank 3.

[0073] Other parameters and values, such as humidity of air at the outlet of the drying drum 2 and/or a temperature difference across a condenser 12 of the laundry dryer 1 may be used to determine and/or calculate the prospective filling level and or residual volume of the condensate tank 3. For this, the CPU may be connected to several humidity sensors adapted to measure respective operational values or parameters related to humidity of laundry contained in the drying drum and/or humidity of air leaving the drying drum and/or the condenser 12. Not only humidity, but also a temperature of air leaving the drying chamber 2 or drying drum, or a temperature difference across the condenser 12 may be sensed by respective temperature sensors, submitted to the CPU and used to calculate the prospective filling level and/or residual volume of the condenser tank 3 of the laundry dryer 1.

[0074] The central processing unit CPU, in particular the control unit, may be connected to a display and/or visualization unit 13. The display unit 13 may comprise several display sections respectively adapted and implemented for displaying a relative filling level, an absolute filling level and corresponding residual volumes of the condensate tank 3, an absolute and/or relative residual filling level or corresponding residual volumes of the condensate tank 3, a prospective absolute and/or relative condensate volume of an actual drying cycle and other humidity and/or condenser related values. Note that the CPU may be adapted to calculate respective values or parameters to be displayed on the display unit 13.

[0075] In the event, that the remaining volume of the condenser tank 13 is not adequate to completely accommodate the condensate liquid generated in an actual and/or future drying cycle, the control unit CPU may issue a warning, for example of audio type by use of a loudspeaker 14, or of audio-visual type, in particular prompting a user to empty the condenser tank 3. If the condenser tank 3 will not be emptied in time, the CPU may stop or block further operation of the laundry dryer 1.

[0076] Fig. 8 shows an exemplary operational flow chart of the laundry dryer 1. In an initial step, a certain drying cycle is selected and is prompted to be started. Before or upon starting a drying cycle, the CPU calculates and/or determines the actual filling level of the condensate tank 3 and/or the volume or amount of humidity to be evaporated in a subsequent drying cycle. Here it shall be explicitly noted, that operating the laundry dryer in accordance with the flow chart in FIG. 8, in particular considering prospective filling level, residual volume and/or volume to be condensed, it is also possible that the, in particular actual, filling level of the condensate tank 3 is determined in any known way, not necessarily using strain gauge sensors or strain gauge sensor units 11 as described in detail further above.

[0077] In a further step, the residual tank volume and/or the prospective filling level of the condenser tank 3 may be calculated and/or determined. In determining and/or calculating the prospective filling level, the amount and/or volume of liquid, in particular water, to be condensed may be determined or calculated. Here, the parameter of condensation efficiency, the total condensate tank capacity, the average laundry humidity and/or average laundry weight of a single drying cycle may be considered and used as parameters.

[0078] If the central processing unit CPU calculates or determines that the residual volume of the condensate tank volume will be sufficient for at least the actual drying cycle, operation of the laundry dryer will not be influenced or interrupted.

[0079] If, however, the central processing unit CPU determines that the residual volume of the condensate tank 3 will not be sufficient to accommodate all condensate water of an actual or subsequent drying cycle, the control unit CPU may issue a warning to a user, in particular prompting the user to empty the condensate tank 3, and/or stop operation of the laundry dryer 1, in order to prevent overflow of the condensate tank 3. In particular, if the condensate tank 3 is or will not be emptied in due time, the control unit may stop operation of the laundry dryer 1.

[0080] Upon emptying the condensate tank 3, operation of the laundry dryer 1 may be continued until the control unit CPU determines or calculates that a residual volume of the condensate tank 3 and/or a prospective condensate volume will exceed the maximal volume of the condensate tank 3.

[0081] In all, it becomes clear, that the proposed laundry dryer 1, in particular filling level unit and corresponding control unit or central processing unit CPU are effective in optimally and efficiently operating the laundry dryer 1.

List of reference numerals

[0082]

1	laundry dryer
2	drying chamber
3	condensate tank
4	front cover
5	handle

6 discharge opening
7 condensate tank bottom wall
8 protrusion
9 receiving housing
10 receiving housing bottom wall
11 strain gauge
12 condenser
13 display unit
14 loudspeaker

CPU central processing unit

Claims

1. Laundry dryer (1) comprising a condensate tank unit (3) adapted to receive condensate fluid generated during laundry drying operation, and further comprising a filling level unit adapted to determine at least a filling level of the condensate tank (3), wherein the filling level unit comprises at least one strain gauge sensor unit (11) for determining at least a fraction of the condensate tank weight as a parameter for determining the filling level.

2. Laundry dryer (1) according to claim 1, wherein the condensate tank (3) is adapted to be removably accommodated in a corresponding receiving housing (9).

3. Laundry dryer (1) according to at least one of claims 1 and 2, wherein the at least one strain gauge sensor unit (11) is installed in or on a supporting wall (10) adapted to support the condensate tank (3) in the installed state.

4. Laundry dryer (1) according to claim 3, wherein the supporting wall (10) is at least one of a bottom wall and side wall of the receiving housing (9).

5. Laundry dryer (1) according to at least one of claims 1 to 4, wherein the condensate tank (3) comprises, for each of the at least one strain gauge sensor units (11), an elevation (8) which, in the mounted state, rests on a respective strain gauge unit (11).

6. Laundry dryer (1) according to at least one of claims 1 to 5, wherein the filling level unit further comprises a control unit (CPU) adapted to control the laundry dryer (1) in dependence of the filling level of the condensate tank (3).

7. Laundry dryer (1) according to claim 6, wherein the control unit (CPU) is adapted to consider at least one of an actual filling level, a prospective filling level of the condensate tank (3) and at least one, in particular operational, parameter or value of the laundry dryer (1).

8. Laundry dryer (2) according to at least one of claims 6 and 7, wherein the control unit (CPU) is adapted to at least one of

   - deactivate operation of the laundry dryer (1),
   - output a warning in the event that the filling level reaches or will reach a predetermined level,
   - display at least one of an actual and/or prospective filling level on a display unit (13).

9. Laundry dryer (1) according to at least one of claims 6 to 8, wherein the control unit (CPU) is further adapted to determine a prospective filling level based on at least one of actual operational parameters and/or conditions of the laundry dryer (1).

10. Laundry dryer (1) according to claim 9, wherein the actual operational parameter and/or condition comprises an air temperature of air leaving a dryer drum (2) in operation, an air humidity of air leaving the dryer drum (2) and/or a temperature difference across a condenser of the laundry dryer (1).

11. Laundry dryer (1), according to at least one of claims 6 to 10, wherein the control unit (CPU) is adapted to issue a warning if the sum of the actual filling level and prospective condensate volume of a drying cycle exceeds the volume of the condensate tank (3).

12. Method of operating a laundry dryer (1) according to at least one of claims 1 to 11, wherein a control unit (CPU) is adapted to operate the laundry dryer (1) in dependence of at least one of a residual volume and prospective filling level of a condensate tank (3) of the laundry dryer (1).

13. Method according to claim 12, wherein determination of the residual volume and/or prospective filling level of the condensate tank (3) is based on at least one of an actual filling level of the condensate tank (3), an average humidity of laundry to be dried, an average weight of laundry to be dried in a single drying cycle, on a temperature and/or humidity of air leaving a drying chamber (2) of the laundry dryer (1) and/or a temperature and/or humidity gradient of air leaving a drying chamber (2) and/or condenser of the laundry dryer (1).

14. Method according to claim 12, wherein in case that the residual volume of the condenser tank (3) lies below and/or the prospective filling level of the condenser tank (3) exceeds a predefined volume or filling level, respectively, the control unit (CPU) is adapted to at least one of outputting a warning, and blocking and/or stopping operation of the laundry dryer (1).

15. Method of operating a laundry dryer (1), wherein the laundry dryer comprises a condensate tank unit (3) adapted to receive condensate fluid generated during laundry drying operation, and further comprising a filling level unit adapted to determine at least a filling level of the condensate tank (3), wherein a control unit (CPU) of the filling level unit is adapted to operate the laundry dryer (1) in dependence of at least one of a residual volume and prospective filling level of the condensate tank (3) of the laundry dryer (1).

16. Method according to claim 15, wherein determination of the residual volume and/or prospective filling level of the condensate tank (3) is based on at least one of an actual filling level of the condensate tank (3), an average humidity of laundry to be dried, an average weight of laundry to be dried in a single drying cycle, on a temperature and/or humidity of air leaving a drying chamber (2) of the laundry dryer (1) and/or a temperature and/or humidity gradient of air leaving a drying chamber (2) and/or condenser of the laundry dryer (1).

17. Method according to at least one of claims 15 and 16, wherein in case that the residual volume of the condenser tank (3) lies below and/or the prospective filling level of the condenser tank (3) exceeds a predefined volume or filling level, respectively, the control unit (CPU) is adapted to at least one of outputting a warning, and blocking and/or stopping operation of the laundry dryer (1).

18. Method according to at least one of claims 15, 16, and 17, wherein the control unit (CPU) is adapted to issue a warning if the sum of the actual filling level and prospective condensate volume of a drying cycle exceeds the volume of the condensate tank (3).

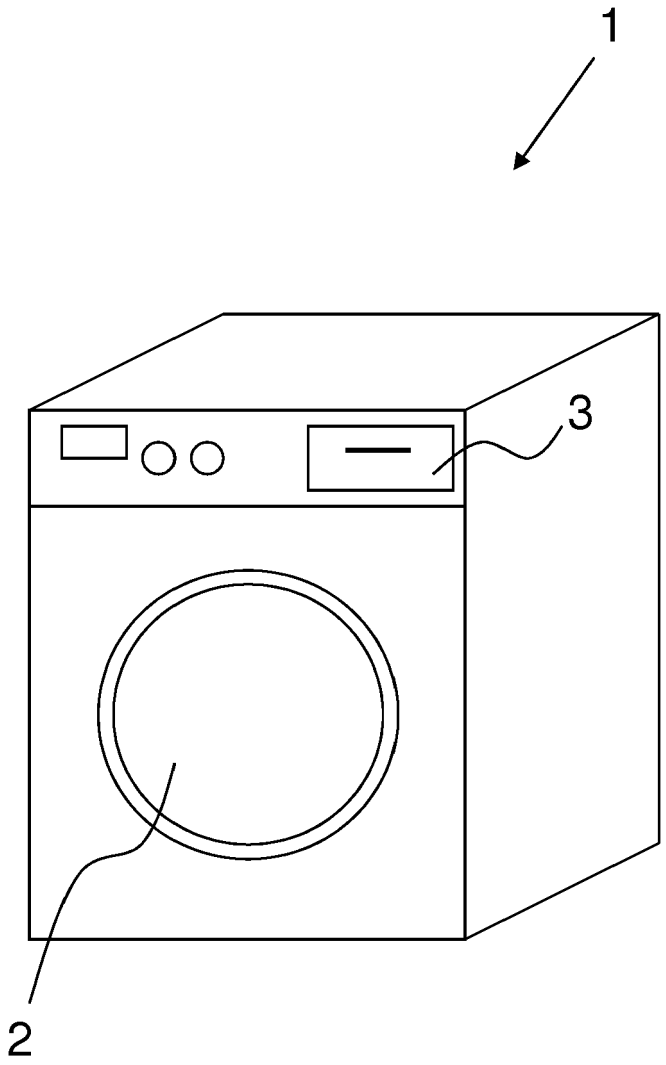

Fig. 1

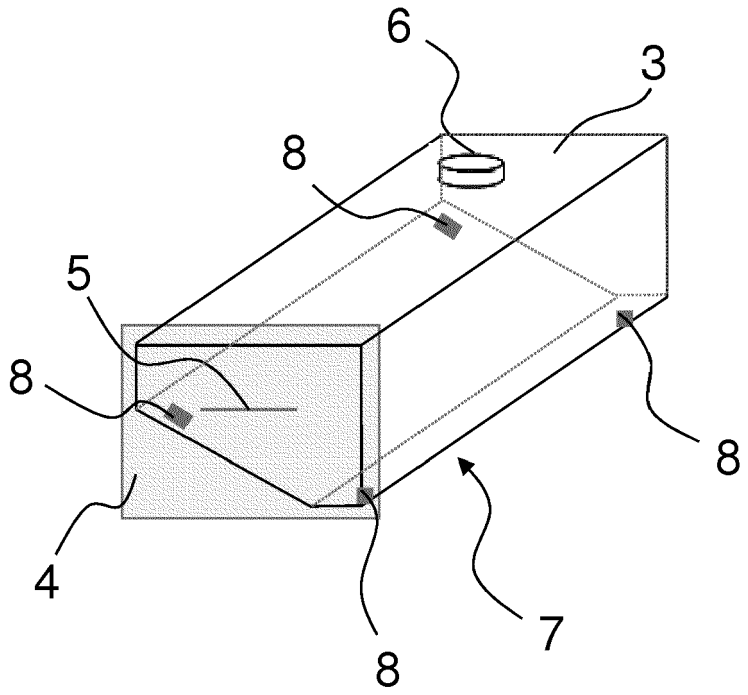

Fig. 2

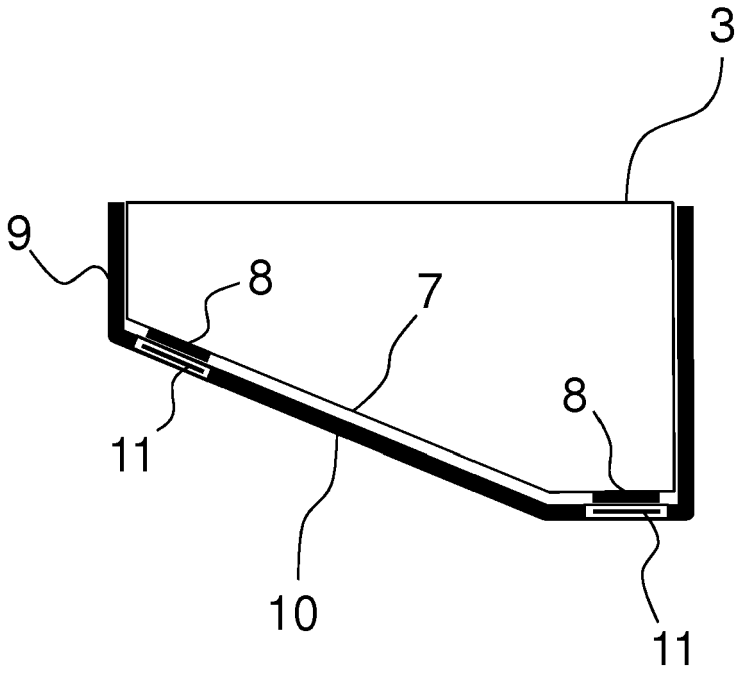

Fig. 3

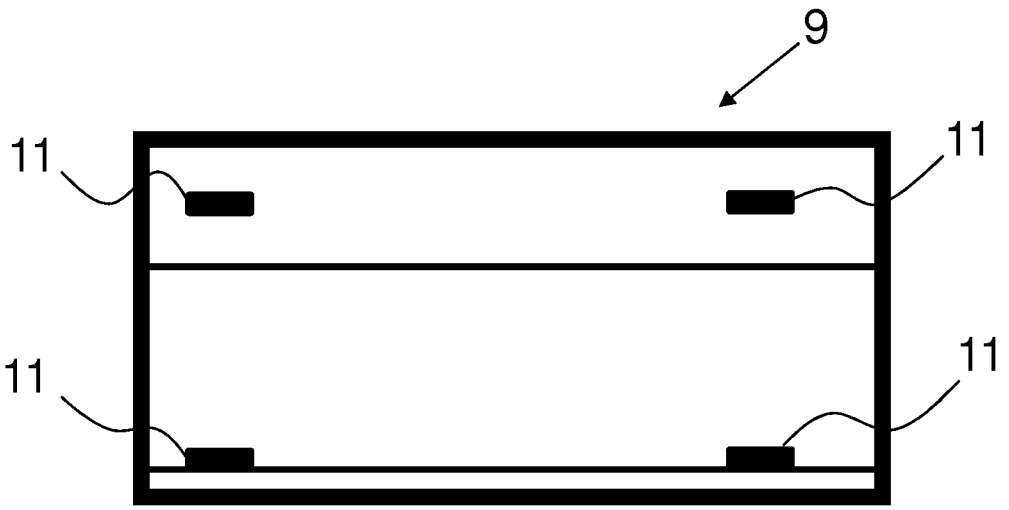

Fig. 4

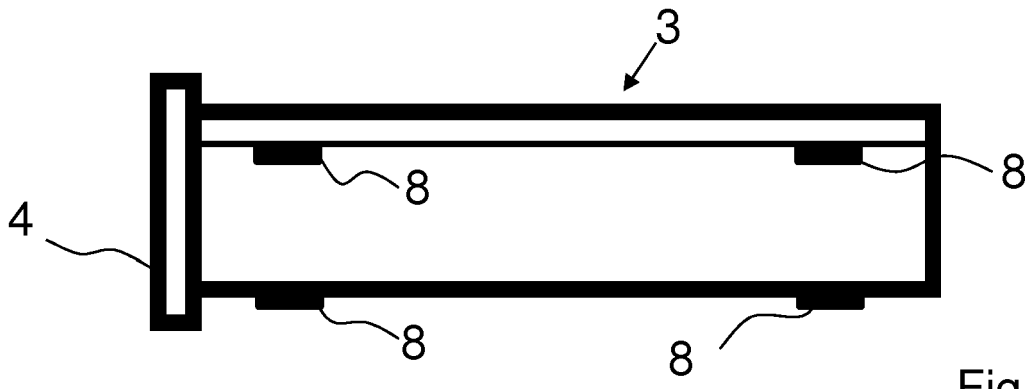

Fig. 5

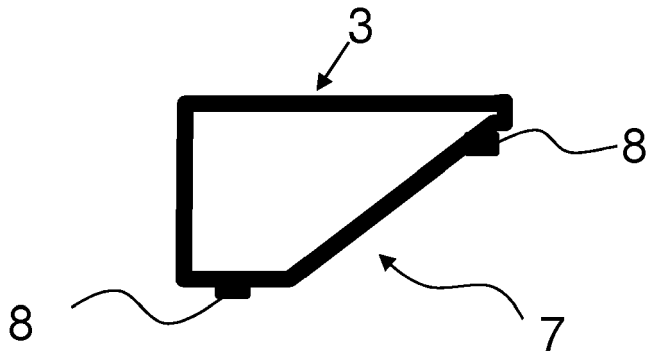

Fig. 6

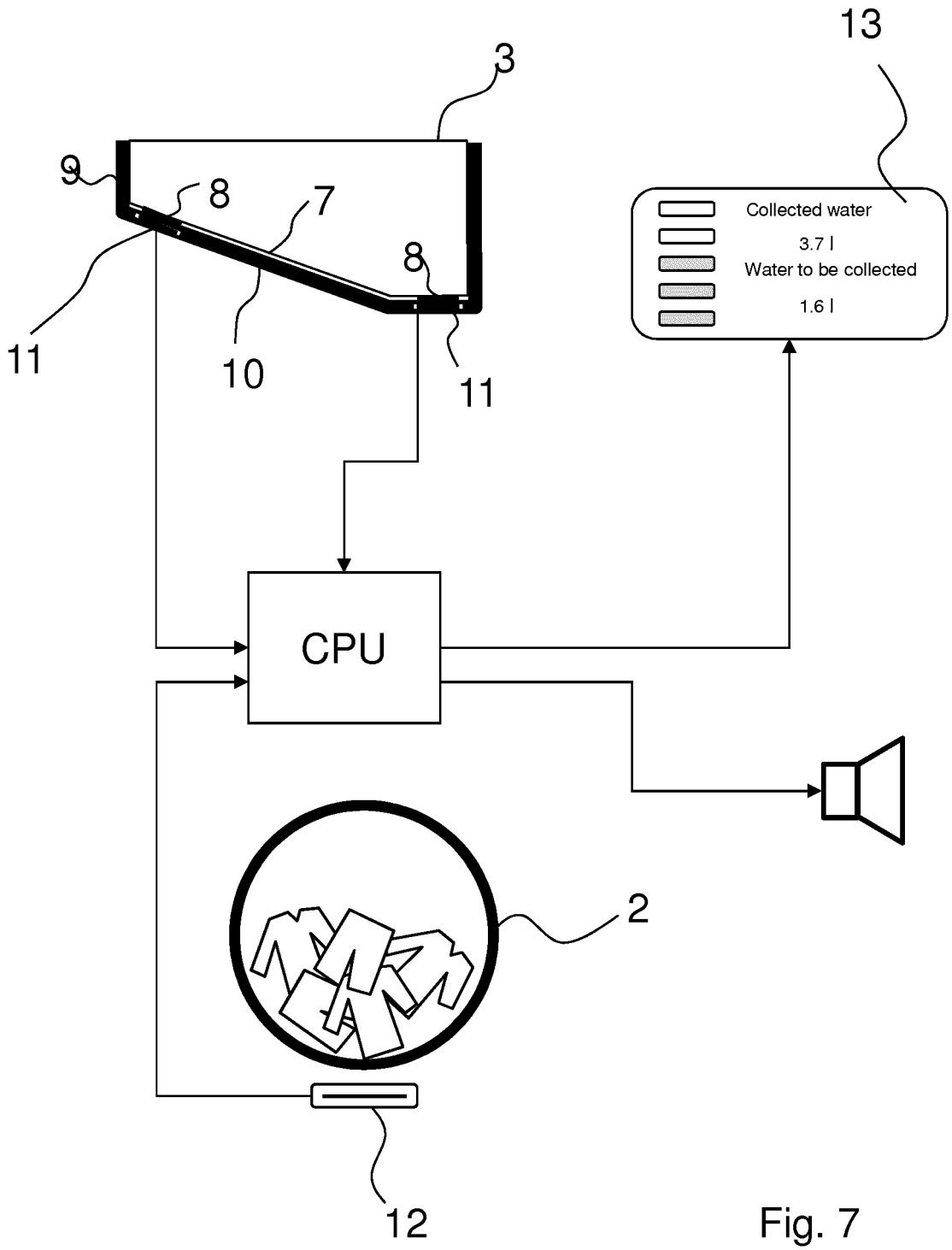
13
3
9
8
7
8
11
10
11
Collected water
3.7 l
Water to be collected
1.6 l
CPU
2
12

Fig. 7

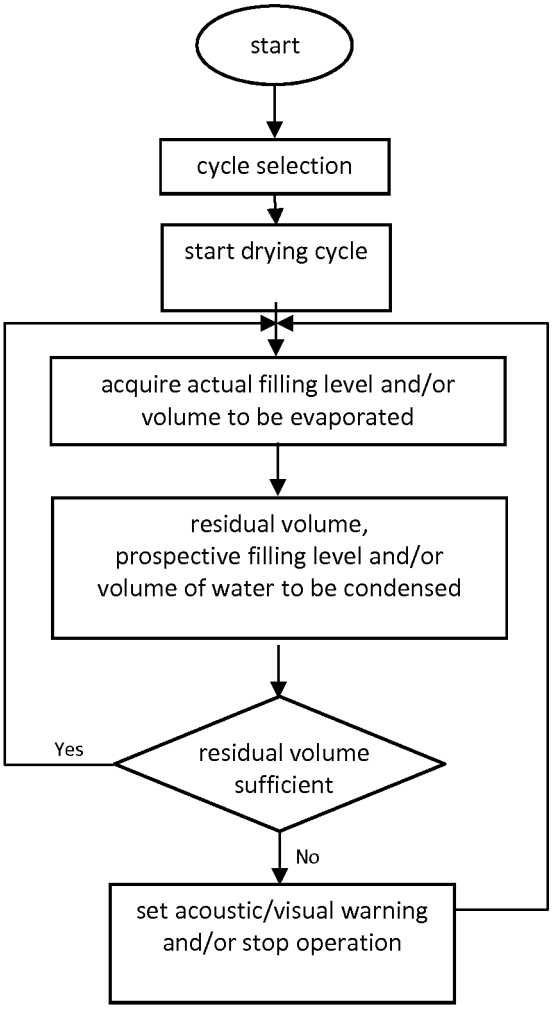
start
cycle selection
start drying cycle
acquire actual filling level and/or volume to be evaporated
residual volume, prospective filling level and/or volume of water to be condensed
residual volume sufficient
Yes
No
set acoustic/visual warning and/or stop operation

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 12 16 8912

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 324 653 A1 (CREDA LTD [GB]) 19 July 1989 (1989-07-19) * the whole document *	1-14	INV. D06F58/24
A	DE 23 07 912 B1 (LICENTIA GMBH) 4 October 1973 (1973-10-04) * column 2, line 46 - column 4, line 18; claim 1; figure 1 *	1-14	
A	DE 88 05 385 U1 (LICENTIA PATENT-VERWALTUNGS-GMBH) 22 June 1989 (1989-06-22) * the whole document *	1-14	
X	EP 1 199 396 A2 (WHIRLPOOL CO [US]) 24 April 2002 (2002-04-24) * paragraphs [0015] - [0016]; claim 1; figures *	15,16	
X	GB 1 390 901 A (LICENTIA GMBH [DE]) 16 April 1975 (1975-04-16) * page 3, line 85 - page 4, line 6; figures *	15,16	

TECHNICAL FIELDS SEARCHED (IPC)

D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 February 2013	Stroppa, Giovanni

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
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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

EPO FORM 1503 03.82 (P04C01)

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Application Number
EP 12 16 8912

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 12 16 8912

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-14

A laundry dryer comprising a condensate tank unit and a strain gauge sensor adapted to determine at least a fraction of the condensate tank weight as a parameter for determining the filling level.

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2. claims: 15-18

Method of operating a laundry dryer wherein a control unit of a filling level unit is adapted to operate the laundry dryer in dependence of at least one of a residual volume and prospective filling level of a condensate tank of the laundry dryer.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 16 8912

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
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25-02-2013

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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- GB 1390901 A **[0002]**
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- FR 2696196 **[0002]**