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(54) **DISHWASHING MACHINE**

(57) There is disclosed a dishwashing machine. The dishwashing machine comprises a controller (334). The dishwashing machine further includes a spray-arm (326) having a plurality of outlets (360, 365) for spraying liquid in a washing compartment (304) of the dishwashing machine during a washing cycle. There is further provided a motor (348) for providing a rotational motion to the spray-arm (326). A transmission arrangement (374) operatively connects the motor (348) and the spray-arm (326). The transmission arrangement (374) is constructed and arranged to provide a translational movement of the spray-arm (326) in the washing compartment (304) as the spray-arm (326) rotates. The controller (334) is arranged to vary a speed of rotation of the motor (348) during the washing cycle to control movement of the spray-arm (326) according to a pre-determined path.

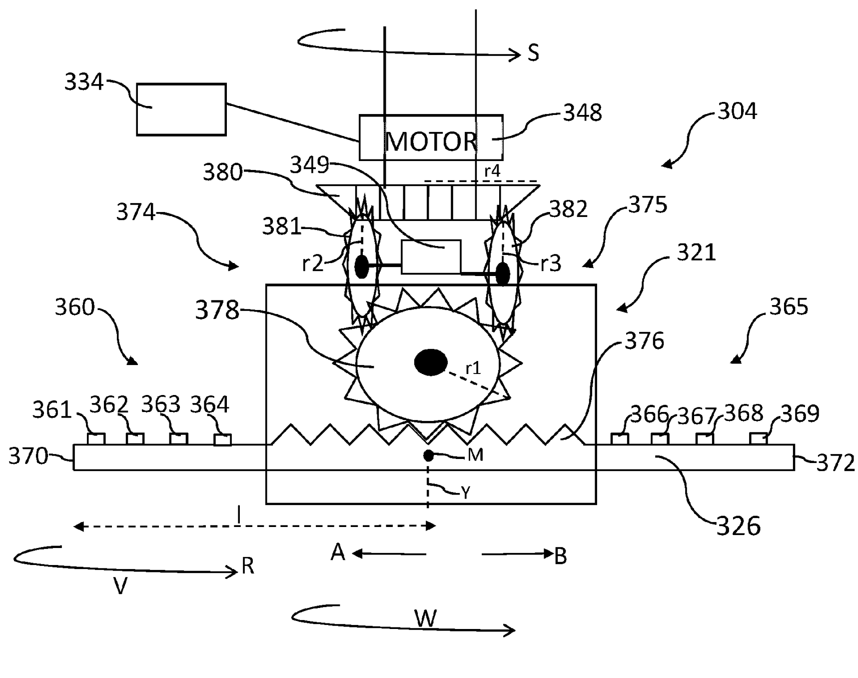

Fig. 3

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Description

Technical Field

[0001] The present disclosure relates to a dishwashing machine and a method of operating a dishwashing machine.

Background

[0002] Dishwashing machines (also referred to as dishwashers) are used for washing items such as crockery and cutlery. A known dishwashing machine comprises a washing compartment for holding one or more items to be washed, and a washing mechanism for washing those items. Typically, a user can select from a plurality of pre-defined washing cycles via a user interface on a front face of the dishwashing machine.

Summary

[0003] According to a first aspect disclosed herein, there is provided a dishwashing machine comprising: a controller; a spray-arm having a plurality of outlets for spraying liquid in a washing compartment of the dishwashing machine during a washing cycle; a motor for providing a rotational motion to the spray-arm; a transmission arrangement operatively connecting the motor and the spray-arm, the transmission arrangement constructed and arranged to provide a translational movement of the spray-arm in the washing compartment as the spray-arm rotates; and the controller being arranged to vary a speed of rotation of the motor during the washing cycle to control movement of the spray-arm according to a pre-determined path.

[0004] According to some examples, the controller is arranged to use a look-up-table to determine how the speed of rotation of the motor is to be varied over time.

[0005] According to some examples, the controller is arranged to use the look-up-table to determine a rotational speed to apply to the motor at a plurality of specific time intervals.

[0006] According to some examples, the controller is arranged to control the speed of rotation of the motor so that a linear velocity of a distal end of the spray-arm remains constant during the translational movement of the spray-arm.

[0007] According to some examples, the dishwashing machine having a first mode in which the controller is arranged to cause only the rotational motion of the spray-arm, and a second mode in which the controller is arranged to provide both the rotational motion and the translational movement of the spray-arm.

[0008] According to some examples, the controller is arranged to cause the dishwashing machine to switch from the first mode to the second mode in response to at least one condition being met.

[0009] According to some examples, the at least one condition comprises one or more of: the washing compartment reaching a threshold temperature; initiation of one or more stages of the washing cycle; an elapsed time of the washing cycle.

[0010] According to some examples, the washing compartment having a generally rectangular profile in plan-view, the transmission arrangement constructed and arranged and the speed of rotation of the spray-arm controlled by the controller so that over the washing cycle the spray-arm is translated towards each corner of the washing compartment at least once.

[0011] According to some examples, the transmission arrangement comprises a rack and pinion arrangement, the rack being located on the spray-arm.

[0012] According to some examples, a clutch is provided between the motor and the transmission arrangement.

[0013] According to some examples, a length of the spray-arm is fixed.

[0014] According to a second aspect there is provided a method of operating a dishwashing machine comprising: controlling movement of a spray-arm of the dishwashing machine by varying a rotational speed of a motor of the dishwashing machine so that the movement of the spray-arm follows a pre-determined path, the motor arranged to provide rotational motion to the spray-arm and the dishwashing machine further comprising a transmission arrangement between the motor and the spray-arm, the transmission arrangement arranged to provide a translational movement of the spray-arm in the washing compartment.

[0015] According to some examples, the method comprises using a look-up-table to determine how the speed of rotation of the motor is to be varied over time.

[0016] According to some examples, the method comprises using the look-up-table to determine a rotational speed to apply to the motor at a plurality of specific time intervals.

[0017] According to a third aspect there is provided a computer program comprising code which when executed causes a dishwashing machine to perform the method of the second aspect.

Brief Description of the Drawings

[0018] To assist understanding of the present disclosure and to show how embodiments may be put into effect, reference is made by way of example to the accompanying drawings in which:

Figure 1 shows schematically a dishwashing machine according to an example;

Figure 2 schematically shows a plan-view of a washing compartment of a dishwashing machine;

Figure 3 schematically shows parts of a dishwashing machine according to an example;

Figure 4 is a plan-view schematically showing parts of a dishwashing machine according to an example.

Detailed Description

[0019] The present disclosure has applicability to dishwashing machines or dishwashers. Dishwashing machines are used to automate the washing of items including crockery such as plates, bowls, cups, mugs etc. Items to be cleaned may also include cutlery such as knives, forks, spoons, or indeed any other cooking or eating utensil. Other items that may be washed include glassware, food containers etc.

[0020] Figure 1 schematically shows an example of a dishwashing machine 100. The dishwashing machine 100 comprises a main body 102, within which there is a washing compartment or chamber 104. Washing compartment 104 may also be referred to as a washing cabinet. In the example of Figure 1 the washing compartment 104 comprises a lower portion 106 and an upper portion 108. The lower portion 106 comprises a tray or rack 110 for holding items to be washed. The upper portion 108 comprises a tray or rack 112 for holding items to be washed. The racks 110 and 112 can be moved in and out of the washing compartment 104 on roller assemblies.

[0021] Items to be washed are schematically shown at 114. In the example of Figure 1 the items to be washed are schematically represented by plates 116 and 118 on rack 112, and plates 120 and 122 on rack 120. Of course, there may alternatively be any other type of item to be washed or combination of items to be washed.

[0022] In the example of Figure 1 a washing mechanism 123 comprises spray arm 124 in lower portion 106, and spray arm 126 in upper portion 108. In other examples the upper spray arm 126 is omitted. Each spray arm comprises a series of outlets (such as holes or nozzles) which can spray water upwardly and/or downwardly towards the items to be washed 114, while the spray arms 124 and 126 rotate.

[0023] In the example of Figure 1 the spray arm 124 is connected to shaft 125. The shaft 125 enables rotation of spray arm 124 about a central axis of the shaft 125. The shaft 125 and spray arm 124 may be considered to be comprised in a spray arm assembly 121. In the example of Figure 1 the spray arm 126 is connected to shaft 127. The shaft 127 enables rotation of spray arm 126 about a central axis of the shaft 127. The shaft 127 and spray arm 126 may be considered to be comprised in a spray arm assembly 129.

[0024] The dishwashing machine 100 further comprises water inlet schematically shown at 128 and water outlet schematically shown at 130, for enabling water to be fed into and taken out of the dishwashing machine respectively. In some examples a heater element (not shown) is provided for heating water as necessary. In other examples hot and cold water is drawn from a building's supply as required. A power connection is schematically shown at 132, which enables the dishwashing machine to be connected to mains electrical power for powering the dishwashing machine.

[0025] A water pump is schematically shown at 150. The water pump 150 is constructed and arranged to distribute water around the dishwashing machine 100. For example, the water pump 150 can pump water to spray arms 124 and 126. Water that has been sprayed falls back down to a base or sump 152 of the dishwashing machine 100, from where that water can be recycled (after filtering, in some examples) by the pump 150.

[0026] In some examples, rotation of the spray arms 124 and 126 is caused by a force of liquid being ejected from outlets of the spray arms. Additionally or alternatively, one or more motors, shown schematically at 148 may be provided for powering rotation of the spray arms 124 and 126.

[0027] A controller is schematically shown at 134 for controlling operations of the dishwashing machine. The controller may comprise at least one memory and at least one processor. The controller 134 can, for example, cause the dishwashing machine to operate according to one or more pre-determined washing cycles selected via a user interface 136. The available washing cycles may differ from each other by temperature and/or duration, for example. Via the user interface 136 a user may also be able to select whether the washing cycle is for a full or half load. A display 138 is also provided which can display information to a user. This may include information such as confirming a user's washing cycle selection, as well as information such as time remaining of a washing cycle that is in progress.

[0028] A door of the dishwashing machine 100 is schematically shown at 140. In Figure 1 the door is in an open position enabling access to washing compartment 104.

[0029] A washing cycle generally comprises three main stages: (i) wetting; (ii) injection of detergent, (iii) rinsing. In some examples one or more of these steps may be omitted. For example, a rinse wash may include just a rinsing cycle. Whichever steps are included or not included, the washing of the washing load may be generally termed a washing cycle. In some examples the rinsing stage is followed by a drying stage.

[0030] Figure 2 is a schematic plan-view of a dishwashing machine 200 according to an example. A washing compartment is shown at 204. The washing compartment is generally square or rectangular in plan view. A spray arm or spray propeller is shown at 226 (and various positions of the spray arm 226 are shown in phantom). As shown schematically at 231, ends of the spray-arm 226 trace a circular path within square washing compartment 204. This creates areas 260, 261, 262, 263, which may be referred to as "blind-spots" that are not reached by water being sprayed by the spray-arm 226. Therefore, any items located in those blind-spots may not be washed properly during a washing-cycle, or at least not washed as well as items within circle 231. Blind spots may also occur in an unpredictable manner, for example where a large plate blocks a smaller plate.

[0031] With this technical problem in-mind, the present disclosure relates to a dishwashing machine in which movement of a spray-arm is controlled so that the blind-spots (such as corner areas of the washing compartment) are reached by the spray arm during a washing cycle. In examples, the disclosed dishwashing machine controls the movement or trajectory of the spray-arm to facilitate movement of the spray arm along a pre-determined path. In examples, the trajectory of the spray arm includes a reciprocating translational movement of the spray arm in the washing compartment, in addition to the rotational movement of the spray arm. In some examples, the translational movement of the spray arm is provided by a transmission arrangement located between a motor of the spray arm (i.e. the same motor that provides rotational movement to the spray arm) and the spray-arm. In some examples, the transmission arrangement comprises a gear-train. In some examples, a controller controls a speed of rotation of the motor. In combination with the transmission arrangement which provides the translational movement of the spray-arm, controlling the speed of rotation of the motor (and consequently the speed of rotation of the spray-arm) effectively controls the location and orientation of the spray-arm at any given point, and more specifically controls a path traced by the distal ends or tips of the spray-arm, at any particular time. Therefore, in some examples the trajectory of the spray arm, and therefore the trajectory of the tips of the spray arm, is effectively controlled by controlling a speed of rotation of the spray-arm. In this way, it can be ensured that over the course of a washing cycle all corners of the washing compartment are reached by the spray-arm. Therefore, in some examples it may be considered that the controller is arranged to control a speed of rotation of the spray-arm motor during a washing cycle, so as to control both the rotational motion and the translational movement of the spray-arm. During the washing cycle the translational movement of the spray-arm causes the spray-arm to be translated onto each of the four corners of the washing compartment.

[0032] An example will now be more fully described with respect to Figure 3 which schematically shows a side-view of a spray-arm apparatus 321 located in washing compartment 304 of a dishwashing machine. For example, the dishwashing machine may be a dishwashing machine such as dishwashing machine 100 of Figure 1. The spray-arm apparatus 321 comprises a spray-arm 326 having a plurality of outlets 360 and 362 for spraying liquid, such as water and/or washing liquor, during a washing cycle. In the example of Figure 3, the plurality of outlets 360 comprise outlets 361, 362, 363, 364; and plurality of outlets 365 comprises outlets 366, 367, 368 and 369. It will be understood that in other examples more or fewer or a different configuration of outlets may be provided. The spray-arm 326 comprises a first distal end 370 and a second distal end 372. A distance between the first distal end 370 and the second distal end 372 defines a length of the spray arm 326. In some examples, the length of the spray arm 326 is fixed.

[0033] A motor 348 is provided. In some examples the motor 348 comprises a brushless direct-current (BLDC) motor. The motor 348 is arranged to cause rotation of spray-arm 326, for example via a shaft of the spray-arm. Rotation of motor 348 is schematically shown by arrow S. Rotation of spray-arm 326 is schematically shown in Figure 3 by arrow R. Therefore, controlling speed of motor 348 correspondingly controls speed of rotation of spray-arm 326. In examples, the motor 348 may selectively cause the spray-arm 326 to rotate in a clockwise or anti-clockwise direction.

[0034] A controller is schematically shown at 334. For example, controller 334 may be a main controller of the dishwashing machine (e.g. equivalent to controller 134 of Figure 1). The controller 334 is arranged to control speed of rotation of motor 348. Controller 334 may also control other operations of the dishwashing machine.

[0035] A transmission arrangement 374 is provided between the motor 348 and the spray-arm 326. The transmission arrangement 374 is constructed and arranged to provide a translational movement of the spray-arm 326 in the washing compartment 304. That is, in examples the transmission arrangement 374 converts rotational motion of motor 374 to linear movement of the spray-arm 326. In the example of Figure 3, the translational movement of the spray-arm 326 is schematically represented by arrows A and B. In examples the translational movement is in a direction perpendicular to the rotational axis Y of the spray-arm. In some examples it may also be considered that the translational movement is in a plane that is parallel to a base of the dishwashing machine. In some examples, it may be considered that the translational movement is radially outwardly and inwardly from rotational axis Y. In other examples, the transmission arrangement 374 can be adapted so that the translational movement is in a direction other than perpendicular to the rotational axis Y of the spray-arm. In some examples, a bearing assembly is provided to facilitate the translational movement of the spray-arm as the spray-arm rotates. For example, the bearing may comprise a plain bearing or a slide bearing.

[0036] In examples, the controller 334 is arranged to control a speed of rotation of the motor 348 during a washing cycle, so as to control both the rotational motion (R) and the translational movement (A and B) of the spray-arm, so that during the washing cycle the translational movement (A and B) of the spray-arm causes the spray-arm to be translated into each of the four corners of the washing compartment. This will be discussed in more detail below, with reference to Figures 3 and 4.

[0037] With reference to Figure 3, the transmission arrangement 374 comprises a gear train 375. In the example of Figure 3, the gear train 375 comprises a rack 376 and pinion 378 arrangement. In some examples, the rack 376 is formed on the spray-arm 326 or is attached to spray-arm 326. In some examples, a centre or mid-point M of rack 376 is located mid-way between distal ends 370 and 372 of spray-arm 326. In the example of Figure 3, pinion 378 is driven by output gear 380 of motor 348. In some examples, output gear 380 comprises a bevel gear. More particularly, in the example of Figure 3 pinion 378 is driven by output gear 380 via intermediate gears 381 and 382. In some examples, intermediate gears 381 and 382 comprise bevel gears.

[0038] In the example of Figure 3, an actuator 349 is provided. In some examples, the actuator 349 controls the limits of linear motion of spray-arm 326, for example to stop the spray-arm 326 from hitting the sides of washing compartment 304. In some examples, during rotation of the spray-arm 326 the motor 348 and gear 380 will be rotating continuously. The actuator 349 acts as a relay or clutch in connecting drive from the motor 348 to the transmission arrangement 374. In examples, controller 334 controls when the actuator 349 enables drive to pass from motor 348 to transmission arrangement 374.

[0039] In some examples, pinion 378 has a radius r1; gear 382 has a radius r2; gear 382 has a radius r3; and gear 380 has a radius r4. In some examples, the radiuses of the gears are measured from the centre of the gear to the outermost point of the gear. In some examples, r2=r3. In examples, the gears of the gear train 375 (including rack 376) and their properties (including radius and number of gear teeth; length of rack) are selected so that the maximum translation of spray-arm 326 will cause the spray-arm 326 to adequately reach in to the corners or blind-spots of the washing compartment 304. The controller 334 is also configured to control the direction of translation of the spray-arm 326 so that the spray-arm 326 is withdrawn back within the washing compartment 304 at a suitable time so that the spray-arm 326 (for example ends 370 and 372) do not collide with interior sides of the washing compartment 304. In some examples, gears 381 and 382 are arranged to rotate in opposite directions, and a clutch (for example actuator 349 or a clutch within actuator 349) controls which of gears 381 and 382 is driven, so as to selectively control direction of motion of pinion 378 and consequently to control translational direction of spray-arm 326. See also Figure 4. In examples, the geometry of the transmission arrangement 374 is selected during design of the washing machine. Therefore, a transmission arrangement 374 having appropriate geometry is installed in the dishwashing machine at the time of manufacture of the washing machine. Therefore different washing machines having different internal dimensions may have different geometry transmission arrangements 374. The geometry of the transmission arrangement may comprise one or more of: size of gears; number of teeth on gears; length of rack; number of teeth on rack. The geometry may also include the length of the spray-arm itself.

[0040] Calculations for trajectory of the spray-arm 326 will now be explained in more detail. With reference to Figure 3, angular velocity of the spray-arm 326 is schematically shown as W, and linear velocity of distal ends 370 and 372 of spray-arm 326 is schematically shown as V (see also Figure 4). Radius of the spray-arm 376 is 1. That is, in some examples it may be considered that the distance between distal ends 370 and 372 is 21. In some examples, it may be considered that the spray-arm 326 has a rest-position where a mid-point M of spray-arm 326 is coincident with a rotational axis Y of the spray-arm 326. A distance that M is translated away from Y may be referred to as a "linear translational distance" of the spray arm 326. Therefore it will be understood that a distance between rotational axis Y and a tip (e.g. distal end 370 or 372) of the spray arm 326 will vary during a washing cycle. In examples, the linear translational distance between Y and distal end 370 or 372 is referred to as "effective x". In some examples effective x varies from $l\sqrt{2} \rightarrow l.$

[0041] In examples, the spray arm 326 has a reference or rest position in terms of rotation. An angle of rotation α of the spray-arm 326 denotes a degree of rotation of the spray-arm 326 away from the reference position. See Figure 4, which is a plan view of washing compartment 304. With continuing reference to Figure 4, washing compartment 304 comprises a front face 386 (which may constitute an inside face of a door of the dishwashing machine when the door is closed), a rear face 388 opposite the front face 386, and sides 387 and 389 connecting the front face 386 to the rear face 388. In the example of Figure 4, the reference position of spray-arm 326 is where a longitudinal axis of the spray arm is parallel with front and rear faces 386 and 388. At the reference position, α=0°. It will be understood that in other examples the reference position may be different. For example, the reference or rest position could be where longitudinal axis of spray-arm 326 is parallel to sides 387 and 389, or indeed any other position so long as relative rotation from the reference position can be determined.

[0042] In some examples, an outermost path that is followed by the distal ends of the spray-arm 326 over the course of a washing cycle is shown schematically by dotted rectangle 390. In some examples, path 390 is traced by the distal ends 370 and 372 of the spray-arm 326 over one full rotation of spray-arm 326. In other examples, it may take more, or less, than one rotation of the spray-arm 326 for path 390 to be traced, depending on geometry (e.g. radius and number of gears) on gears 378, 381 and 382. It will be appreciated that a single distal end of the spray-arm doesn't simply follow this rectangular path (because the end is also rotating), but over the course of a number of rotations the path 390 will have been traced by the distal ends in combination. Path 390 may be considered a pre-defined path. Therefore in some examples it may be considered that movement of the spray-arm distal end or ends is controlled to follow a pre-determined path over a washing cycle. In some examples, the spray-arm 326 is selected so that the perimeter distance of path 390 that is covered by the spray-arm tips is equal to 81 (i.e. eight times the radius of the spray arm). The perimeter 390 may also be referred to as a rectangular trajectory distance.

[0043] In some examples, the time it takes for the distal end(s) of the spray arm 326 to trace perimeter 390 may be referred to as a tour time, T. In some examples, one complete tour means that rectangular path 390 has been completed once by one tip. In an example, one tour time T = 81/V.

[0044] Therefore, to summarise:

1 = radius of spray-arm
V= linear velocity of distal end of spray-arm
w = angular velocity of spray arm

$$\text{effective x} = \text{range from } \; l\sqrt{2} \rightarrow l$$

α = angle of spray-arm from reference position;

$$\mathrm{T} = 8\mathrm{l}/\mathrm{V}$$

Rectangular trajectory distance = 81

[0045] According to some examples, the controller 334 is configured to cause the linear velocity V to be kept constant while a distal end of spray-arm is following path 390. Keeping linear velocity V constant aids homogenous water distribution within the washing compartment 304. Also, in some examples, maintaining linear velocity V constant minimises processing power required by controller 334.

[0046] Linear velocity at any point in time can be calculated with the equation:

$$\text{Linear velocity (V)} = \text{angular velocity (w)} * \text{effective x}$$

[0047] According to the laws of motion the above equation must be kept satisfied.

[0048] In some examples, the distance "effective x" is monitored, and information of effective x is fed back to controller 334. For example, effective x may be monitored by monitoring number of rotations of pinion 378, or with a movement sensor for sensing translational movement of spray-arm 326, or the like.

[0049] In some examples, angular velocity of the spray arm (related to motor speed) controls the effective x distance changes as shown by the equation below:

$$linear\ velocity\ V = angular\ velocity\ \times effective\ x$$

$$keep\ constant\ (wl) = \left(w\sqrt{2} \leftrightarrow w\right) \times (l\sqrt{2} \leftrightarrow l)$$

[0050] Therefore, it will be understood that there is a relationship between angular speed of the spray-arm 326, which is controlled by controller 334 controlling speed of motor 348, and the effective x (translational movement of the spray-arm 326). Therefore, in examples, by controlling the speed of the motor 348 the distance that the spray-arm 326 is linearly translated at a given rotation can be controlled. In other words, controlling the speed of the motor 348 enables the controller 334 to control effective x for a given α. Or in other words, controlling the speed of the motor 348 enables the controller 334 to control the trajectory of the spray-arm 326. It may also be considered that the controller 334 is enabled to track or monitor the trajectory of the spray-arm 326.

[0051] Referring back to Figure 4, the washing compartment 304 may be considered to comprise corners 392, 393, 394 and 395. Initially, spray-arm 326 is at its rest position where effective x = 1 and rotation α = 0°. In this example, spray-arm 326 is (at least initially) rotated anti-clockwise (when viewing Figure 3). At a point in time, α = 45°. As shown in Figure 4, when α = 45° then spray-arm 326 has been linearly translated to an extent so that distal end 370 is proximate to corner 392 of washing compartment 304. As previously explained, when α=45° then effective $x = l\sqrt{2}$. It will be appreciated that at the same time, distal end 372 is some way inside, or spaced from, corner 394. Therefore, it will be considered that during translation of the spray-arm 326 the actual overall length (2l) of spray-arm 326 remains constant. Intermediate positions of the spray arm between α=0° and α=45° are schematically shown in phantom. It will be appreciated that in the example of Figure 4, whilst the spray-arm 326 is being linearly translated a linear velocity (V) of its tip (or distal end) remains constant. The linear velocity of the distal ends is in a direction parallel to the front face 386, rear face 388, or sides 387 and 389 dependent on the position of the spray-arm. For example, and with reference to Figure 4, as α varies from 0° to 45°, linear velocity V is in a direction parallel to side 387, and so on.

[0052] According to some examples, a look-up-table (LUT) is used by the controller 334 in order to control motor speed. According to some examples, the LUT is used so that the controller 334 controls a speed of the motor in dependence on time. In examples, the time is over a time period that equates to one tour of the spray arm 326 (e.g. the time it takes for the spray-arm to follow perimeter path 390 as shown in Figure 3). In some examples, the controller then repeats the process for n tours (where n is a positive integer). An example LUT that may be used by controller 334 is shown in Table 1 below:

Table 1: Look-up table for driving spray-arm

1 tour time	Linear velocity	Perimeter	Angular velocity (related with motor speed)	Effective x (related with gear system)
0^{th} sec	V m/s	8*l* m	w rad/s	1.414 *l*
0.01th sec	V	8*l*	1.01w	1.424 *l*
0.02th sec	V	8*l*	1.02w	1.434 *l*
0.03th sec	V	8*l*	1.03w	1.444 *l*
...	...	...	...	...
1^{st} sec	V	8*l*	1.414w	*l*

[0053] As shown in the example LUT above, the angular velocity of the spray-arm is related to the motor speed. Therefore, the required motor speed at a point in time to meet the criteria of the LUT can be derived by the controller 334. It can also be seen from the LUT that the angular velocity of the spray-arm varies with time during one tour. Therefore, it will be appreciated that in examples the speed of the motor is varied in a controlled manner over time during each tour of the spray-arm 326. As previously discussed, with the selected geometry of the transmission arrangement 374, controlling the motor speed enables position and orientation of the spray-arm 326 to be controlled and therefore enables distal ends 370 and 372 to follow a controlled path over a time period (for example to follow path 390). It will also be appreciated from Table 1 that the linear velocity of the distal ends of the spray arm is kept constant. The amount of linear translation of the spray-arm (effective x) also varies over time.

[0054] In some examples, linear translation of the spray-arm 326 is initiated in response to one or more conditions being met. In some examples, the one or more conditions comprises an interior temperature of the dishwashing machine (e.g. washing compartment 304) reaching a threshold temperature. For example, the threshold temperature may comprise 50°C. In one example, the one or more conditions comprises a stage of a washing cycle. For example, the one or more conditions may comprise the initiation of a rinse cycle. In some examples, the one or more conditions comprises a program time. For example, the one or more conditions may comprise the mid-point of a program time. For example, the program time may be considered an elapsed time. Any dirt that is on the items to be washed in the dishwashing machine may be easier to remove once the one or more conditions have been met, for example because the dirt has been softened at that point. Therefore in some examples it may be considered that there is a first mode or stage of spray-arm motion in which the spray-arm is configured for rotation only, and a second mode or stage of spray-arm motion in which the spray-arm is configured for rotation and translation. In some examples it may be considered that the second mode of spray-arm motion is initiated in response to the at least one condition being met. In some examples it may be considered that the spray-arm 326 switches from the first mode of operation to the second mode of operation in response to the at least one condition being met. Initiating the second stage only once the at least one condition has been met may save energy compared to enabling both of the rotational and translational motions at all times.

[0055] It will therefore be appreciated that the described system for causing linear translation of a spray-arm can be provided with a simple modification of the drive mechanism between the spray-arm and the spray-arm motor. In examples, no additional motor is required for causing the linear translation of the spray-arm. Therefore, the present disclosure provides an easy to implement and manufacture arrangement for providing effective cleaning at all points of a washing compartment of a dishwashing machine. It will be understood that the described embodiments may equally apply to one or both of upper and lower spray arms.

[0056] Although at least some aspects of the embodiments described herein with reference to the drawings comprise computer processes performed in processing systems or processors, the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of non-transitory source code, object code, a code intermediate source and object code such as in partially compiled form, or in any other non-transitory form suitable for use in the implementation of processes according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may comprise a storage medium, such as a solid-state drive (SSD) or other semiconductor-based RAM; a ROM, for example a CD ROM or a semiconductor ROM; a magnetic recording medium, for example a floppy disk or hard disk; optical memory devices in general; etc.

[0057] The examples described herein are to be understood as illustrative examples of embodiments of the invention. Further embodiments and examples are envisaged. Any feature described in relation to any one example or embodiment may be used alone or in combination with other features. In addition, any feature described in relation to any one example or embodiment may also be used in combination with one or more features of any other of the examples or embodiments, or any combination of any other of the examples or embodiments. Furthermore, equivalents and modifications not described herein may also be employed within the scope of the invention, which is defined in the claims.

Claims

1. A dishwashing machine comprising:

   a controller;
   a spray-arm having a plurality of outlets for spraying liquid in a washing compartment of the dishwashing machine during a washing cycle;
   a motor for providing a rotational motion to the spray-arm;
   a transmission arrangement operatively connecting the motor and the spray-arm, the transmission arrangement constructed and arranged to provide a translational movement of the spray-arm in the washing compartment as the spray-arm rotates; and
   the controller being arranged to vary a speed of rotation of the motor during the washing cycle to control movement of the spray-arm according to a pre-determined path.

2. A dishwashing machine according to claim 1, the controller arranged to use a look-up-table to determine how the speed of rotation of the motor is to be varied over time.

3. A dishwashing machine according to claim 2, the controller arranged to use the look-up-table to determine a rotational speed to apply to the motor at a plurality of specific time intervals.

4. A dishwashing machine according to any of claims 1 to 3, the controller arranged to control the speed of rotation of the motor so that a linear velocity of a distal end of the spray-arm remains constant during the translational movement of the spray-arm.

5. A dishwashing machine according to any of claims 1 to 4, the dishwashing machine having a first mode in which the controller is arranged to cause only the rotational motion of the spray-arm, and a second mode in which the controller is arranged to provide both the rotational motion and the translational movement of the spray-arm.

6. A dishwashing machine according to claim 5, wherein the controller is arranged to cause the dishwashing machine to switch from the first mode to the second mode in response to at least one condition being met.

7. A dishwashing machine according to claim 6, wherein the at least one condition comprises one or more of: the washing compartment reaching a threshold temperature; initiation of one or more stages of the washing cycle; an elapsed time of the washing cycle.

8. A dishwashing machine according to any of claims 1 to 7, the washing compartment having a generally rectangular profile in plan-view, the transmission arrangement constructed and arranged and the speed of rotation of the spray-arm controlled by the controller so that over the washing cycle the spray-arm is translated towards each corner of the washing compartment at least once.

9. A dishwashing machine according to any of claims 1 to 8, wherein the transmission arrangement comprises a rack and pinion arrangement, the rack being located on the spray-arm.

10. A dishwashing machine according to any of claims 1 to 9, comprising a clutch between the motor and the transmission arrangement.

11. A dishwashing machine according to any of claims 1 to 10, a length of the spray-arm being fixed.

12. A method of operating a dishwashing machine comprising:
controlling movement of a spray-arm of the dishwashing machine by varying a rotational speed of a motor of the dishwashing machine so that the movement of the spray-arm follows a pre-determined path, the motor arranged to provide rotational motion to the spray-arm and the dishwashing machine further comprising a transmission arrangement between the motor and the spray-arm, the transmission arrangement arranged to provide a translational movement of the spray-arm in the washing compartment.

13. A method according to claim 12, comprising using a look-up-table to determine how the speed of rotation of the motor is to be varied over time.

14. A method according to claim 13, comprising using the look-up-table to determine a rotational speed to apply to the motor at a plurality of specific time intervals.

15. A computer program comprising code which when executed causes a dishwashing machine to perform the method of any of claims 12 to 14.

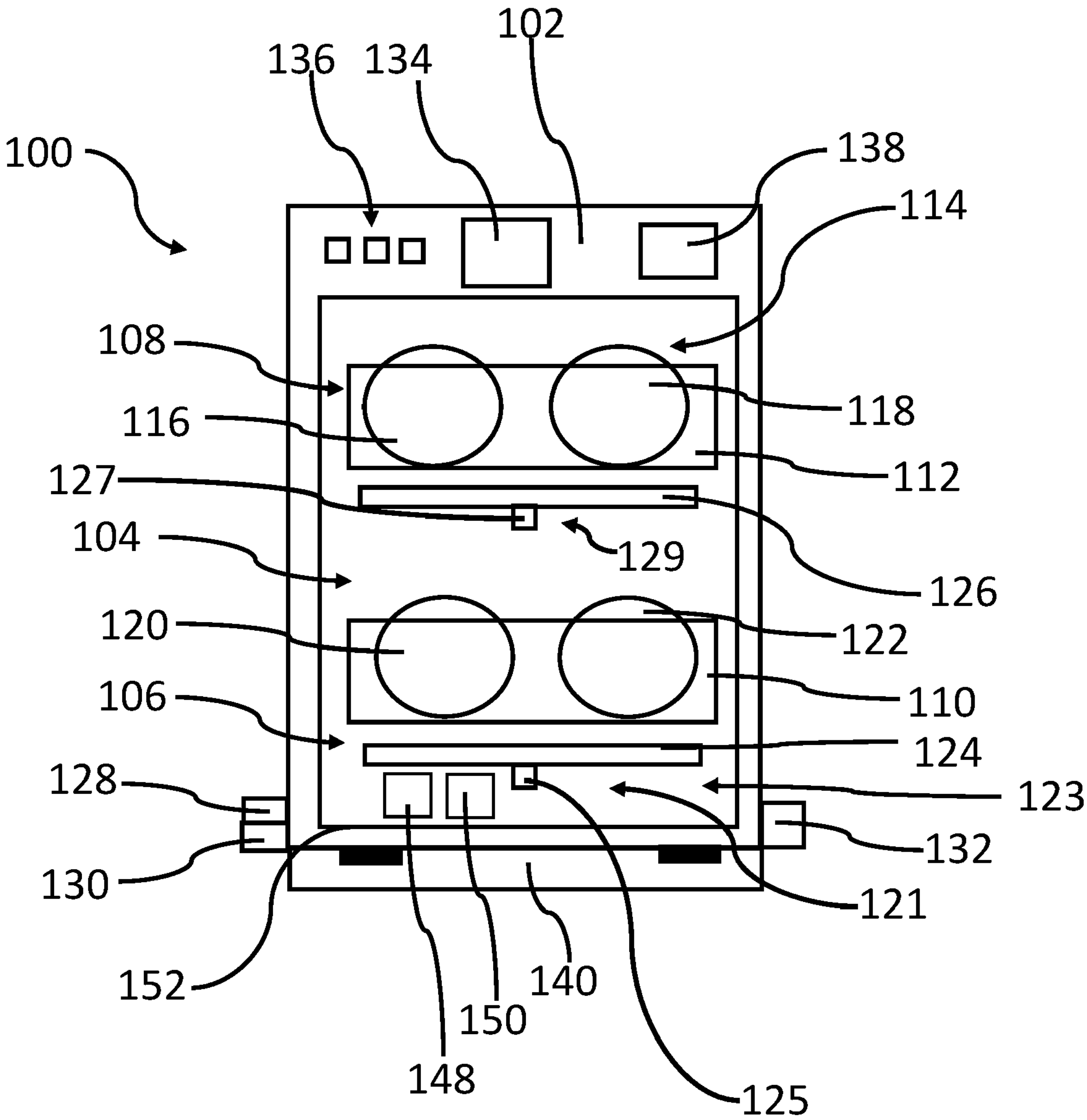
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Fig. 1

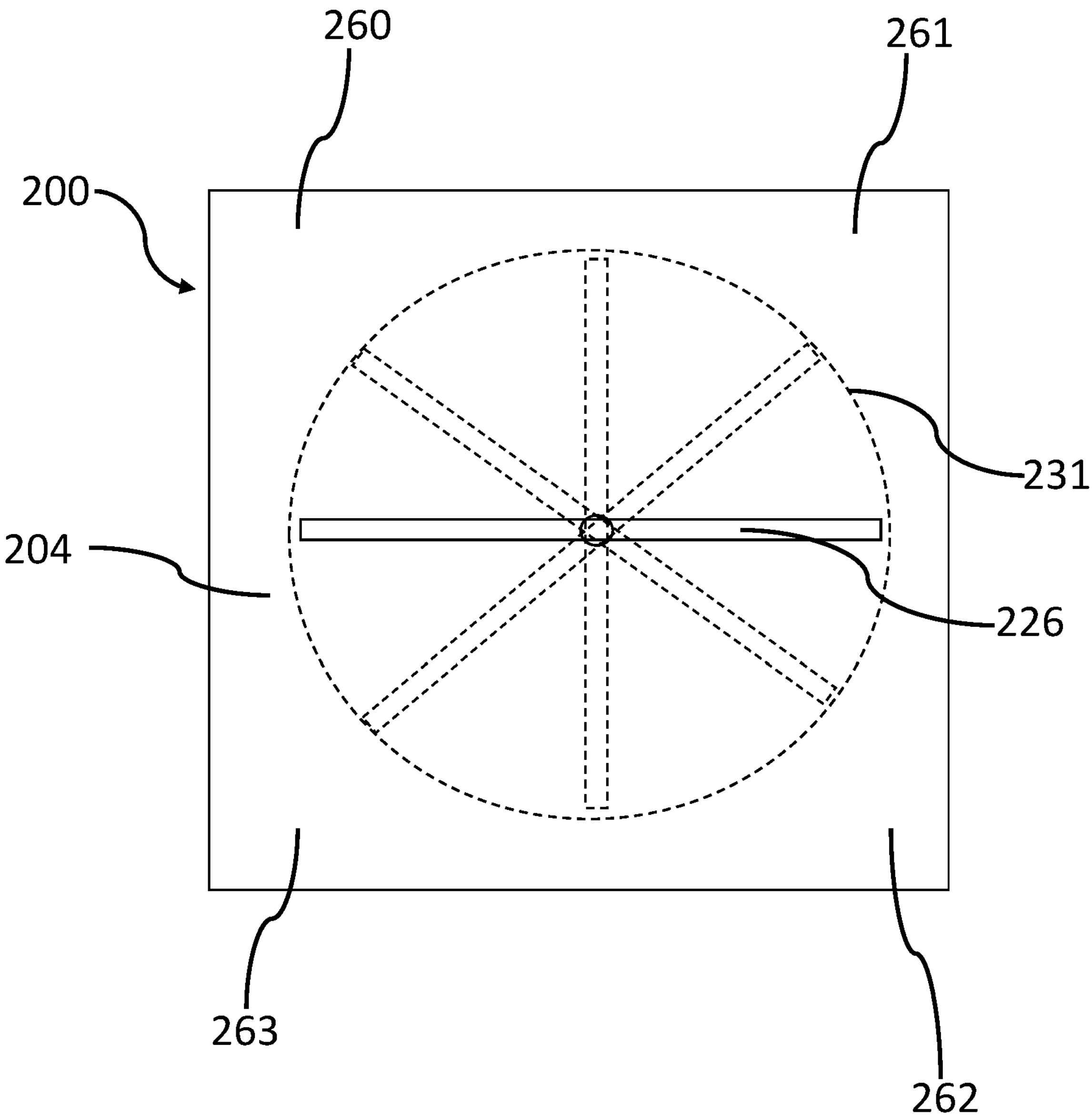

Fig. 2

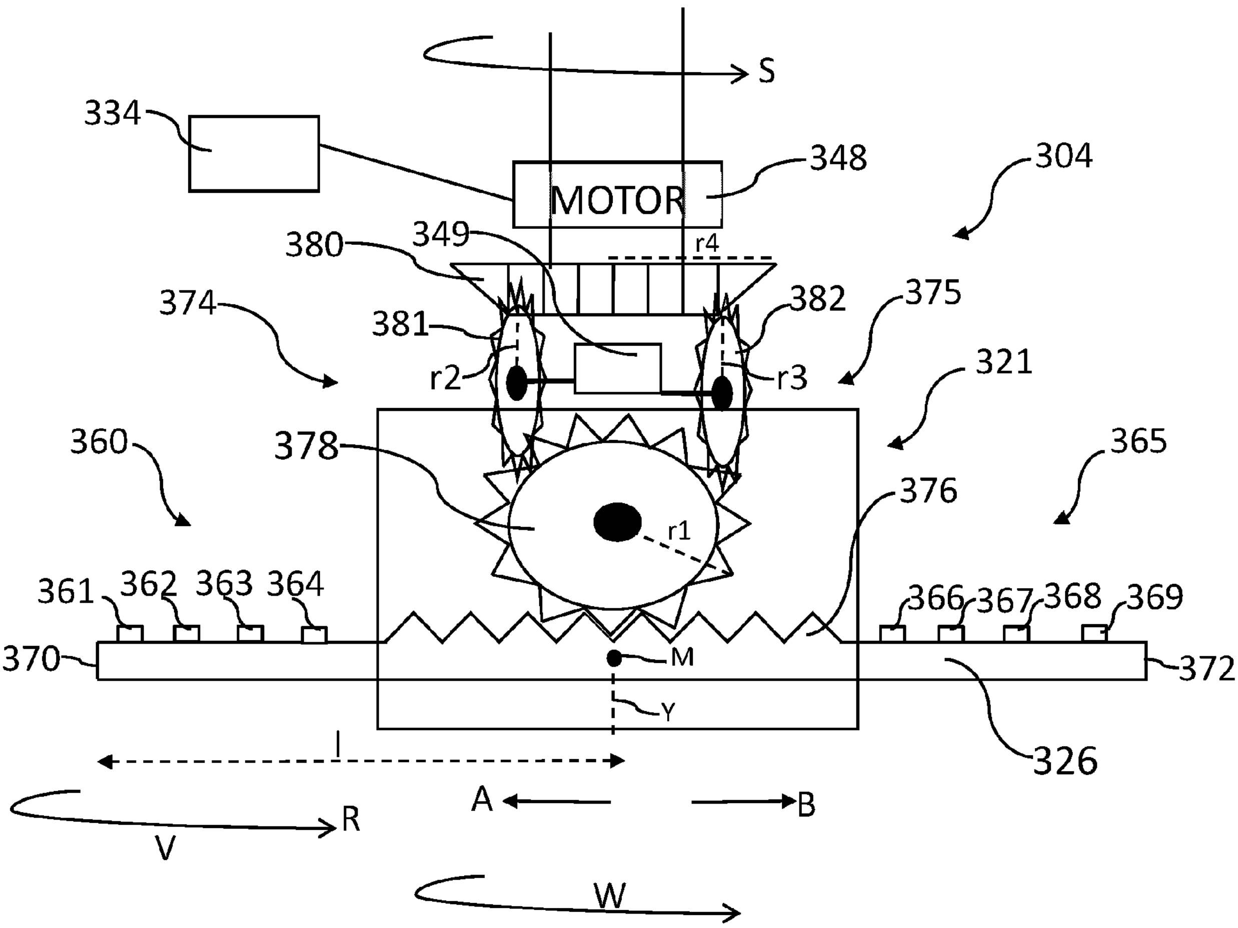
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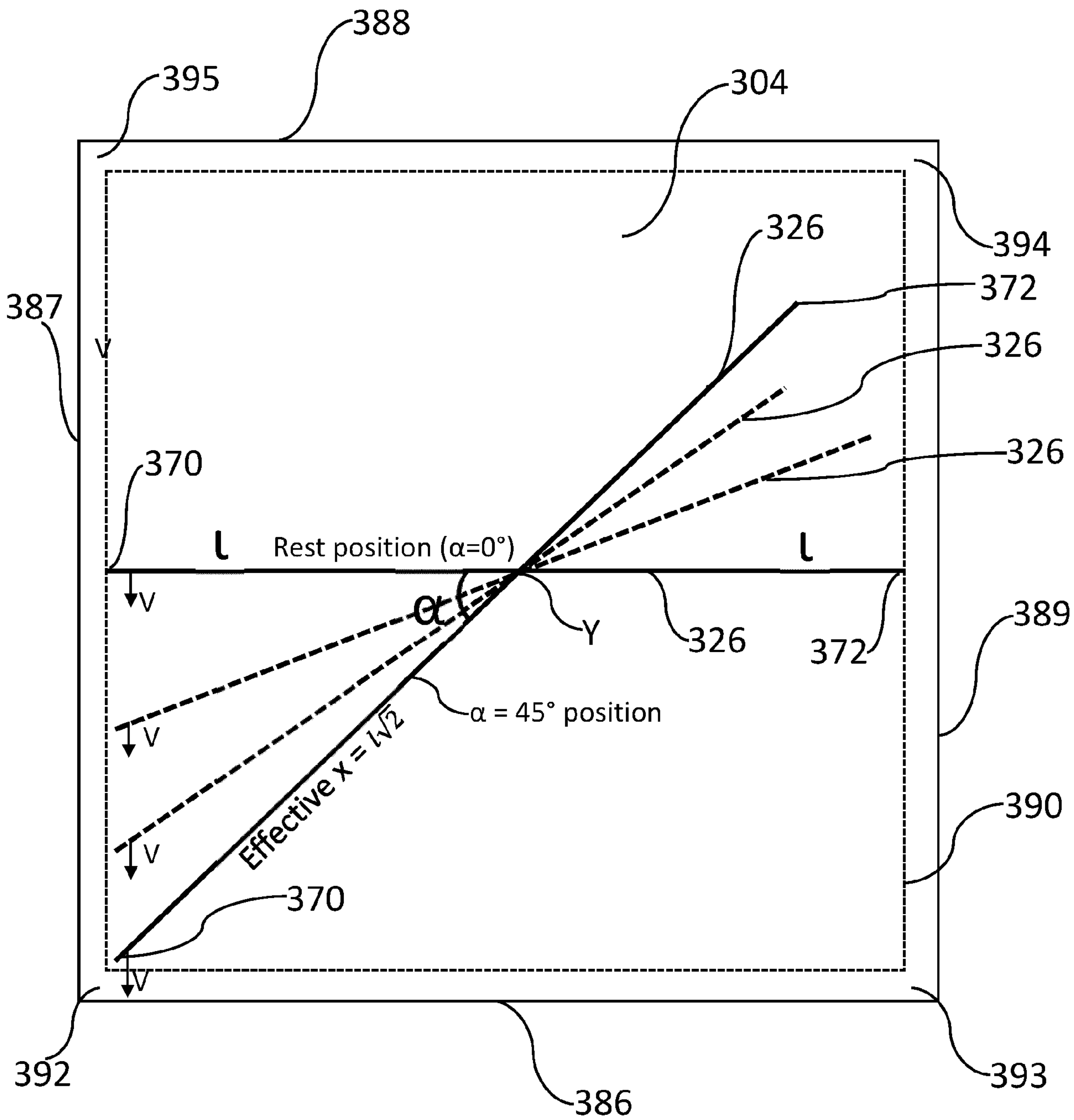
Fig. 3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l
V
α
Y
326
372
389
α = 45° position
V
Effective x = l√2
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V
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V
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386
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Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 20 19 7239

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1

Place of search	Date of completion of the search	Examiner
Munich	27 January 2021	Jezierski, Krzysztof

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27-01-2021

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