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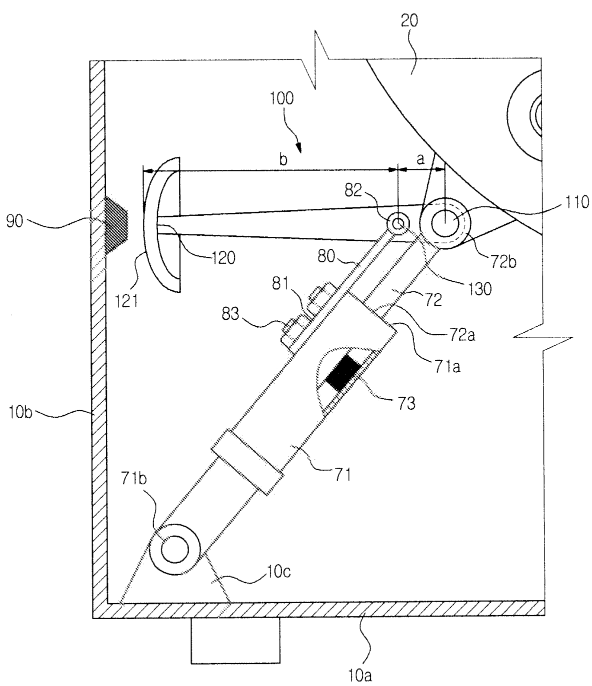
(54) Washing machine and laundry amount detection apparatus thereof

(57) Disclosed herein are a washing machine that amplifies the displacement of a tub according to input of laundry such that the displacement of the tub is accurately sensed by a sensor module and a laundry amount detection apparatus thereof. The washing machine includes a housing forming an external appearance thereof, a tub provided in the housing to contain water, an amplification unit to amplify displacement of the tub, and a sensor module to sense weight of laundry using the amplified displacement of the tub.

FIG. 3



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Description

BACKGROUND

1. Field

[0001] Embodiments of the present invention relate to a washing machine that amplifies the displacement of a tub according to input of laundry such that the displacement of the tub is sensed by a sensor module and a laundry amount detection apparatus thereof.

2. Description of the Related Art

[0002] Generally, a washing machine (normally, a drum washing machine) includes a tub mounted in a housing to receive water containing a detergent, i.e., detergent water, a drum rotatably mounted in the tub to wash laundry, and a door hingedly coupled to the front of the housing to open and close an opening formed at the front of the housing. Laundry is put into the drum through the opening of the housing, a predetermined amount of detergent water is supplied into the tub, and the drum is rotated to wash the laundry.

[0003] When a user selects a washing course, the weight of the laundry is sensed to decide the amount of wash water, wash water sufficient to wet the laundry is supplied into the tub together with a detergent according to the decided amount of wash water, and the drum is rotated to perform a washing cycle and a spin-drying cycle.

[0004] When the weight of the laundry is accurately sensed, the amount of water corresponding to the sensed weight of the laundry is supplied to wash the laundry. Consequently, the amount of water and power used is reduced, thereby reducing energy consumption.

[0005] In the related art, laundry in the drum is used as an inertia load, and inertia is estimated to sense the weight of the laundry. For example, predetermined voltage is applied to a motor to accelerate the drum, and inertia is estimated using change in voltage and velocity of the motor during acceleration of the drum to sense the weight of the laundry.

[0006] In this method of sensing the weight of the laundry, no additional sensor is provided, thereby reducing material costs. However, a weight sensing error may occur according to the waveform of the voltage. Also, washing machines may have different deviations, with the result that an error may occur during sensing of the weight of the laundry.

[0007] Also, the displacement of the tub according to the descent of the tub due to input of laundry may be measured to estimate the amount of laundry. If the descent of the tub according to the input of the laundry is slight, however, a weight sensing error may occur. In particular, when a small amount of laundry is input, the descent of the tub is very slight, with the result that weight detection may fail.

SUMMARY

[0008] It is an aspect of to provide a washing machine that amplifies the displacement of a tub according to input of laundry such that the displacement of the tub is accurately sensed by a sensor module and a laundry amount detection apparatus thereof.

[0009] Additional aspects will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

[0010] In accordance with one aspect, a washing machine includes a housing forming an external appearance thereof, a tub provided in the housing to contain water, an amplification unit to amplify displacement of the tub, and a sensor module to sense weight of laundry using the amplified displacement of the tub.

[0011] The amplification unit may include a lever configured to be rotated about a predetermined shaft in proportion to the displacement of the tub to amplify the displacement of the tub and a fixing member rotatably coupled to a predetermined region of the lever at one end thereof to form the shaft of the lever.

[0012] The lever may include an input end provided at the tub such that the displacement of the tub is transmitted to the input end and an output end provided opposite to the input end to amplify and transmit the displacement of the tub to the sensor module.

[0013] The lever may be formed such that a length from the input end of the lever to the shaft of the lever is shorter than a length from the output end of the lever to the shaft of the lever.

[0014] The washing machine may further include a damper provided below the tub to dampen vibration, and the damper may include a cylinder mounted at a bottom of the housing and a piston provided below the tub such that the piston is advanced and retreated in the cylinder.

[0015] The piston may be coupled to the input end of the lever provided below the tub such that the displacement of the tub is transmitted to the input end of the lever.

[0016] The fixing member may have the other end fixedly mounted to an outer circumference of the cylinder.

[0017] The sensor module may include an optical sensor module mounted at a side of the housing, and the output end of the lever may include a reflection plate corresponding to the optical sensor module.

[0018] The sensor module may include a capacitance sensor module mounted at a side of the housing and the output end of the lever.

[0019] The capacitance sensor module may include a first electrode plate mounted at the side of the housing and a second electrode plate mounted at the output end of the lever such that the second electrode plate faces the first electrode plate.

[0020] The capacitance sensor module may constitute an RC circuit and/or an LC circuit using change in capacitance between the first electrode plate and the second electrode plate.

[0021] The sensor module may include a resistor sensor module mounted at a side of the housing and the output end of the lever.

[0022] The resistor sensor module may include a variable resistor mounted at the side of the housing and a resistance adjuster mounted at the output end of the lever such that the resistance adjuster is connected to the variable resistor to adjust a resistance value of the variable resistor.

[0023] The resistor sensor module may constitute an RC circuit or an RR circuit using change in output voltage of the variable resistor.

[0024] In accordance with another aspect of the present invention, a washing machine includes a housing, a tub provided in the housing to contain water, a lever having an output end to amplify displacement of the tub transmitted to an input end according to input of laundry into the washing machine, and a sensor module configured to measure displacement of the output end of the lever to sense weight of the laundry.

[0025] The washing machine may further include a fixing member coupled to a predetermined region of the lever to form a shaft of the lever, and the lever may be rotated about the shaft such that the displacement of the tub transmitted to the input end of the lever is amplified at the output end of the lever.

[0026] In accordance with a further aspect of the present invention, a laundry amount detection apparatus of a washing machine includes a sensor module configured to measure descent of a tub to sense weight of laundry and a lever configured to be rotated about a shaft to amplify the descent of the tub such that the descent of the tub is sensed by the sensor module, wherein the lever includes an input end fixedly mounted to the tub such that the descent of the tub is transmitted to the input end and an output end provided opposite to the sensor module.

[0027] The laundry amount detection apparatus may further include a fixing member rotatably coupled to a predetermined region of the lever at one end thereof to form the shaft of the lever.

[0028] The sensor module may include an optical sensor module, and the output end of the lever may include a reflection plate corresponding to the optical sensor module.

[0029] The sensor module may include a capacitance sensor module, and the capacitance sensor module may include a first electrode plate having a predetermined size and a second electrode plate mounted at the output end of the lever such that the second electrode plate corresponds to the first electrode plate.

[0030] The sensor module may include a resistor sensor module, and the resistor sensor module may include a variable resistor and a resistance adjuster mounted at the output end of the lever such that the resistance adjuster is connected to the variable resistor to adjust a resistance value of the variable resistor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] These and/or other aspects of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a schematic side sectional view illustrating the structure of a drum washing machine according to an embodiment of the present invention;

FIG. 2 is a front sectional view of the drum washing machine shown in FIG. 1;

FIG. 3 is a partially enlarged view of FIG. 2;

FIG. 4 is a view illustrating the operation of a lever shown in FIG. 3;

FIG. 5 is a schematic control block diagram of a sensor module shown in FIG. 3;

FIG. 6 is a control flow chart illustrating a process of sensing image change based on displacement of an object, which is changed depending upon the weight of laundry, in the drum washing machine shown in FIG. 2 to confirm the weight of the laundry;

FIG. 7 is a view illustrating a pixel mapping process to determine a correlation coefficient between a reference image and a current image of FIG. 6;

FIG. 8 is a partial view illustrating a drum washing machine according to another embodiment of the present invention;

FIG. 9 is a view illustrating the operation of a lever shown in FIG. 8;

FIG. 10 is a partial view illustrating a drum washing machine according to a further embodiment of the present invention; and

FIG. 11 is a view illustrating the operation of a lever shown in FIG. 10.

DETAILED DESCRIPTION

[0032] Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

[0033] FIG. 1 is a schematic side sectional view illustrating the structure of a drum washing machine 1-1 according to an embodiment of the present invention. FIG. 2 is a front sectional view of the drum washing machine shown in FIG. 1. FIG. 3 is a partially enlarged view of FIG. 2. FIG. 4 is a view illustrating the operation of a lever shown in FIG. 3.

[0034] As shown in FIGS. 1 to 4, the drum washing machine 1-1 includes a box-shaped housing 10 forming the external appearance thereof, a tub 20 provided in the housing 10 to contain water, a cylindrical drum 30 rotatably mounted in the tub 20, the drum 30 having through holes 31 through which water and air pass, and a drive motor 40 to transmit rotational force to the drum 30 such that the drum 30 is rotated to wash and spin-dry laundry in the drum 30.

[0035] The tub 20 and the drum 30 are partially open at the front middle portions thereof to constitute inlet ports 20a and 30a through which laundry is put into or removed from the drum 30. To the front of the housing 10 is hingedly coupled a door 50 to open and close the inlet ports 20a and 30a of the tub 20 and the drum 30.

[0036] At the inner circumference of the drum 30 are arranged lifters 32 at predetermined intervals. During rotation of the drum 30 in alternating directions, the laundry is lifted and dropped by the lifters 32, by which the laundry is washed.

[0037] In this embodiment, the drum washing machine 1-1 also includes suspension springs 60 disposed above the tub 20 to elastically support the tub 20 and dampers 70 disposed below the tub 20 to dampen vibration, thereby preventing the occurrence of vibration during the operation of the drum washing machine 1-1.

[0038] The suspension springs 60 and the dampers 70 movably support the tub 20 above and below the tub 20. That is, vibration generated from the drum 30 during rotation of the drum 30 is transmitted to the tub 20, with the result that the tub 20 is vibrated in all directions, for example back and forth, side to side, and up and down. Such vibration of the tub 20 is dampened by the suspension springs 60 and the dampers 70.

[0039] Each of the dampers 70 may be mounted to the tub 20 at one end 70a thereof and to a bottom 10a of the housing 10 at the other end 70b thereof via an intervention member 10c to dampen vibration generated from the tub 20 during rotation of the drum 30.

[0040] Each of the dampers 70 includes a cylinder 71 having one open end 71a and the other end 71 b mounted to the bottom 10a of the housing 10 of the washing machine, a piston 72 having one end 72a mounted in the cylinder 71 in an advancing and retreating manner and the other end 72b mounted to the bottom of the tub 20, and a friction pad 73 having one major surface mounted to the piston 72 and the other major surface in tight contact with the inner surface of the cylinder 71 such that the friction pad 73 is advanced and retreated in the cylinder 71 together with the piston 72 to dampen vibration through friction between the friction pad 73 and the cylinder 71.

[0041] When vibration from the tub 20 is transmitted to each of the dampers 70, therefore, the friction pad 73 moves along the inner surface of the cylinder 71 according to the movement of the piston 72 to dampen vibration transmitted from the tub 20 through friction between the friction pad 73 and the cylinder 71.

[0042] Meanwhile, a fixing member 80 is mounted to the outer circumference of the cylinder 71 such that the fixing member 80 is coupled to a predetermined region of a lever 100, which will be described later. One end 81 of the fixing member 80 is fixedly mounted to the cylinder 71 via screws 83, and the other end 82 of the fixing member 80 is fixedly mounted to the predetermined region of the lever 100, with the result that the lever 100 is rotated about the predetermined region as the tub 20 descends.

[0043] In the drawings, the fixing member 80 is mounted to the outer circumference of the cylinder 71 although the fixing member 80 may be formed in various shapes and mounted at the bottom 10a or a side 10b of the housing 10.

[0044] In this embodiment, the drum washing machine 1-1 also includes a sensor module 90 to sense displacement of the tub 20 before and after laundry is put into the drum 30 to confirm laundry amount, i.e., the weight of the laundry. The sensor module 90 may be mounted to the side 10b of the housing 10 such that the sensor module 90 is opposite to the outer circumference of the tub 20.

[0045] When laundry is put into the drum 30, the tub 20 descends vertically. The heavier the laundry is, the more the tub 20 descends.

[0046] The sensor module 90 senses displacement of the tub 20 before and after the laundry is put into the drum 30 to confirm the weight of the laundry.

[0047] The sensor module 90 may be an optical sensor module, which will be described in detail with reference to FIGS. 4 to 6.

[0048] In this embodiment, the drum washing machine 1-1 also includes a lever 100 to amplify the displacement of the tub 20 such that displacement of the tub 20 is sensed by the optical sensor module 90.

[0049] The lever 100 is long and disposed between the lower part of the tub 20 and the optical sensor module 90. The lever 100 includes an input end 110 fixedly mounted to the tub 20 and an output end 120 opposite to the input end 110 such that the output end 120 faces the optical sensor module 90.

[0050] As shown in FIGS. 3 and 4, the input end 110 of the lever 100 may be coupled to a position where the piston 72 of a corresponding one of the dampers 70 is mounted at the lower part of the tub 20. The input end 110 of the lever 100 may be coupled to any region of the tub 20 as long as the input end 110 of the lever 100 amplifies or magnifies micro displacement of the tub 20 such that the displacement of the tub 20 is sensed by the optical sensor module 90.

[0051] The lever 100 is provided with a rotation shaft 130 coupled to the fixing member 80 such that the rotation shaft 130 is adjacent to the input end 110 of the lever 100. The rotation shaft 130 serves as a rotation center of the lever 100.

[0052] The output end 120 of the lever 100 amplifies micro displacement of the tub 20 input to the input end 110 of the lever 100. That is, on the assumption that the distance from the input end 110 of the lever 100 to the rotation shaft 130 is a and the distance from the rotation shaft 130 to the output end 120 of the lever 100 is b, the output end 120 of the lever 100 amplifies micro displacement of the tub 20 by b/a according to the principle of the lever.

[0053] The output end 120 of the lever 100 may includes a reflection plate 121 to reflect light emitted from the optical module sensor 90. The reflection plate 121 may not be provided as long as the width of the output end 120 of the lever 100 facing the optical sensor module is sufficiently large, and the output end 120 of the lever 100 is formed of a reflective material to reflect light.

[0054] When laundry is put into the drum 30, the tub 20 descends. As a result, the lever 100 is rotated about the rotation shaft 130 as shown in FIG. 4. At this time, the lever 100 amplifies micro displacement of the tub 20 by b/a such that the displacement of the tub 20 is sensed by the optical module sensor 90.

[0055] For example, if b/a is 4, the displacement of the output end 120 of the lever 100 is four times that of the tub 20. That is, on the assumption that the displacement of the tub 20 is 1 mm, the displacement of the output end 120 of the lever 100 is amplified to 4 mm, which is sufficient for the optical sensor module 90 to sense the weight of laundry.

[0056] In this way, the displacement of the tub 20 is amplified according to the principle of the lever using the optical sensor module 90 and the lever 100, and the amplified displacement of the tub 20 is sufficient for the optical sensor module 90 to sense the weight of laundry. Although the tub 20 descends very slightly, therefore, the weight of laundry is sensed by the optical sensor module 90.

[0057] Also, the use of the optical sensor module 90 and the lever 100 may reduce the occurrence of weight sensing errors based on a voltage waveform as compared with the use of a motor in the related art.

[0058] FIG. 5 is a schematic control block diagram of the optical sensor module shown in FIG. 3. FIG. 6 is a control flow chart illustrating a process of sensing image change based on displacement of an object, which is changed depending upon the weight of laundry, in the drum washing machine shown in FIG. 2 to confirm the weight of the laundry. FIG. 7 is a view illustrating a pixel mapping process to determine a correlation coefficient between a reference image and a current image of FIG. 6.

[0059] As shown in FIGS. 5 to 7, the optical sensor module 90 may include a light source 91, a lens 92, an image sensor 93 and an image processor 94.

[0060] The light source 91 may be a light emitting diode (LED) or a laser. However, it is not limited thereof. The light source 91 irradiates light to the output end 120 of the lever 100.

[0061] The lens 92 adjusts the direction of the light emitted from the light source 91 such that the light is directed to the output end 120 of the lever 100 and the direction of the light reflected from the output end 120 of the lever 100 such that the light is directed to the image sensor 93.

[0062] The image sensor 93 receives the light reflected from the output end 120 of the lever 100 to create an image of the output end 120 of the lever 100. The light source 91 and the image sensor 93 may be incorporated into the sensor module 90 to achieve structural integration.

[0063] The image processor 94 calculates displacement of two images using a common correlation algorithm to compare the two images.

[0064] A controller 200 communicates with the image processor 94 to receive the image change between the two images from the image processor 94 and retrieves the weight of laundry corresponding to the image change from a memory 210 thereof to confirm the weight of the laundry.

[0065] Hereinafter, a process of sensing image change based on displacement of the tub to confirm the weight of laundry will be described with reference to FIG. 6.

[0066] First, the controller 200 commands the optical sensor module 90 to sense and store an image of the output end 120 of the lever 100 before laundry is put into the drum 30. However, it is also understood that the image of output end 120 of the lever 100 can be pre-stored.

[0067] Upon receiving the command from the controller 200, the optical sensor module 90 irradiates light to the output end 120 of the lever 100 through the light source 91 (S100). The light emitted from the light source 91 is irradiated to the output end 120 of the lever 100 through the lens 92. The light irradiated to the output end 120 of the lever 100 is reflected from the output end 120 of the lever 100 and is received by the image sensor 93 through the lens 92.

[0068] The optical sensor module 90 senses an image of the output end 120 of the lever 100 using the light reflected from the output end 120 of the lever 100 and received by the image sensor 93 (S101).

[0069] The controller 200 receives the image of the output end 120 of the lever 100 from the optical sensor module 90 to store the same in the memory 210 as a reference image of the output end 120 of the lever 100 (S102). At this time, the image of the output end 120 of the lever 100 may be stored in a memory of the optical sensor module 90.

[0070] The controller 200 determines whether laundry has been put into the drum 30 (S103). The determination as to whether the laundry has been put into the drum 30 may be achieved based on the operation of the door, a laundry sensor, or a user command.

[0071] Upon determining at Operation S103 that the laundry has not been put into the drum 30, the controller 200 returns to a predetermined routine.

[0072] On the other hand, upon determining at Operation S103 that the laundry has been put into the drum 30, the controller 200 commands the optical sensor module 90 to sense and store an image of the output end 120 of the lever 100 again. At this time, when the laundry has been put into the drum 30, the output end 120 of the lever 100 is moved in the direction indicated by an arrow in FIG. 4 according to the weight of the laundry, with the result that the image of the lever 100 sensed by the optical sensor module 90 is changed.

[0073] According to the command from the controller 200, the optical sensor module 90 irradiates light to the output end 120 of the lever 100 through the light source 91 (S104). At this time, the light emitted from the light source 91 is irradiated to the output end 120 of the lever 100 through the lens 92, and the light irradiated to the output end 120 of the lever 100 is reflected from the output end 120 of the lever 100 and received by the image sensor 93 through the lens 92.

[0074] The optical sensor module 90 senses an image of the output end 120 of the lever 100 using the light source 91 reflected from the output end 120 of the lever 100 and received by the image sensor 93 (S105).

[0075] The controller 200 receives the image of the output end 120 of the lever 100 from the optical sensor module 90 to store the same in the memory 210 as a current image of the output end 120 of the lever 100 (S106).

[0076] The image processor 94 compares the current image of the output end 120 of the lever 100 with the reference image of the output end 120 of the lever 100 to sense the image change of the output end 120 of the lever 100 (S107).

[0077] Subsequently, the controller 200 retrieves (or detects) the weight of laundry corresponding to the image change between the reference image and the current image of the output end 120 of the lever 100 from the memory 210 to confirm the weight of the laundry (S108).

[0078] As shown in FIG. 7, the image change based on displacement of the output end 120 of the lever 100, which is changed depending upon the weight of the laundry, is confirmed by comparison between the reference image and the current image of the output end 120 of the lever 100.

[0079] An image of the output end 120 of the lever 100 before the laundry is put into the drum 30 is set as the reference image on which a mask window is defined. The mask window is a common portion between the reference image and the current image. When comparing the mask window with the current image, the pixels in the mask window are compared with the total pixels of the input frame although each pixel in the mask window may be compared with the most adjacent pixel thereof.

[0080] In this embodiment, the mask window (for example, a window of 4 x 4 pixels) is set from the reference image (for example, an image of 12 x 12 pixels), and the mask window is moved with respect to the entirety of the current image (for example, an image of 12 x 12 pixels) by an arbitrary pixel unit (for example, one pixel) to determine a correlation coefficient.

[0081] Comparison between the mask window of the reference image and a first region of the current image is performed to determine a correlation coefficient, and comparison between the mask window of the reference image and a second region of the current image is performed to determine a correlation coefficient. This process is repeatedly performed until comparison between the mask window of the reference image and an N region of the current image is performed.

[0082] At the position having the largest correlation efficient, X-axis and Y-axis displacement values (image change values) are created. X-axis and Y-axis displacement values may include a range from the coordinate values (0, 0) of the output end 120 of the lever 100 before the laundry is put into the drum 30 to the maximum coordinate values (n, n) of the output end 120 of the lever 100. The maximum displacement value n is decided based on the entire window size of the current image and the mask window size of the reference image.

[0083] The obtained image change value, indicating the displacement of the output end 120 of the lever 100, is provided to the controller 200 which uses the image change value to confirm the weight of the laundry.

[0084] Hereinafter, another embodiment will be described with reference to FIGS. 8 and 9. Components of this embodiment identical to those of the previous embodiment are denoted by the same reference numerals, and a description thereof will not be given. FIG. 8 is a partial view illustrating a drum washing machine 1-2 according to another embodiment. FIG. 9 is a view illustrating the operation of a lever shown in FIG. 8.

[0085] As shown in FIGS. 8 and 9, the drum washing machine 1-2 includes a housing 10 having a bottom 10a and a side 10b to form the external appearance thereof, a tub 20 provided in the housing 10 to contain water, a capacitance sensor module 300 to measure displacement of the tub 20 according to the weight of laundry, and a lever 100 to amplify the displacement of the tub 20 such that the displacement of the tub 20 is sensed by the capacitance sensor module 300.

[0086] The capacitance sensor module 300 includes a first electrode plate 310 mounted at the side 10b of the housing 10 and a second electrode plate 320 mounted at an output end 120 of the lever 100 such that the second electrode plate 320 corresponds to the first electrode plate 310. The capacitance sensor module 300 measures change in capacitance between the first and second electrode plates 310 and 320 to confirm displacement of the output end 120 of the lever 100 according to the descent of the tub and thus the weight of laundry in the drum washing machine.

[0087] The capacitance between the electrode plates 310 and 320 is inversely proportional to the distance between the electrode plates 310 and 320 and is directly proportional to the overlap area between the electrode plates 310 and 320 as represented by Equation 1. In Equation 1, εr indicates permittivity in vacuum and $\varepsilon 0$ indicates dielectric constant. S indicates the overlap area between the first and second electrode plates 310 and 320, and d indicates the distance between the first and second electrode plates 310 and 320.

$$C = \epsilon_r \epsilon_0 \frac{S}{d} \quad \text{(Equation 1)}$$

[0088] Therefore, the descent of the tub 20 is changed according to the amount of laundry in the drum washing machine, and the displacement of the tub 20 is amplified by b/a at the output end 120 of the lever 100. The overlap area, i.e., the effective area S, between the first and second electrode plates 310 and 320 is changed according to the displacement of the tub 20 and the output end 120 of the lever 100, with the result that the capacitance between the first and second electrode plates 310 and 320 is changed. Therefore, the weight of the laundry in the drum washing machine is conformed through measurement of the capacitance change.

[0089] The capacitance change may be measure using, for example, an RC circuit as shown in FIG. 9. In this case, the capacitance change may be calculated through the measurement of the change in voltage between the electrode plates 310 and 320.

[0090] That is, the first electrode plate 310, the second electrode plate 320, an input voltage (Vin) 330, and a reference resistance (R0) 340 constitute the circuit. In this case, a first output voltage output between the electrodes 310 and 320 is measured before laundry is input into the drum washing machine, a second output voltage output between the electrodes 310 and 320 is measured after the laundry is input into the drum washing machine, and the first output voltage and the second output voltage are compared to measure the capacitance change.

[0091] Although the capacitance change is not shown in the drawings, the change in resonance frequency between the electrode plates 310 and 320 may be measured using a known LC circuit to calculate the capacitance change.

[0092] Hereinafter, a further embodiment will be described with reference to FIGS. 10 and 11. Components of this embodiment identical to those of the previous embodiments are denoted by the same reference numerals, and a description thereof will not be given. FIG. 10 is a partial view illustrating a drum washing machine 1-3 according to a further embodiment. FIG. 11 is a view illustrating the operation of a lever shown in FIG. 10.

[0093] As shown in FIGS. 10 and 11, the drum washing machine 1-3 includes a housing 10 having a bottom 10a and a side 10b to form the external appearance thereof, a tub 20 provided in the housing 10 to contain water, a resistor sensor module 400 to measure displacement of the tub 20 according to the weight of laundry, and a lever 100 to amplify the displacement of the tub 20 such that the displacement of the tub 20 is sensed by the resistor sensor module 400.

[0094] The resistor sensor module 400 includes a variable resistor 410 mounted at the side 10b of the housing 10 and a resistance adjuster 420 mounted at an output end 120 of the lever 100. The resistor sensor module 400 measures voltage output from the variable resistor 410 to confirm displacement of the output end 120 of the lever 100 according to the descent of the tub 20.

[0095] Therefore, the descent of the tub 20 is changed according to the amount of laundry in the drum washing machine, and the displacement of the tub 20 transmitted to an input end 110 of the lever 100 is amplified by b/a at the output end 120 of the lever 100.

[0096] The variable resistor 410, the resistance adjuster 420, an input voltage (Vin) 430, and a reference resistance (R0) 440 constitute a circuit. In this case, the changes in output voltage according to the displacement of the tub 20 and the output end 120 of the lever 100 are compared to measure the weight of laundry.

[0097] In the embodiments as described above, the displacement of the tub based on the weight of the laundry is amplified by the lever such that the displacement of the tub is sensed by the sensor module.

[0098] As is apparent from the above description, the displacement of the tub due to the descent of the tub according to the weight of laundry is amplified such that the displacement of the tub is sensed by the sensor module, thereby achieving automatic and accurate measurement of the weight of the laundry.

[0099] Although a few embodiments have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the embodiments, the scope of which is defined in the claims and their equivalents.

Claims

1. A washing machine comprising:

a housing forming an external appearance thereof;
a tub provided in the housing to contain water;
an amplification unit to amplify displacement of the tub; and
a sensor module to sense weight of laundry using the amplified displacement of the tub.

2. The washing machine according to claim 1, wherein the amplification unit comprises:

a lever configured to be rotated about a predetermined shaft in proportion to the displacement of the tub to amplify the displacement of the tub; and
a fixing member rotatably coupled to a predetermined region of the lever at one end thereof

to form the shaft of the lever.

3. The washing machine according to claim 2, wherein the lever comprises:

an input end provided at the tub such that the displacement of the tub is transmitted to the input end; and
an output end provided opposite to the input end to amplify and transmit the displacement of the tub to the sensor module.

4. The washing machine according to claim 3, wherein the lever is formed such that a length from the input end of the lever to the shaft of the lever is shorter than a length from the output end of the lever to the shaft of the lever.

5. The washing machine according to claim 3, further comprising:

a damper provided below the tub to dampen vibration, wherein
the damper comprises a cylinder mounted at a bottom of the housing and a piston provided below the tub such that the piston is advanced and retreated in the cylinder.

6. The washing machine according to claim 5, wherein the piston is coupled to the input end of the lever provided below the tub such that the displacement of the tub is transmitted to the input end of the lever.

7. The washing machine according to claim 5, wherein the fixing member has the other end fixedly mounted to an outer circumference of the cylinder.

8. The washing machine according to claim 3, wherein the sensor module comprises an optical sensor module mounted at a side of the housing, and
the output end of the lever comprises a reflection plate corresponding to the optical sensor module.

9. The washing machine according to claim 3, wherein the sensor module comprises a capacitance sensor module mounted at a side of the housing and the output end of the lever.

10. The washing machine according to claim 9, wherein the capacitance sensor module comprises a first electrode plate mounted at the side of the housing and a second electrode plate mounted at the output end of the lever such that the second electrode plate faces the first electrode plate.

11. The washing machine according to claim 10, wherein the capacitance sensor module constitutes an RC circuit and/or an LC circuit using change in capacitance between the first electrode plate and the second electrode plate.

12. The washing machine according to claim 3, wherein the sensor module comprises a resistor sensor module mounted at a side of the housing and the output end of the lever.

13. The washing machine according to claim 12, wherein the resistor sensor module comprises a variable resistor mounted at the side of the housing and a resistance adjuster mounted at the output end of the lever such that the resistance adjuster is connected to the variable resistor to adjust a resistance value of the variable resistor.

14. The washing machine according to claim 13, wherein the resistor sensor module constitutes an RC circuit or an RR circuit using change in output voltage of the variable resistor.

FIG. 1

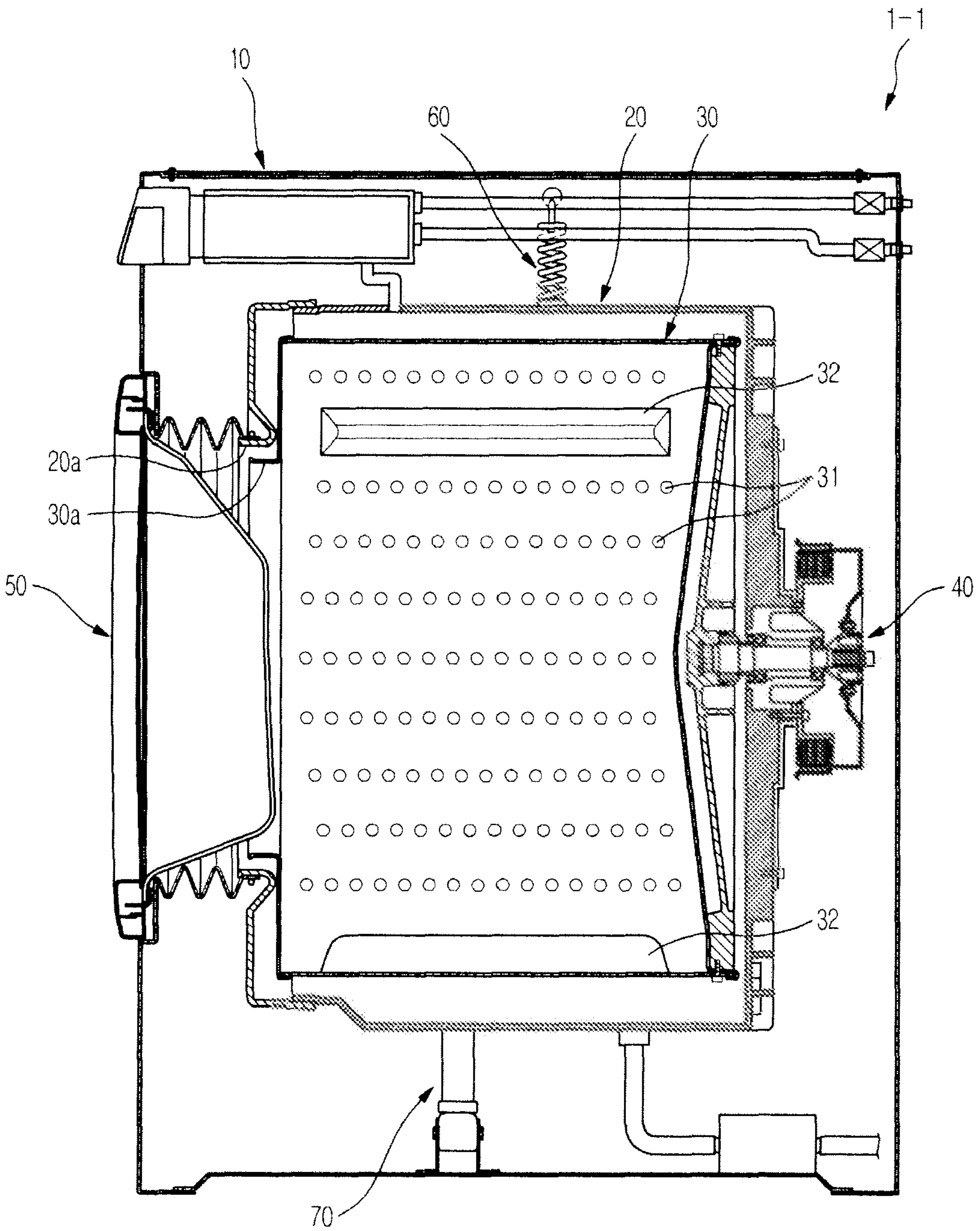


FIG. 2

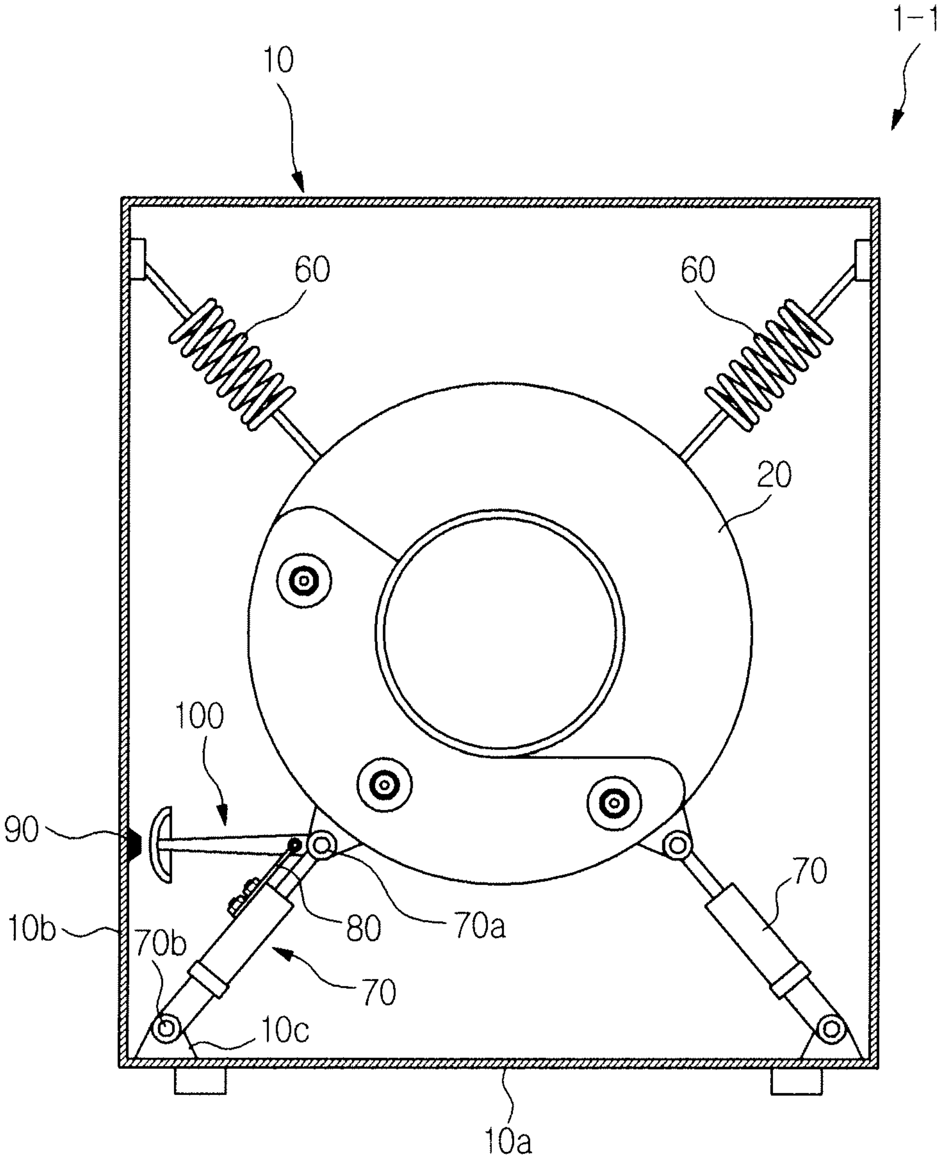


FIG. 3

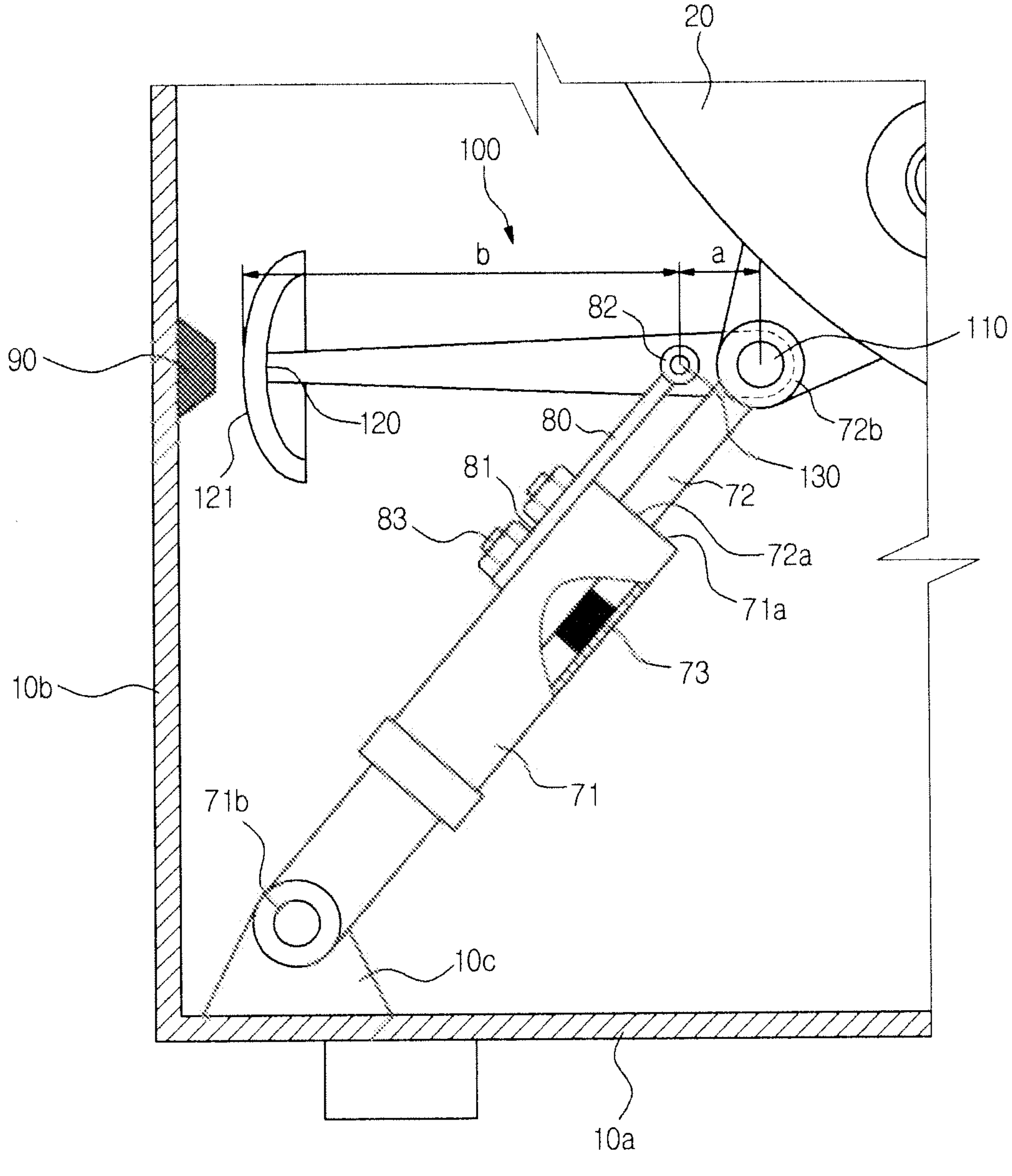

20
100
b
a
82
110
90
120
80
72b
121
81
130
72
83
72a
71a
73
10b
71
71b
10c
10a

FIG. 4

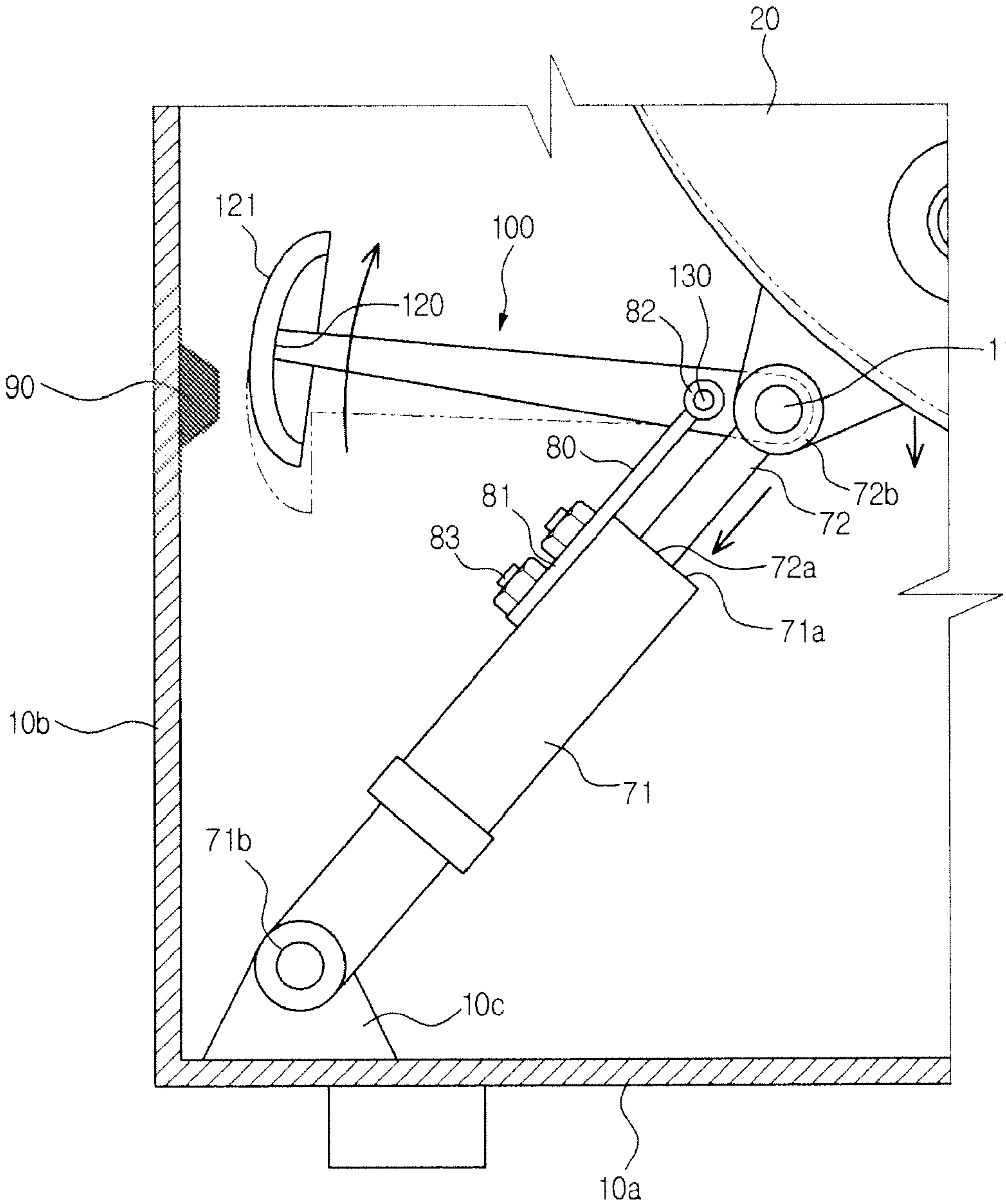

20
121
100
130
120
82
110
90
80
72b
81
72
83
72a
71a
10b
71
71b
10c
10a

FIG. 5

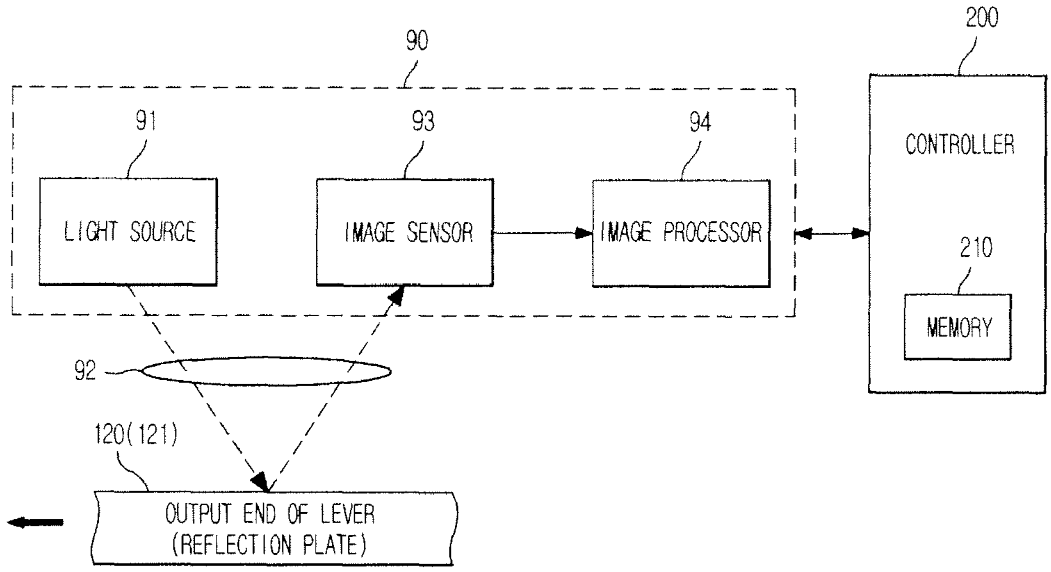

90
91
93
94
200
LIGHT SOURCE
IMAGE SENSOR
IMAGE PROCESSOR
CONTROLLER
210
MEMORY
92
120(121)
OUTPUT END OF LEVER
(REFLECTION PLATE)

FIG. 6

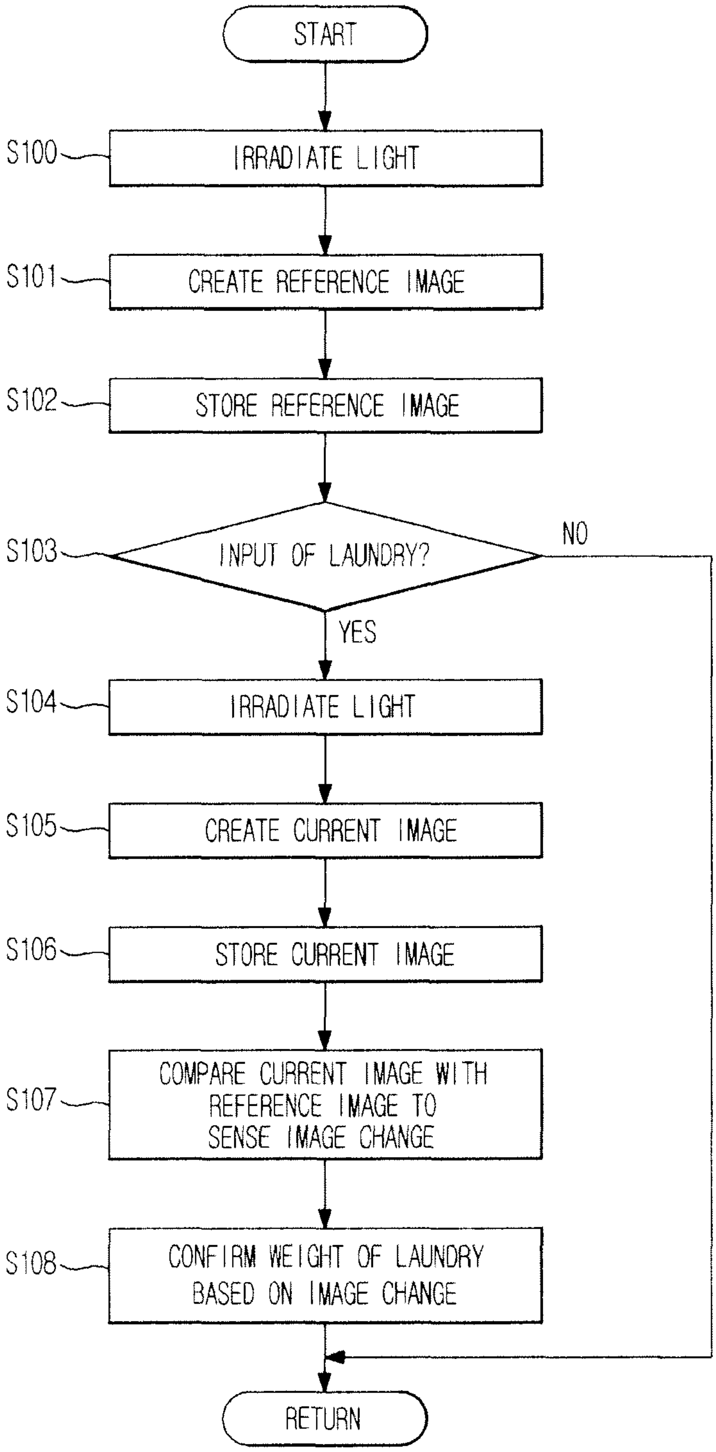

START
S100
IRRADIATE LIGHT
S101
CREATE REFERENCE IMAGE
S102
STORE REFERENCE IMAGE
S103
INPUT OF LAUNDRY?
NO
YES
S104
IRRADIATE LIGHT
S105
CREATE CURRENT IMAGE
S106
STORE CURRENT IMAGE
S107
COMPARE CURRENT IMAGE WITH REFERENCE IMAGE TO SENSE IMAGE CHANGE
S108
CONFIRM WEIGHT OF LAUNDRY BASED ON IMAGE CHANGE
RETURN

FIG. 7

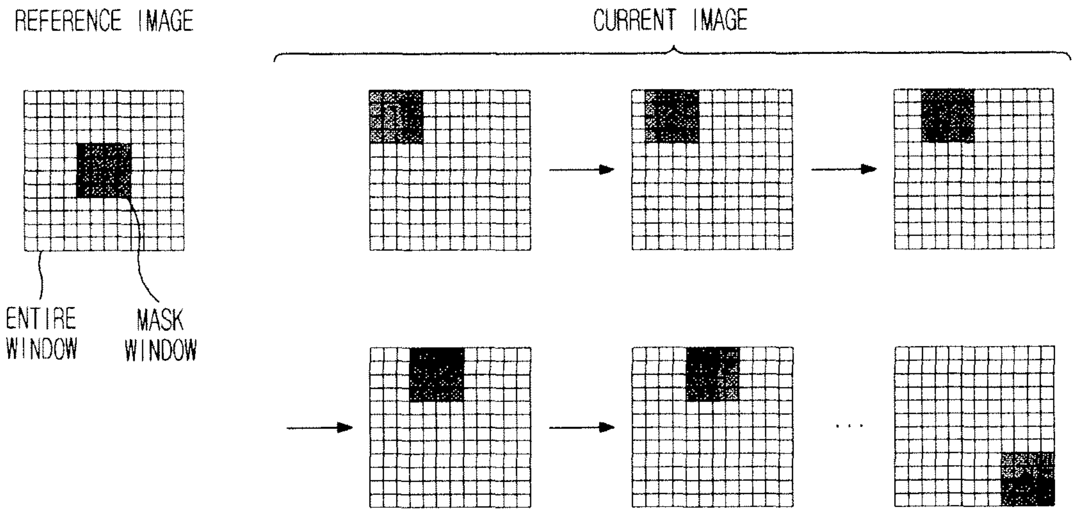


FIG. 8

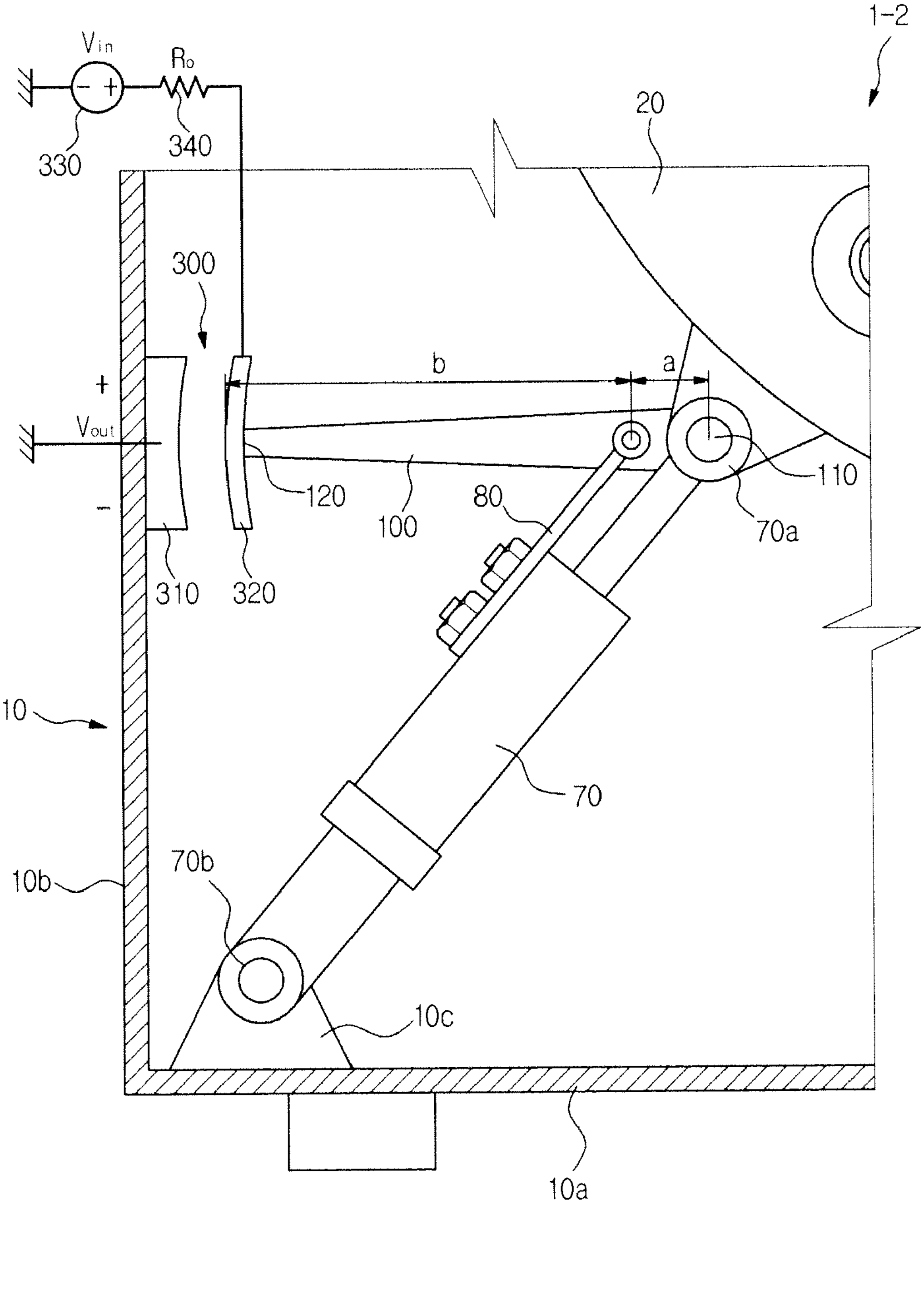

Vin
Ro
330
340
1-2
20
300
b
a
+
Vout
-
120
100
80
110
70a
310
320
10
70
70b
10b
10c
10a

FIG. 9

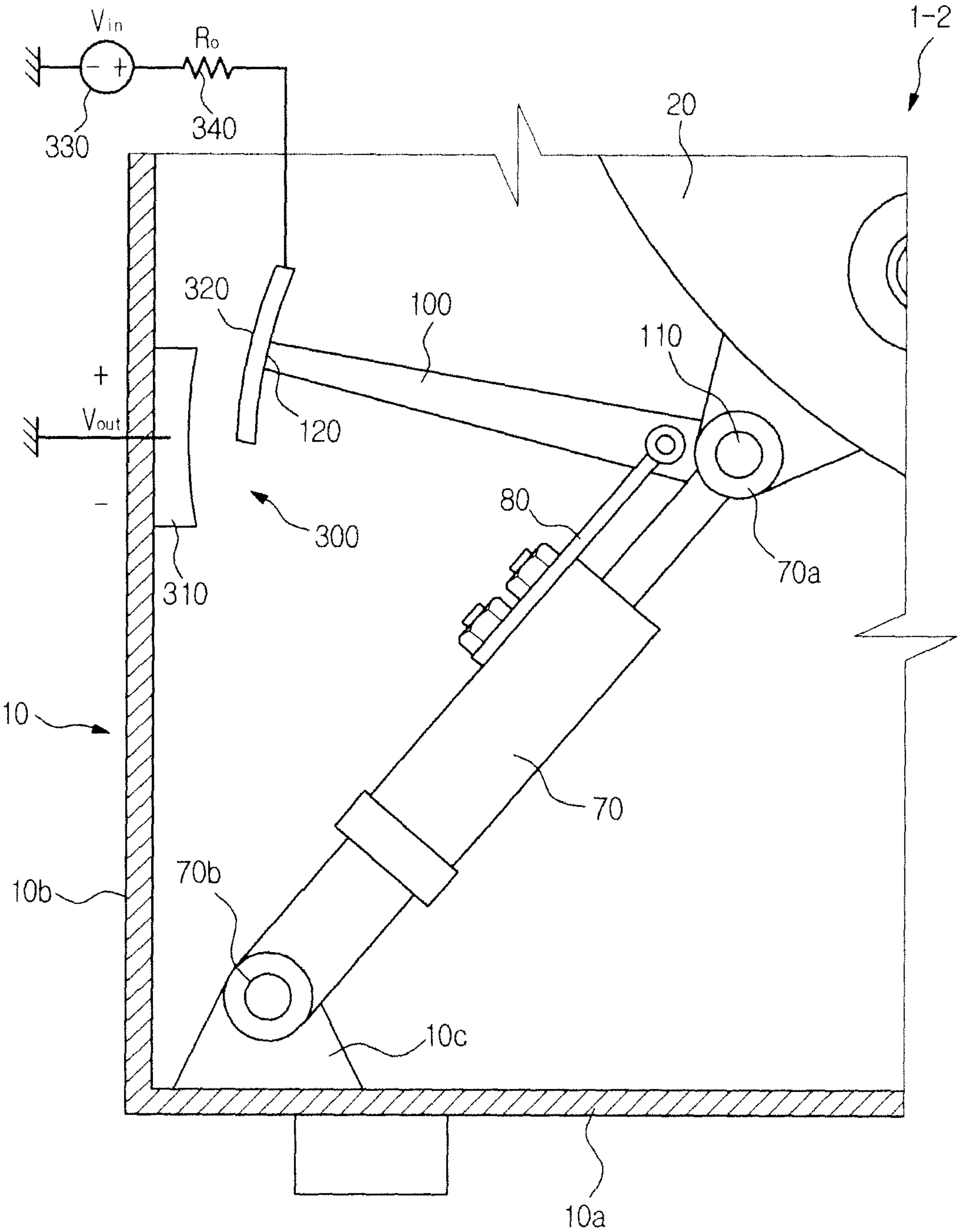

Vin
Ro
330
340
1-2
20
320
100
110
+
Vout
-
120
80
300
70a
310
10
70
70b
10b
10c
10a

FIG. 10

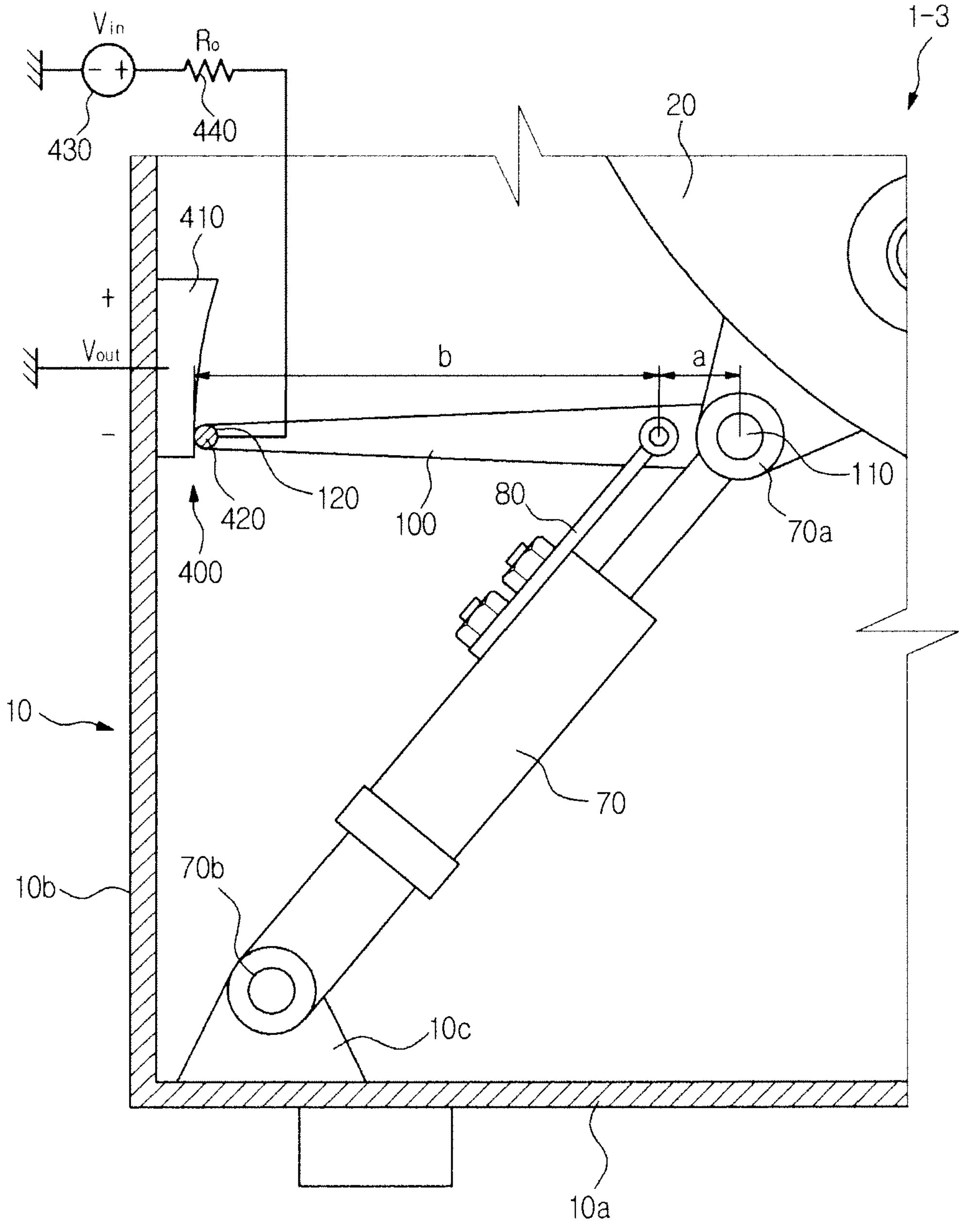
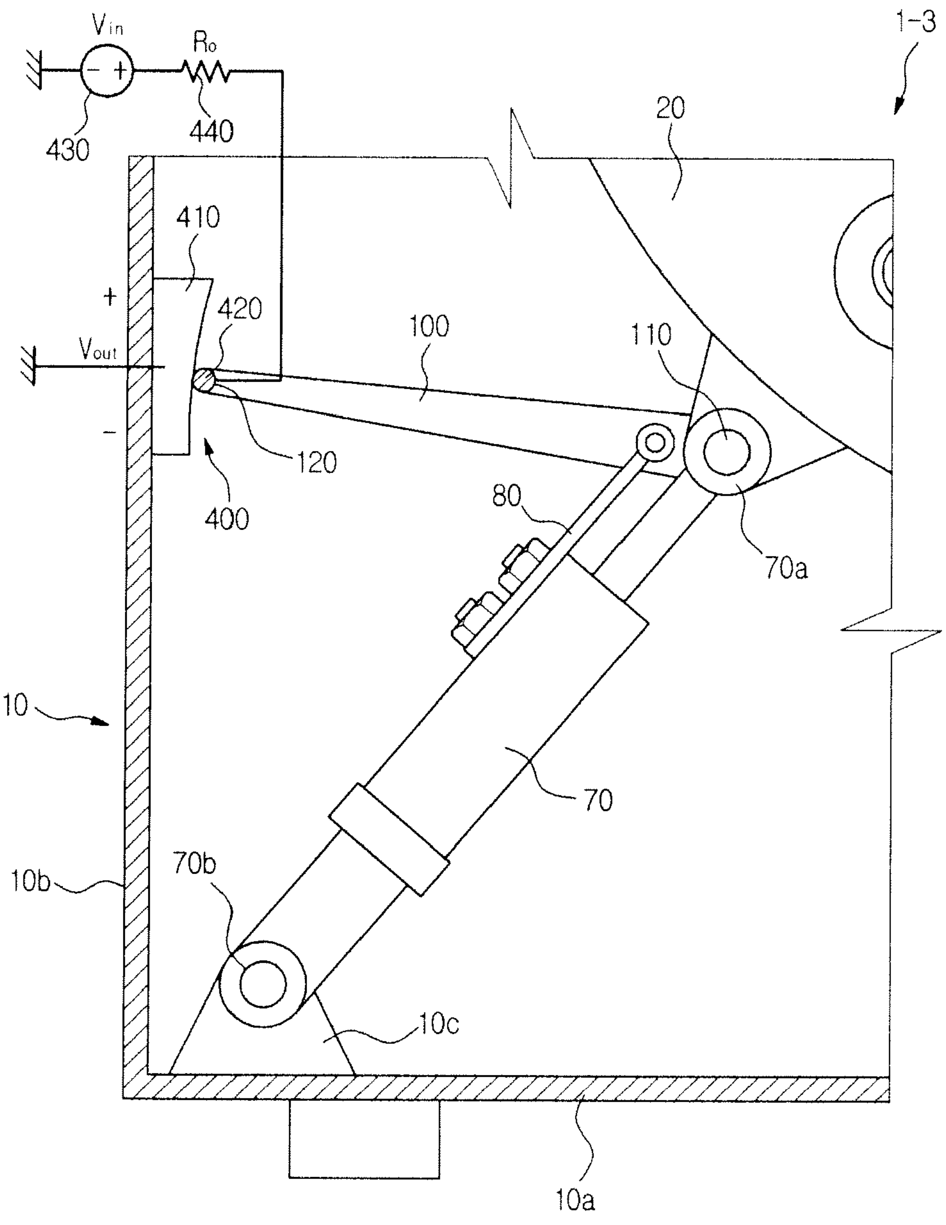

Vin
Ro
430
440
1-3
20
410
+
Vout
b
a
-
420
120
100
80
110
70a
400
10
70
10b
70b
10c
10a

FIG. 11


Vin
Ro
430
440
1-3
20
410
+
420
Vout
-
100
110
120
400
80
70a
10
70
10b
70b
10c
10a