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Fig. 2

Description

Technical Field

[0001] The present disclosure relates to a washing and/or drying machine.

Background

[0002] Washing machines are used for washing washable items, including garments such as clothes. Typically a user can select a suitable washing cycle via an interface on a front face of the washing machine. The interface usually includes a number of control knobs and/or buttons. A drying machine, also known as a tumble dryer, is operable to dry items such as garments placed therein. Typically a user can select a suitable drying cycle via an interface on a front face of the drying machine. The interface usually includes a number of control knobs and/or buttons. Some machines have both washing and drying functionality. Such machines may be known as washer-dryers.

Summary

[0003] According to a first aspect disclosed herein, there is provided a washing and/or drying machine comprising: a main body portion; a drum for receiving one or more items to be washed and/or dried, the drum arranged for rotation within the main body portion; a controller in communication with a sensor, the sensor constructed and arranged to sense position information of the drum and to provide the position information to the controller; and an actuator constructed and arranged to cause movement of the drum; and wherein in response to determining that a position of the drum differs from a reference position of the drum, the controller configured to send a control signal to the actuator so as to cause the actuator to cause the drum to move towards the reference position of the drum.

[0004] According to an example, the drum is comprised in a drum assembly, the drum assembly comprising a tub within which the drum can rotate.

[0005] According to an example, the actuator is constructed and arranged to act on the tub so as to cause corresponding movement of the drum.

[0006] According to an example, the actuator is constructed and arranged to push the drum towards the reference position of the drum.

[0007] According to an example, the actuator is constructed and arranged to pull the drum towards the reference position of the drum.

[0008] According to an example, the actuator comprises an electromagnetic actuator.

[0009] According to an example, the actuator comprises an electromagnetic coil, the electromagnetic coil surrounding an actuator element.

[0010] According to an example, the actuator element

comprises a magnet, the actuator element arranged to move in response to an electrical current passing through the electromagnetic coil.

[0011] According to an example, the electromagnetic coil comprises a first resilient coil, and the actuator element comprises a second resilient coil.

[0012] According to an example, the sensor comprises the actuator.

[0013] According to an example, the controller is configured to determine the position information based upon a determined current or inductance in the electromagnetic coil and/or the actuator element.

[0014] According to an example, the reference position comprises an axis which coincides with a central rotational axis of the drum when the drum is at rest.

[0015] According to an example, the determining that a position of the drum differs from a reference position of the drum comprises determining that a position of the drum differs from a reference position of the drum by more than a threshold amount.

Brief Description of the Drawings

[0016] 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 washing and/or drying machine according to an example.

Figure 2 is a schematic side view of some aspects of a washing and/or drying machine according to an example.

Figure 3 is a schematic side view of some parts of a washing and/or drying machine according to an example.

Figure 4 schematically shows a washing load in a washing and/or drying machine drum according to an example.

Figure 5 schematically shows a washing load in a washing and/or drying machine drum according to an example.

Figure 6 schematically shows an actuator of a washing and/or drying machine according to an example.

Figure 7 schematically shows an actuator of a washing and/or drying machine according to an example.

Figure 8 schematically shows a damper in communication with an actuator of a washing and/or drying machine according to an example.

Figure 9 schematically shows a control method according to an example.

Detailed Description

[0017] The present disclosure has applicability to clothes washing and/or drying machines.

[0018] When a user places a washable item such as a garment or garments in a washing and/or drying ma-

chine the user typically selects a washing and/or drying cycle from a variety of available washing cycles. Before the cycle begins a user places a washing load comprising one or more items to be washed and/or dried in to a drum of the machine. The items may include garments such as clothes. The items may also include bedsheets, pillowcases, shoes etc. During the cycle(s) the drum of the machine rotates. The rotation may be particularly fast during a spin cycle. As the drum rotates the centrifugal force causes the items in the drum to be pushed against an inside surface of the drum. This causes the weight of the washing load to be concentrated around the circumference of the drum, and often the items are not evenly distributed around the circumference. The centrifugal force, combined with the unevenly distributed items, may cause the drum (and drum assembly comprising the drum) to vibrate in the machine. Such vibrations may cause noise and make the machine shake. The vibrations may reduce the lifetime of the machine, for example due to wear on bearings supporting the drum in the machine. The problems described may be present in washing machines, drying machines, and combined washing and drying machines. For conciseness the term washing machine is used herein to encompass any of these types of machines.

[0019] Figure 1 schematically shows a washing machine 102 according to an example. The washing machine 102 comprises a main body portion 104 and a drum 106 which is arranged to hold one or more garments or items of a washing load to be washed.

[0020] Washing detergent and/or fabric softener may also be placed directly in to the drum 106. Alternatively washing detergent and/or fabric softener may be placed in to a tray or holder 112 arranged for this purpose. It will be understood that this feature may be omitted where the machine is a drying machine with no washing functionality.

[0021] A user interface 108 is provided which enables a user to select one or more washing and/or drying parameters and/or settings. A display 110 is also provided which outputs information to a user of the washing machine. For example information displayed on the display 110 may be information regarding options selected via user interface 108, information regarding a washing cycle in progress such as time remaining etc. The washing machine 102 also comprises a controller 130 shown schematically at 130. The controller 130 is arranged for controlling operations of the washing machine 102.

[0022] The washing machine 102 also comprises a suitable power connection enabling the washing machine 102 to be connected to an electricity supply such as mains electricity, as well as a suitable inlet and outlet for water where the machine has washing functionality. These aspects are known per se and, for conciseness, are not discussed further.

[0023] Figure 2 is a schematic side view of some aspects of a washing machine according to an example. A drum assembly is shown generally at 205. The drum as-

sembly 205 comprises a drum 206 which can rotate within a fixed part of the washing machine, in this example outer drum or tub 214. In this example a roller bearing 218 is provided for enabling the relative rotation of the drum 206 within tub 214. A motor 220 is provided for driving the rotation of the drum 206 via a drive shaft 222. The rotation of the drum may be clockwise or anti-clockwise.

[0024] A frame of the washing machine is shown schematically at 225. In this example the tub 214 is attached to the frame 224 via at least one actuator 224. Although only one actuator 224 is shown in this example, it will be understood that two or more such actuators may be provided between the frame 225 and tub 214. Where two or more actuators 224 are provided, in some examples the two or more actuators 224 are evenly distributed about a circumference of the tub 214. As will be explained in more detail below, the at least one actuator 224 may be attached to a damper. One or more further dampers may also be provided between the frame 225 and tub 214, to damp vibrations of the drum assembly 205.

[0025] A position sensor is shown schematically at 226. The position sensor 226 is constructed and arranged to detect a position of the drum assembly 205 and/or components of the drum assembly 205, e.g. the drum 206 and/or tub 214. Therefore the position sensor 226 can obtain information of movement or vibrations of the drum 206 and/or tub 214. In one example the position sensor 226 comprises an optical sensor. In one example the position sensor 226 comprises an ultrasonic sensor. In one example the position sensor 226 comprises a camera. It may be considered that the sensor 226 can directly or indirectly sense or detect a position of the drum 206. For example for direct detection, the sensor 226 directly senses a position or movement of the drum e.g. by transmitting and receiving signals reflected off a surface of the drum. For indirect detection, the sensor may sense a position of the tub 214, which is indicative of a position of the drum 206 which is held in the tub 214. Therefore where mention is made of detecting a position of the drum, this may comprise detecting a position of the drum and/or detecting a position of the tub 214. Likewise where mention is made of causing movement of the drum 206, this may comprise causing movement of the drum 206 directly, or causing movement of the drum 206 by causing movement of the tub 214.

[0026] A controller is shown schematically at 230. The controller 230 comprises a memory 232 and a processor 234. The controller 230 is configured to control operations of the washing machine. For example the controller 230 can control the actuator 224. The controller 230 may also receive information from the actuator 224. To this end the controller 230 is communicatively connected to the actuator 224, as shown schematically by line 236. The controller 230 is configured to receive position information of the drum assembly 205 (e.g. drum 206 and/or tub 214) from position sensor 226. To this end the controller 230 is communicatively connected to the position sensor 226, as shown schematically by line 238. The

controller 230 may also control operations of the motor 220. The controller may receive information from the motor 220. To this end the controller 230 is communicatively connected to the motor 220, as shown schematically by line 240.

[0027] Figure 3 schematically shows reference positions of one or more items of the drum assembly 205. Dashed line 260 shows a reference position, being a central rotational axis of the drum 206. Dashed line 262 shows a reference position, being an outer edge of the drum 206. Dashed line 264 shows a reference position, being an outer edge of the tub 214. In an example, these reference positions are positions when the drum 206 is at rest i.e. not being rotated and therefore not subject to centrifugal forces. The position sensor 226 can sense movement of the drum 206, and/or the tub 214, away from one or more of these reference positions. That is the position sensor 226 can be used to sense vibration of the drum 206 and/or tub 214. In some embodiments the position sensor 226 is configured and arranged to sense movement of the drum 206 and/or tub 214 in a direction perpendicular to a rotational axis of the drum 206. That is when viewing Figure 3 the position sensor 226 may be arranged to sense movement of the drum 206 in the directions of arrows A and B. Although in the Figures a single position sensor 226 is shown, it will be understood that in some examples the washing machine may comprise two or more such position sensors. Although in the Figures the position sensor 226 is shown located outside the tub 214, it will be understood that in some examples one or more position sensors may be located within the tub 214 e.g. to detect movement of the drum 206 directly. In one example the position sensor 226 directly senses movement of the tub 214 only (although of course this may be representative of corresponding movement of the drum 206).

[0028] Figures 4 and 5 schematically show the effect of the centrifugal force of a washing load in a washing machine drum.

[0029] In Figure 4 a washing load is shown at 450. The washing load 450 comprises one or more items being washed or dried in the machine 406. As a result of a centrifugal force caused by the drum rotating at speed, the washing load 450 is pushed against an inside surface 407 of the drum 406. In this example this causes the drum 406 to move or vibrate up (when viewing Figure 4) and out from its reference or rest position 460, in the direction of arrow 452. In this example, and for the purposes of explanation, the reference position is an edge of the drum 406. As will be discussed in more detail below, in examples an actuator is provided in order to counteract this movement. That is the actuator can cause the drum 406 to be pushed or pulled back towards its reference position 460, in the direction of arrow 454. This has the effect of eliminating or at least reducing vibrations. Where reference is made to moving the position of the drum by the actuator, it will be understood that in some examples the actuator does not act directly on the drum. In some

examples the actuator acts on the tub which is holding the drum (e.g. tub 214 in Figure 2). In some examples the actuator does act directly on the drum 406.

[0030] Figure 5 follows on from Figure 4. In Figure 5 the drum has rotated so that the washing load 450 is located at or proximate to a lowest point of the drum 450. The centrifugal force has caused the drum 406 to move or vibrate down (when viewing Figure 5) and out from its reference or rest position 460, in the direction of arrow 456. In examples the actuator can cause the drum 406 to be pushed or pulled back towards its reference position 460, in the direction of arrow 458.

[0031] Figure 6 schematically shows an actuator 624 according to an example. The actuator 624 comprises a casing 627 attached to washing machine frame 625. The actuator 624 comprises, in this example, an actuator element or piston 662 which is attached at one end 663 to tub 614 holding drum 606. In another example the actuator 624 is positioned so that the actuator element 662 is attached to drum 606. In one example the actuator element comprises a rod. Therefore movement of actuator element 662 in the direction of arrow A causes a corresponding movement of the tub 614 and drum 606 in the direction of arrow A. Movement of actuator element 662 in the direction of arrow B causes a corresponding movement of the tub 614 and drum 606 in the direction of arrow B. The actuator element 662 is located within an electromagnetic coil or solenoid shown schematically at 660. It may be considered that the electromagnetic coil 660 substantially surrounds the actuator element 662. In this example the actuator element 662 comprises a magnet. In this example the actuator element 662 comprises a permanent magnet. For example, the actuator element 662 may comprise an iron core.

[0032] The electromagnetic coil 660 comprises terminals 664 and 666 for enabling electrical current to pass through the coil 660. This creates a magnetic field within the coil 660. The magnetic field acts on the magnetic actuator element 662, causing movement thereof. The current may be passed through the coil 660 in a manner that selectively controls the direction in which the actuator element 662 moves. This may be by way of switching the direction in which current flows through the coil 660. Accordingly the actuator can selectively move the drum assembly 605 (i.e. tub 614 and consequently drum 606) in the direction of arrow A or arrow B.

[0033] In one example the electromagnetic coil and the actuator element of the actuator both comprise resilient coils. In an example the actuator element also comprises an electromagnetic coil.

[0034] Figure 7 is a schematic cross section showing elements of an actuator 724 according to an example. The actuator 724 comprises an outer coil 760 and an inner coil 762. The outer coil 760 substantially surrounds inner coil 762. Outer coil 760 and inner coil 762 are coaxial about axis X-X. Outer coil 760 comprises electrical terminals 764 and 766. Inner coil 762 comprises electrical terminals 768 and 770. The inner and outer coils may

each be considered springs, for example helical springs. In an example both outer coil 760 and inner coil 762 are configured to compress and expand from a rest position. As shown schematically, at a first end the inner coil 762 is attached to drum assembly 705. At its second end, the inner coil 762 is attached to machine frame 725. Thus the inner coil 762 may be considered to comprise the actuator element. The outer coil 760 is, in this example (though not shown for clarity), attached to machine frame 725 at one end of the outer coil 760. The opposite end of the outer coil 760 may, in an example, be attached to drum assembly 705. In an example one or both of the outer coil 760 and inner coil 762 may comprise an iron core. Thus a magnetic field may be created by selectively passing current through outer coil 760 and/or inner coil 762, causing corresponding movement of outer coil 760 and/or inner coil 762 so as to actuate movement of the drum assembly 705. Using inner and outer springs to provide the actuator 724, as described with respect to Figure 7, provides a dual function. The springs, by means of their resiliency, can provide a damping effect to the vibrations of the drum assembly 705, as well as being able to actuate movement of the drum assembly 705.

[0035] According to some examples the actuator element of the actuator is connected to a damper assembly. This is schematically shown in Figure 8 which shows an actuator 824 comprising electromagnetic coil 860 and actuator element 862. In one example the coil 860 and actuator element 862 may take the form as described with respect to Figure 7. One end of the actuator element 862 is attached to the drum assembly shown schematically at 805. The other end of the actuator element 862 is in communication with a damper, shown schematically at 863. The damper 863 is attached to frame 825 of the washing machine. In one example the actuator element 862 is attached to a damper rod of the damper 863. Thus the movement of the actuator element 862 can be damped by damper 825. In an example the damper comprises a hydraulic damper. In an example the fluid of the hydraulic damper comprises oil. In one example the hydraulic damper rod comprises an iron core, that may act to magnify the magnetic field generated by the actuator element 662 (e.g. inner spring 772) and/or electromagnetic coil 660. Where the hydraulic damper is or was acting in a passive manner, the damper effectively becomes active in the system by virtue of the iron damper rod being affected by the magnetic field. Where the damper is an active (or powered) damper, then the active damper may supplement the force of the actuator 824. In an example the damper 863 does not use any magnetorheological (MR) fluids.

[0036] According to an example the position sensor comprises the actuator. For example and referring to Figure 2, the actuator 224 may provide the functionality of the position sensor 226. For example, and referring now to Figure 6, movement of the actuator element 662 in electromagnetic coil 660 may cause the current flowing through the coil 660 to change. That is it may also be

considered that the inductance of the coil 660 changes as the actuator element 662 moves within it. Information of the current and/or inductance in the coil 660 may be provided to or determined by the controller. The controller can use this information to determine a position of the actuator element 662, and consequently a position of the drum assembly 605 (and consequently the drum 606). Referring to Figure 7, where the actuator 724 comprises outer coil 760 and inner coil 762, the outer and inner coils may be modelled as variable inductors. As the coils 760 and 762 the number of turns on the coils does not change, although the length of the coils 760 and 762 does change, which changes the inductances of the respective coils 760 and 762. This inductance information can be used to determine how extended or compressed the inner 762 and/or outer 760 coils are, and therefore enables a position of the drum to be determined. Generally speaking, it may be considered that the controller is configured to determine the position information of the drum based upon a determined current or inductance in the electromagnetic coil and/or the actuator element.

[0037] According to an example there may be provided a control system. The control system comprises a control circuit comprising a controller 230, an actuator 224 and a position sensor 226. Operation of the control circuit is schematically shown in the flow chart of Figure 9.

[0038] At S 1, a washing or drying cycle is begun or initiated.

[0039] At S2, a position of the drum is detected. It will be understood that detecting the position of the drum may comprise directly or indirectly detecting a position of the drum. That is detecting a position of the drum may comprise detecting a position of the drum itself or detecting a position of the tub holding the drum.

[0040] At S3 a determination is made, by the controller, as to whether a sensed position of the drum differs from a reference position of the drum (i.e. whether the drum has moved away from its reference position). In some examples this comprises determining whether a sensed position of the drum differs from a reference position of the drum by more than a threshold amount. The threshold amount may be a distance e.g. 5mm or 10mm. This allows for minor or acceptable levels of vibrations without intervention.

[0041] If the determination at S3 is "no", then the process loops back to S2. That is in some examples it may be considered that movement of the drum is continuously monitored during a washing or drying cycle.

[0042] If the determination at S3 is "yes", then the process proceeds to S4 where the controller causes the actuator to be driven, so as to move the drum back towards its reference position.

[0043] It will be understood that the examples may reduce the effect of drum vibrations during a washing or drying cycle by actively correcting or repositioning the drum when it moves away from a reference position of the drum. This differs from, for example, altering a resistance or damping force of a damper as a strength or force

of vibrations increase (although it will be understood that this disclosure does not exclude using a variable force damper in combination with the technique of active correction of drum position disclosed herein).

[0044] The disclosed apparatus is relatively easy to manufacture and implement, and does not require expensive and/or complicated dampers, such as dampers that utilise magnetorheological fluid to change damping force of the damper.

[0045] According to an example the control system may be operable to actively reposition the machine drum in response to movement or vibrations caused by other factors in addition to or alternatively from centrifugal force caused by rotation of the drum. For example, where the washing and/or drying machine is located in a vehicle, then the control system may be able to compensate for drum movements caused by movement of the vehicle e. g. the vehicle moving over uneven ground.

[0046] It will be understood that the processor or processing system or circuitry referred to herein may in practice be provided by a single chip or integrated circuit or plural chips or integrated circuits, optionally provided as a chipset, an application-specific integrated circuit (ASIC), field-programmable gate array (FPGA), digital signal processor (DSP), graphics processing units (GPUs), etc. The chip or chips may comprise circuitry (as well as possibly firmware) for embodying at least one or more of a data processor or processors, a digital signal processor or processors, baseband circuitry and radio frequency circuitry, which are configurable so as to operate in accordance with the exemplary embodiments. In this regard, the exemplary embodiments may be implemented at least in part by computer software stored in (non-transitory) memory and executable by the processor, or by hardware, or by a combination of tangibly stored software and hardware (and tangibly stored firmware).

[0047] Reference is made herein to data storage or memory for storing data. This may be provided by a single device or by plural devices. Suitable devices include for example a hard disk and non-volatile semiconductor memory.

[0048] 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 record-

ing medium, for example a floppy disk or hard disk; optical memory devices in general; etc.

[0049] 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 washing and/or drying machine comprising:
 - a main body portion;
 - a drum for receiving one or more items to be washed and/or dried, the drum arranged for rotation within the main body portion;
 - a controller in communication with a sensor, the sensor constructed and arranged to sense position information of the drum and to provide the position information to the controller; and
 - an actuator constructed and arranged to cause movement of the drum; and wherein
 - in response to determining that a position of the drum differs from a reference position of the drum, the controller configured to send a control signal to the actuator so as to cause the actuator to cause the drum to move towards the reference position of the drum.
2. A washing and/or drying machine according to claim 1, the drum being comprised in a drum assembly, the drum assembly comprising a tub within which the drum can rotate.
3. A washing and/or drying machine according to claim 2, wherein the actuator is constructed and arranged to act on the tub so as to cause corresponding movement of the drum.
4. A washing and/or drying machine according to any of claims 1 to 3, the actuator being constructed and arranged to push the drum towards the reference position of the drum.
5. A washing and/or drying machine according to any of claims 1 to 4, the actuator being constructed and arranged to pull the drum towards the reference position of the drum.

6. A washing and/or drying machine according to any of claims 1 to 5, wherein the actuator comprises an electromagnetic actuator.
7. A washing and/or drying machine according to any of claims 1 to 6, wherein the actuator comprises an electromagnetic coil, the electromagnetic coil surrounding an actuator element. 5
8. A washing and/or drying machine according to claim 7, the actuator element comprising a magnet, the actuator element arranged to move in response to an electrical current passing through the electromagnetic coil. 10
9. A washing and/or drying machine according to claim 7 or claim 8, wherein the electromagnetic coil comprises a first resilient coil, and the actuator element comprises a second resilient coil. 15
10. A washing and/or drying machine according to any of claims 7 to 9, wherein the sensor comprises the actuator. 20
11. A washing and/or drying machine according to claim 10, wherein the controller is configured to determine the position information based upon a determined current or inductance in the electromagnetic coil and/or the actuator element. 25
12. A washing and/or drying machine according to any of claims 1 to 11, wherein the reference position comprises an axis which coincides with a central rotational axis of the drum when the drum is at rest. 30
13. A washing and/or drying machine according to any of claims 1 to 12, wherein the determining that a position of the drum differs from a reference position of the drum comprises determining that a position of the drum differs from a reference position of the drum by more than a threshold amount. 35 40

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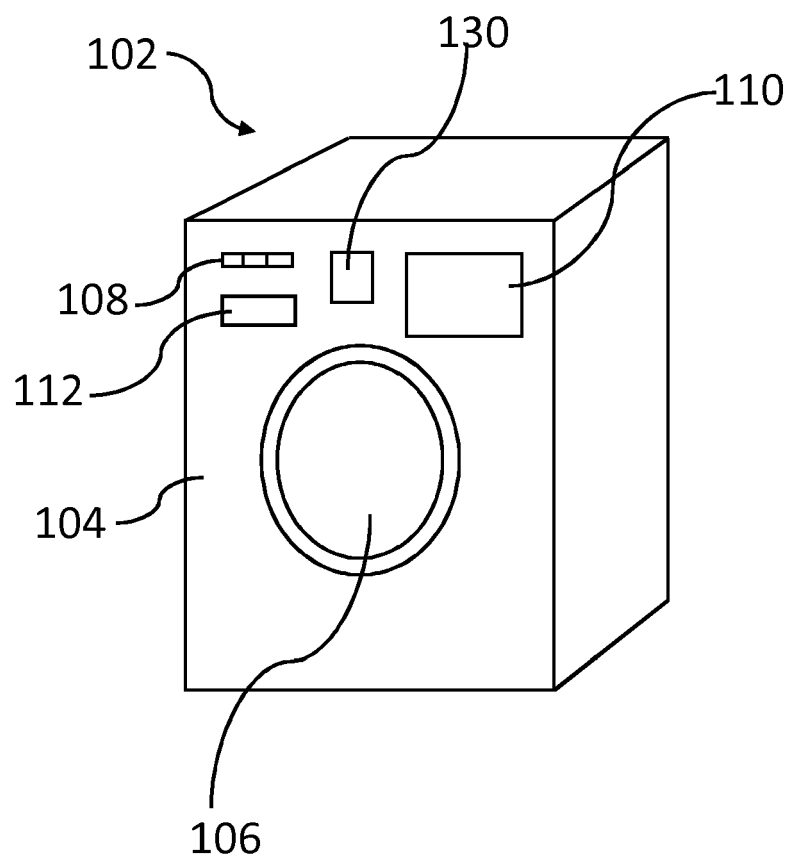


Fig. 1

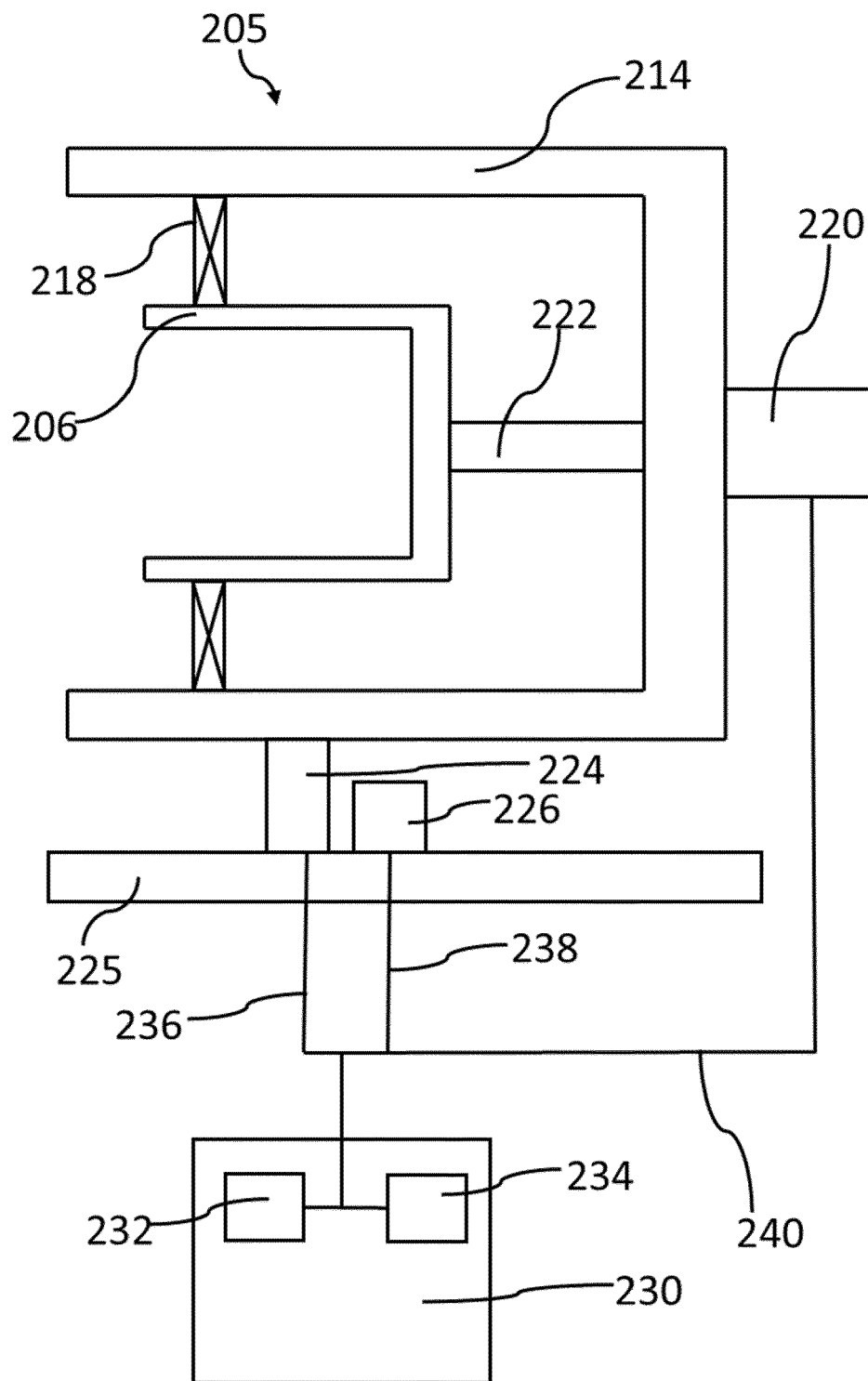


Fig. 2

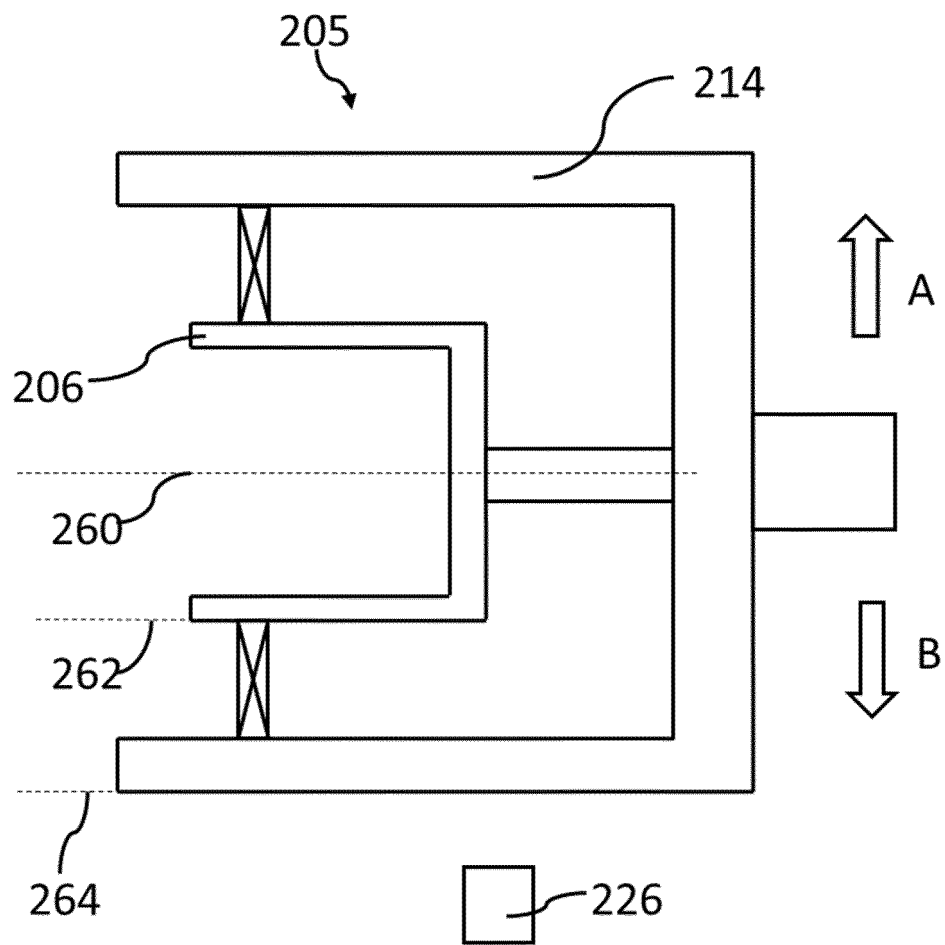


Fig. 3

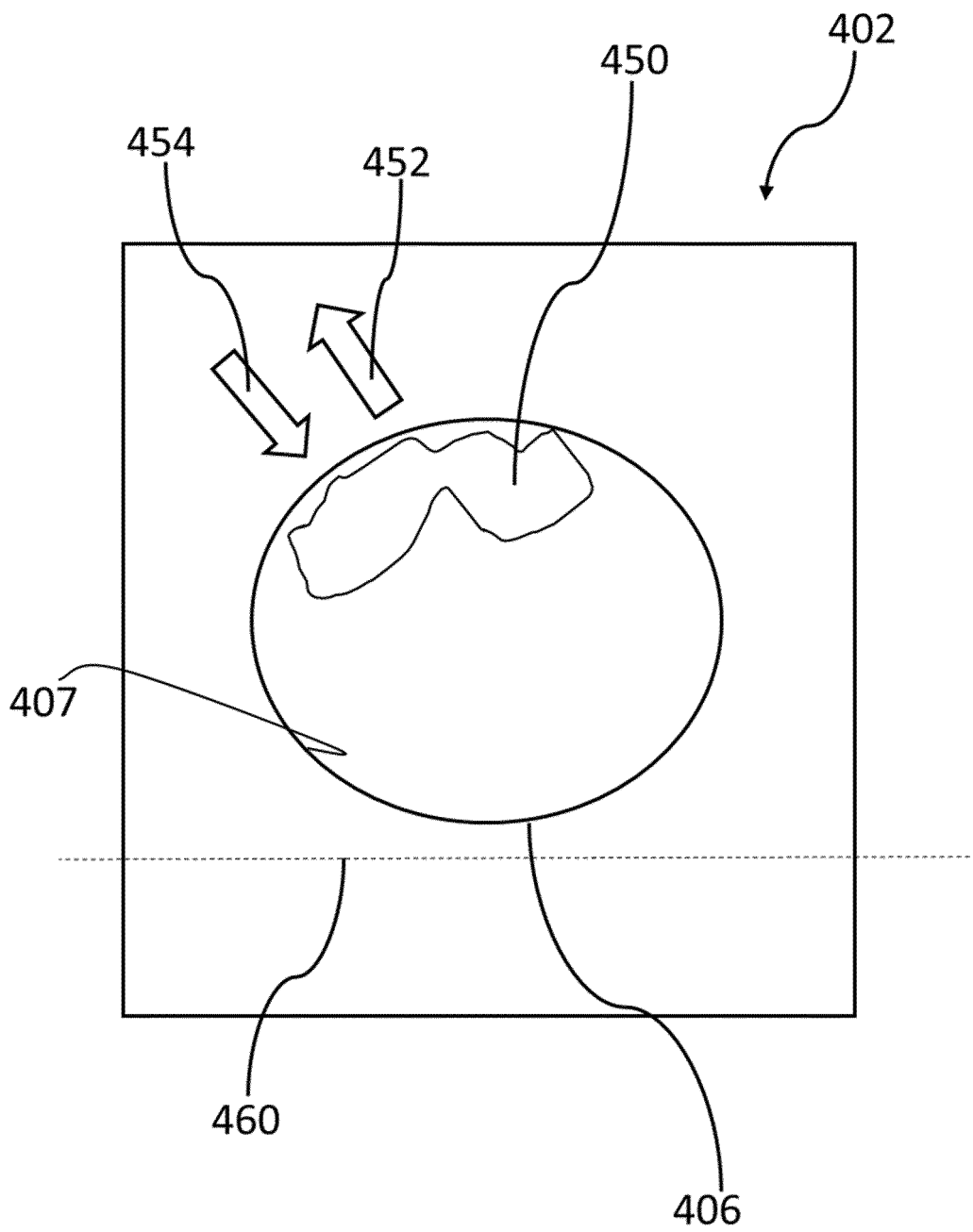


Fig. 4

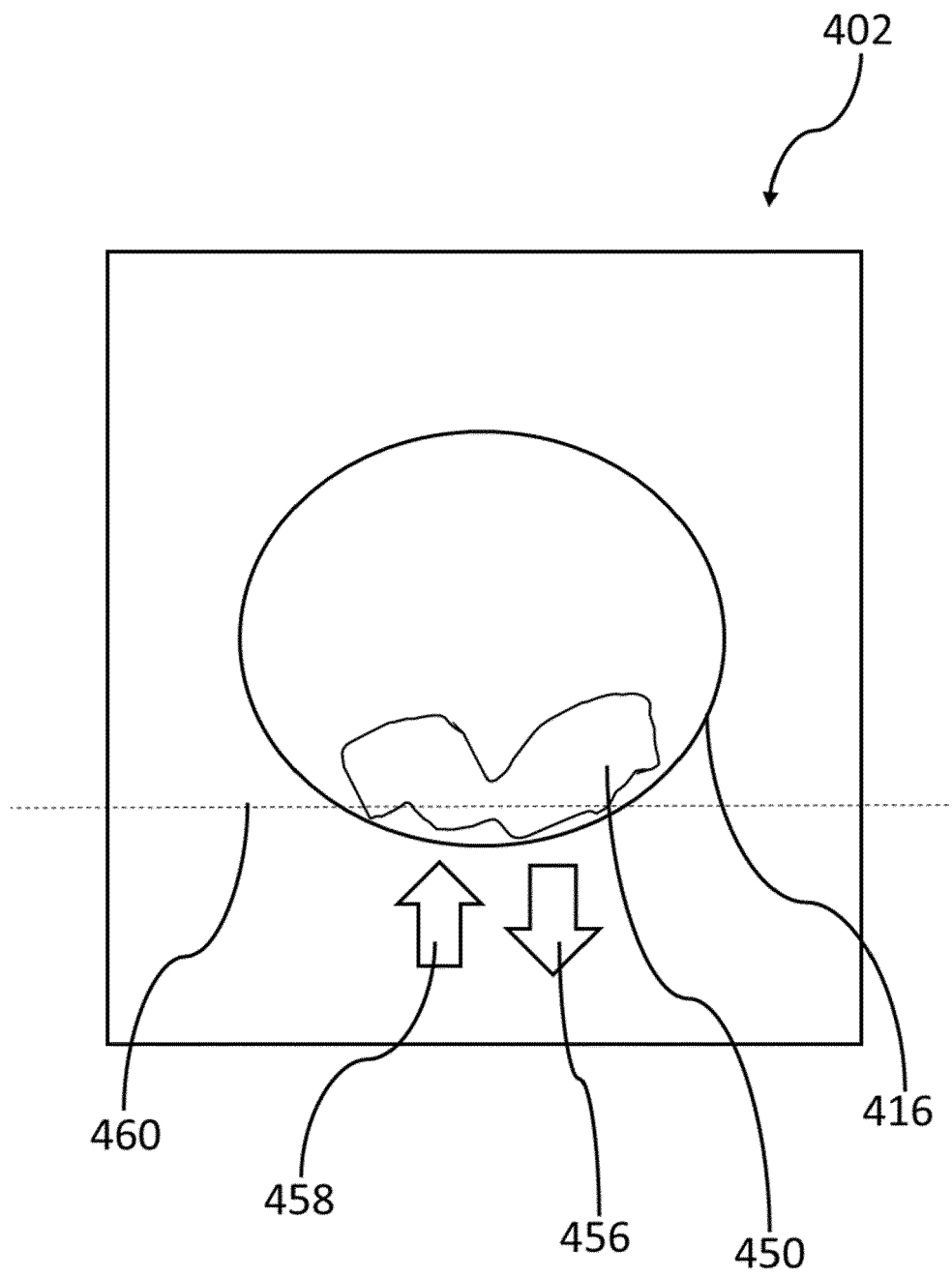


Fig. 5

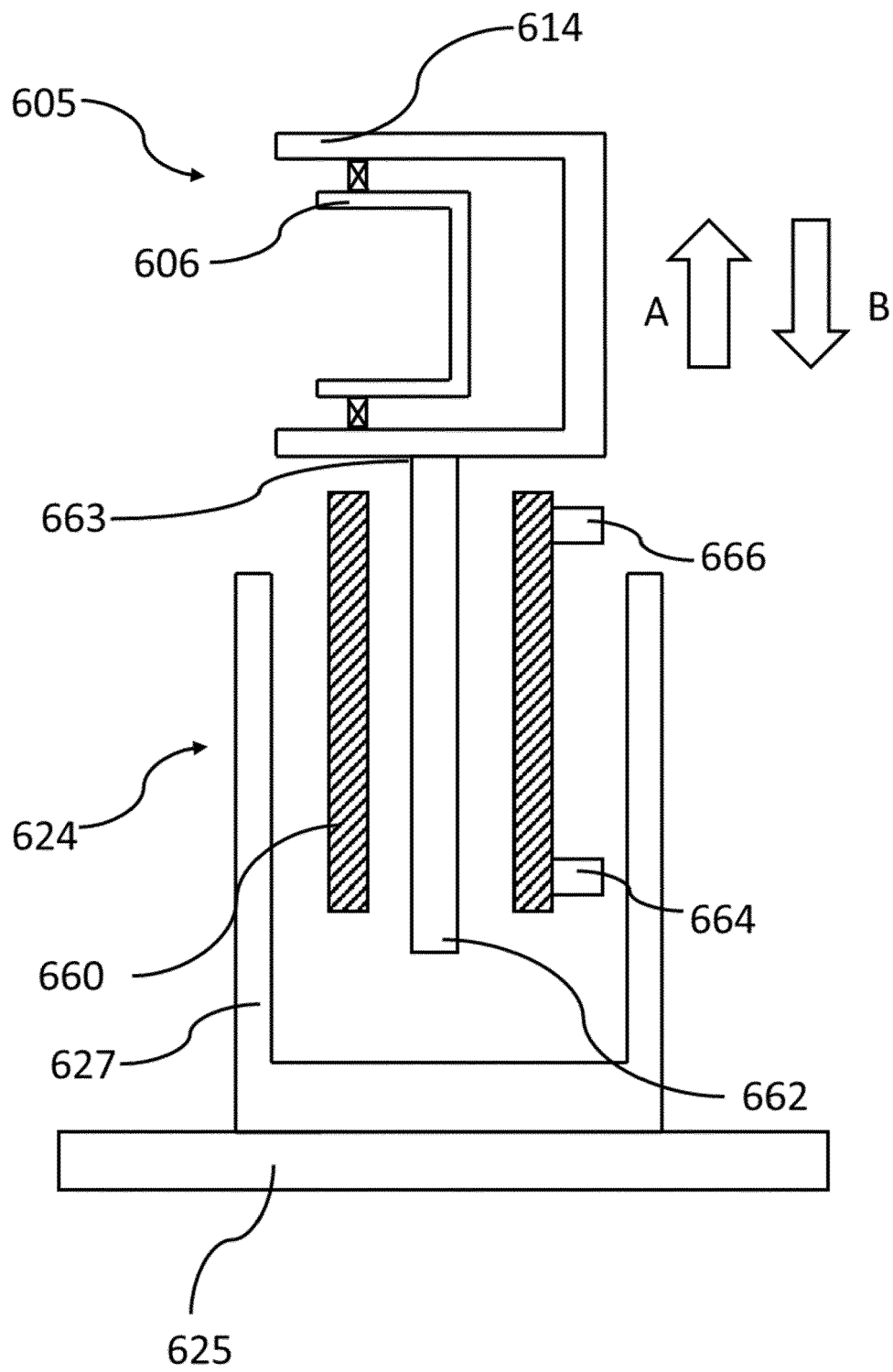


Fig. 6

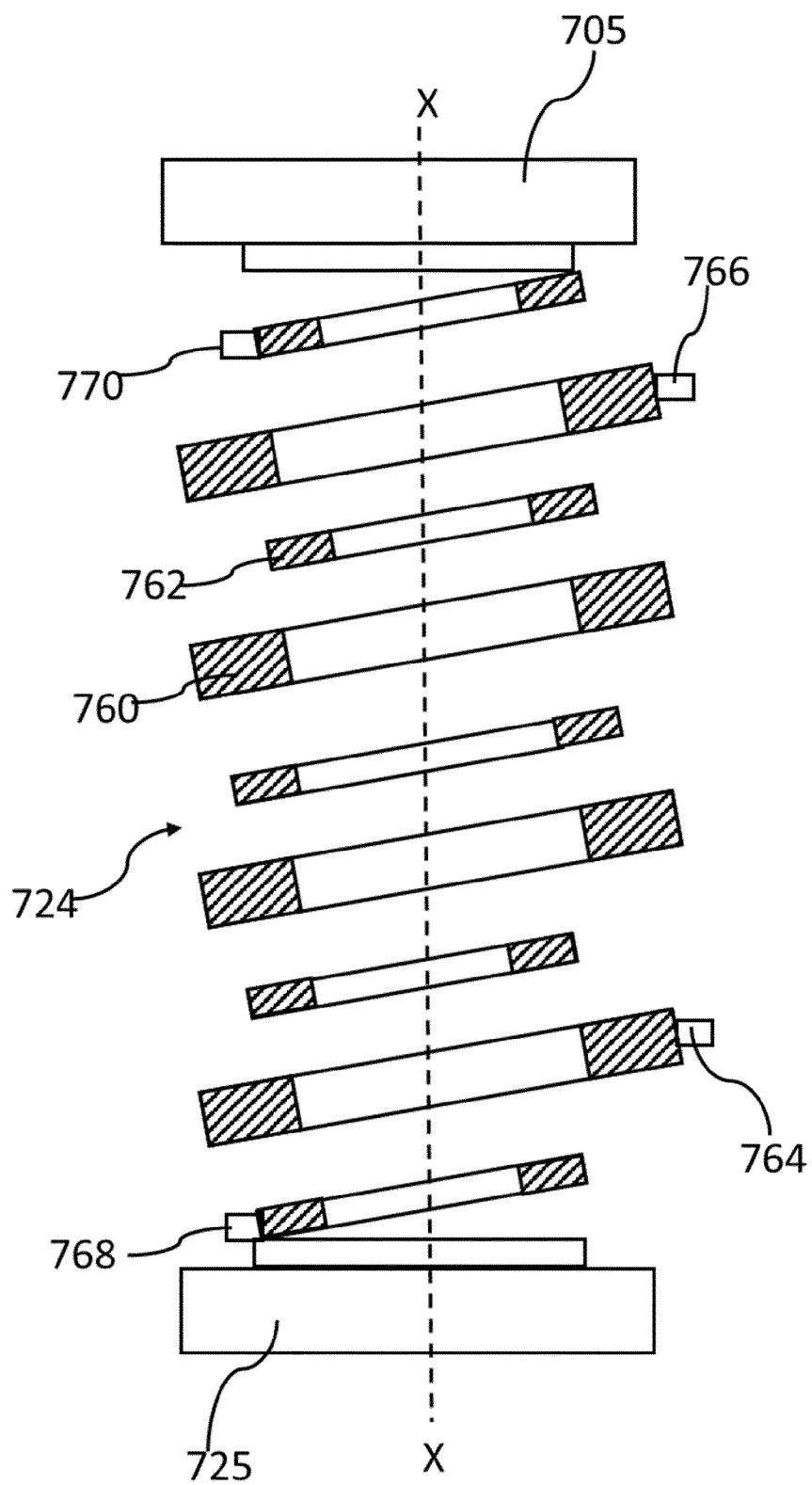


Figure 7

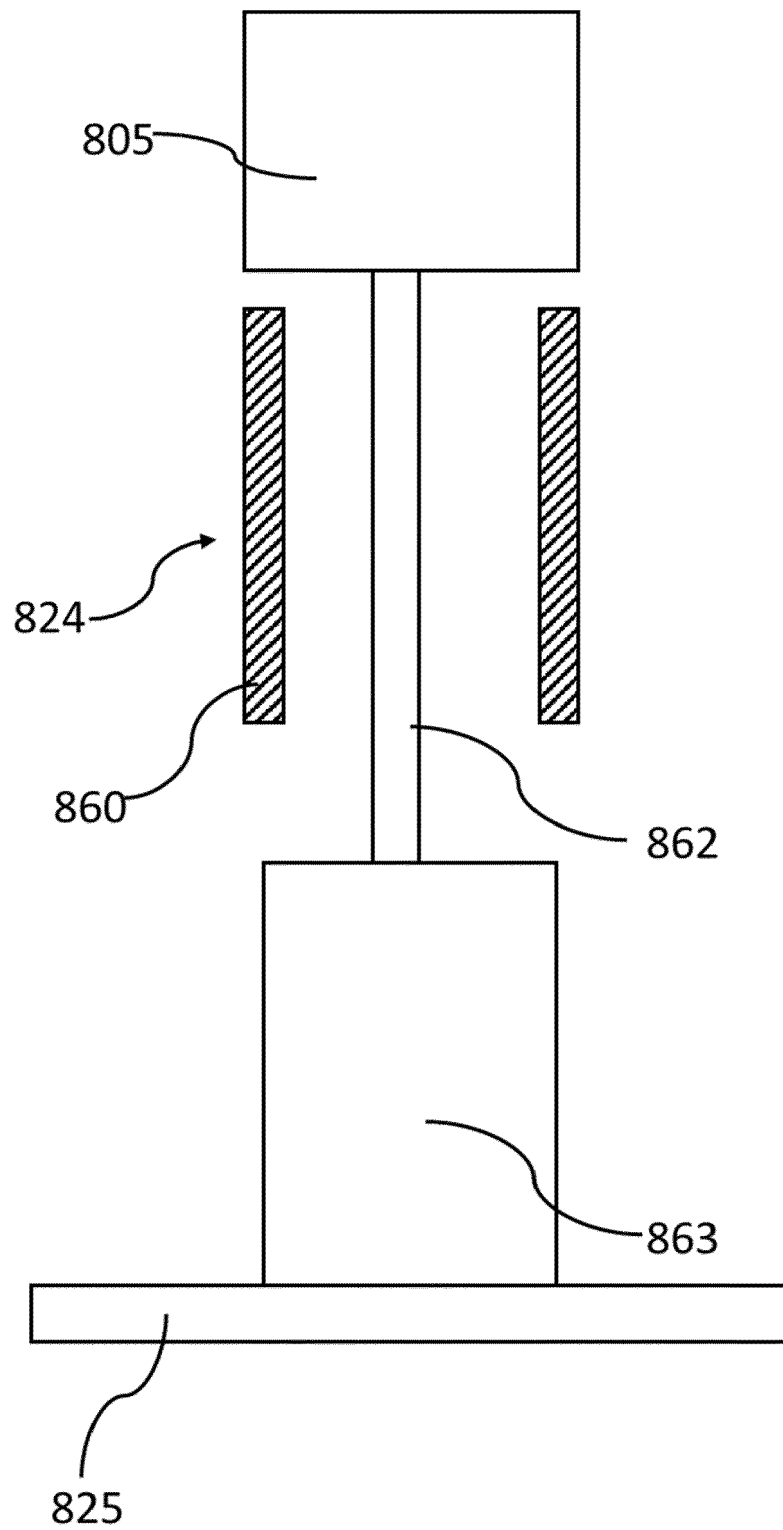


Figure 8

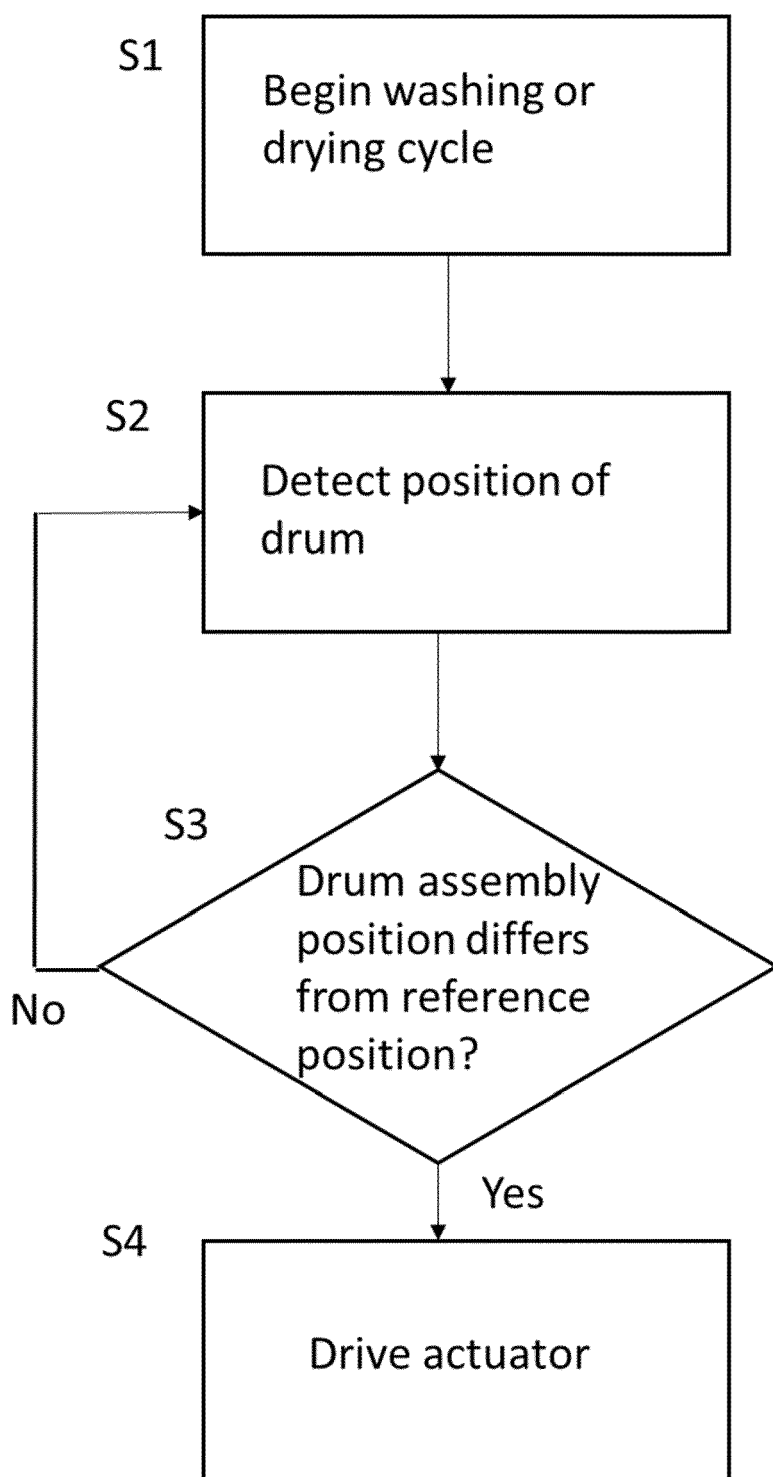


Figure 9



EUROPEAN SEARCH REPORT

Application Number
EP 17 19 6484

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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 P : intermediate document 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)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 17 19 6484

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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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