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(54) **CONTROL SYSTEM COMPRISING A ROTARY KNOB**

(57) A system 101 is described comprising a knob 207, a spring 202 and electrical conductive pliable and flexible material 204 configured to change an electrical resistance in response to the rotation of the knob 207. A processor 102, e.g. a microprocessor 102, registers this

change of electrical resistance and based on this determined change can adapt a configuration module or actuator 103 of the device 100, e.g. activate or deactivate a program, e.g. washing program of a device 100.

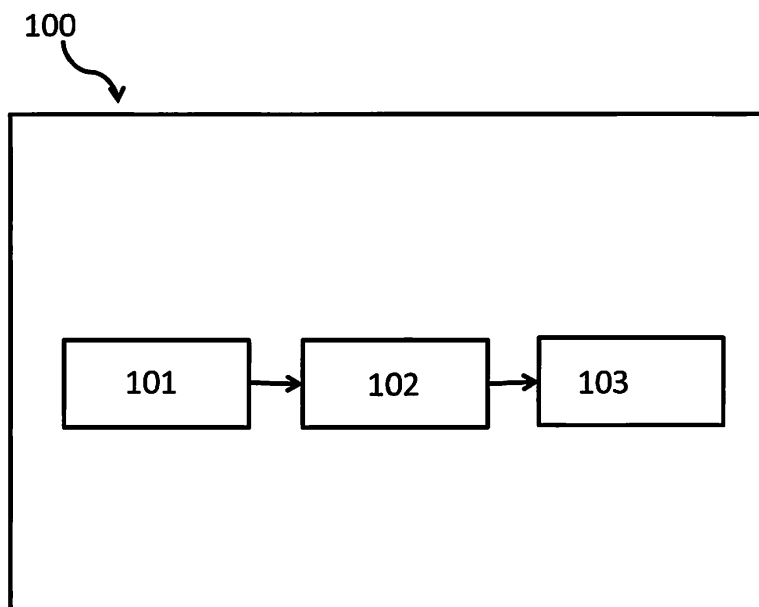


Figure 1

Description

FIELD OF THE INVENTION

[0001] The invention relates to a control system comprising a rotary knob.

BACKGROUND

[0002] Rotary knobs in different variations are used to adjust the setting of a number of devices, in particular, white goods. In general, those knobs are connected to potentiometers where a mechanical movement is used to adjust the electrical resistance of a conductor. Capacitive and magnetic knobs are also known. The majority of these potentiometers involve the friction of metal to carbon or metal surfaces. Due the friction the potentiometer parts of the knobs are subjected to high wear and tear and a limited life time.

[0003] For example, US 5 537 893 A relates to a control knob being secured to a D-shaped shaft or lever of a switch or potentiometer which is supported on a control panel. The control panel is furnished with detent ramps or indentations in its surface adjacent the shaft or lever. A D-spring (202) between the knob and the shaft retains the knob in the shaft and has a laterally extending leaf spring with a detent button formed in the leaf near its free end. The leaf spring biases the detent button against the detent ramps to afford detent action upon rotation of a shaft or linear movement of a lever. The detent ramps are formed in a forward-facing surface of the panel or in a wall formed by a recess or aperture in the panel. The leaf spring is shaped to accommodate the position of the detent ramps.

[0004] Further, US 6 223 610 B1 relates to a device comprising a leaf spring. When a leaf spring is rotated integrally with the rotation of a knob dial, the leaf spring is pushed and deflected by three corners of a cylindrical section. After that, when three corners of the cylindrical section get over the leaf spring and new three surfaces are engaged with the leaf spring, rotation of the knob dial is regulated.

OBJECT OF THE DISCLOSURE

[0005] Therefore, it is an object of the present disclosure to provide an improved control system overcoming the drawbacks of the prior art, in particular, avoiding friction based abrasion in potentiometers.

SUMMARY

[0006] The object has been solved with the subject matter defined in the appended claims.

[0007] Disclosed is a control system 101 comprising

- a. a panel 201
- b. an electrically conductive spring 202 with a first

and a second end, the first end fixed to the panel 201; c. a rotatable knob 207, the knob 207 comprising an exterior surface and a bore forming an interior surface in the knob 207;

d. an electrically conductive cable having a first end fixed to the exterior surface of the knob 207 and electrically connected to the second end of the spring 202 and having a second end fixed to the interior surface of the knob 207;

e. an electrically conductive shaft 206 fixed to the panel 201, the circumference of the shaft 206 being a surface at a distance to the interior surface of the knob 207 and thus providing a space between the shaft 206 and the interior surface of the knob 207;

f. an electrically conductive pliable and flexible material 204 in the space between the shaft 206 and the interior surface of the knob 207; and

g. a set of circularly arranged electrically conductive protrusions 208 in the space between the shaft 206 and the interior surface of the knob 207, where a first subset of the protrusions has a arcuate shape 208a and a second subset of the protrusions has an acute shape 208b, wherein the protrusions 208 are configured to deform the pliable material when the knob 207 is rotated providing an electrical connection between the spring 202 and the shaft 206.

[0008] The pliable material can be fixed to the interior surface of the knob 207 and electrically connected to the second end of the cable and the protrusions 208 are fixed to the shaft 206.

[0009] The pliable material can be fixed to the shaft 206 and the protrusions 208 are fixed to the interior surface of the knob 207 and electrically connected to the second end of the cable.

[0010] The first subset of protrusions 208 can be a continuous set of protrusions 208 and the second subset of protrusions 208 is a continuous set of protrusions 208. The protrusions 208 in the set of protrusions 208 can be equidistant to each other with respect to their position on the circle.

[0011] The protrusions 208 having an acute shape 208b and the protrusions 208 having an arcuate shape 208a can have a base with a shape complimentary to the surface of the shaft 206.

[0012] The protrusions 208 having an acute shape 208b and the protrusions 208 having an arcuate shape 208a can have a base with a shape complimentary to the interior surface of the knob 207.

[0013] The protrusions 208 of the set of protrusions 208 can have the same height and the protrusions 208 of the set of protrusions 208 can have the same width at the base of the protrusions 208.

[0014] The ratio of the height of the protrusions 208 to the width of the protrusions 208 can be between 0.5:3, 0.8: 2.5 or is 1:2.

[0015] The protrusions 208 having an acute shape 208b have sidewalls forming an apex and the angle be-

tween the sidewalls can be between 40° and 170°.

[0016] The protrusions 208 having an arcuate shape 208a can have the shape of a half-sphere.

The protrusions 208 having an acute shape 208b and the protrusions 208 having an arcuate shape 208a and the shaft 206 or the knob 207 can be made from a continuous material.

[0017] A distance in the space between the shaft 206 and the interior surface of the knob 207 is the closest distance between the surface of the shaft 206 and the interior surface of the knob 207 and the height of the protrusions 208 and the pliable material can be independently at least 60%, 70%, 80% of the first distance.

[0018] The electrically conductive pliable material can be a polymer comprising conducting particles.

[0019] The particles can be carbon particles, carbon nanotubes, or metal particles.

[0020] Further features, goals and advantages of the present invention will now be described in association with the accompanying drawings, in which exemplary components of the invention are illustrated. Components of the devices and methods according to the invention, which are at least essentially equivalent to each other with respect to their function can be marked by the same reference numerals, wherein such components do not have to be marked or described in all of the drawings.

[0021] In the following description, the invention is described by way of example only with respect to the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

[0022]

Figure 1 provides an overview over the disclosed system 101.

Figure 2 illustrates the essential elements of the disclosed system 101 when the control system 101 is in a starting or default position.

Figure 3 illustrates the interaction of a first subset of protrusions 208 with a conductive flexible material 204.

Figure 4 illustrates the interaction of a second subset of protrusions 208 with a conductive flexible material 204.

Figure 5 illustrates the essential elements of the disclosed system 101 when the knob 207 of the control system 101 has been rotated.

DETAILED DESCRIPTION OF THE FIGURES

[0023] Disclosed is a control system 101 as illustrated in figures 1-5.

[0024] The system 101 is based on the concept that in

response to the rotation of a knob 207 the electrical resistance of its main components, i.e. a spring 202 and an electrical conductive pliable and flexible material 204, changes by a certain degree and, in part, by a certain gradient. A processor 102, e.g. a microprocessor 102, registers this change of electrical resistance and based on this determined change can adapt a configuration module or actuator 103 of the device 100, e.g. activate or deactivate a program, e.g. washing program of a device 100.

[0025] The device 100 can comprise the control system 101.

[0026] The system 101 comprises a panel 201, in particular, a panel 201 of a white good 100, like a washing machine, a drying machine or the like. The panel 201 is merely a support to which the electrically interacting components are attached and can be made of any suitable material as long as it is insulated from the electrically conductive parts of the control system 101.

[0027] The control system 101 further comprises a spring 202, which is electrically conductive having a first and second end. The spring 202 can be made of any suitable conductive material, like metal or preferably carbon and is configured to change its electrical resistivity in response to a change of an extension of the spring 202, i.e. an extension or extraction in response to a mechanical force applied to the spring 202 via the first and second end.

[0028] A rotatable knob 207 is also provided. It may be rotatably fixed to the panel 201 by a connection that allows rotation of the knob 207 or it may be rotatably fixed to a shaft 206. The rotatable knob 207 can be preferably made of electrically non-conductive material and contain an electrically conductive cable or the knob 207 is made of an electrically conductive material and has insulating material between the surface that a user touches and any other components of the control system 101 which may cause a short circuit. The rotatable knob 207 has an exterior surface (in figure 2 the external circumference of the knob 207), and a bore indicated by the inner circumference of the knob 207 in figure 2. The bore forms an interior surface of the knob 207.

[0029] The system 101 may also comprise an electrically conductive cable having a first end fixed to the exterior surface of the knob 207 and electrically connected to the second end of the spring 202 and having a second end fixed to the interior surface of the knob 207. The cable can be made of metal or any other electrically conductive material. The configuration of the electrically conductive cable or path is not relevant as long as only an electrical connection between the second end of the spring 202 and a limited area or point on the interior surface of the knob 207 is provided.

[0030] A shaft 206 is (non-rotatably) fixed to the panel 201, the circumference of the shaft 206 being an external surface at a distance to the interior surface of the knob 207 and thus providing a space between the shaft 206 and the interior surface of the knob 207. The shaft 206

may be massive or hollow or hollow with a support construction. The shaft 206 may be made entirely of metal or any other electrically conducting material. Alternatively, the support construction may be electrically insulating and the external surface be electrically conductive only.

[0031] An electrically conductive pliable and flexible material 204 is provided in the space between the shaft 206 and the interior surface of the knob 207. The material when being attached to a surface of the system 101 and not being compressed by any means may have an arcuate shape 208a, i.e. forms a hemisphere on a surface of the system 101.

[0032] The system 101 further comprises a set of circularly arranged electrically conductive protrusions 208 in the space between the shaft 206 and the interior surface of the knob 207, where a first subset of the protrusions 208 has a arcuate shape 208a and a second subset of the protrusions 208 has an acute shape. The protrusions 208 are configured to deform the flexible material 204 when the knob 207 is rotated thereby ultimately providing an electrical connection between the spring 202 and the shaft 206 when the protrusions 208 are in contact with the pliable material.

[0033] Furthermore, the system 101 can comprise an electrical connection between the first end of the spring 202 and an (electrical) instrument for measuring electrical resistance (e.g. an Ohmmeter) 209 and an electrical connection between the shaft 206 and the instrument for measuring electrical resistance 209.

[0034] Furthermore, the system 101 can comprise the processor 102. The processor 102 is connected to the electrical instrument for measuring electrical resistance 209.

[0035] As illustrated in figures 2-5 the pliable material is preferably fixed to the interior surface of the knob 207 and electrically connected to the second end of the cable and the protrusions 208 are fixed to the shaft 206.

[0036] Alternatively and not illustrated in the figures, the pliable material is fixed to the shaft 206 and the protrusions 208 are fixed to the interior surface of the knob 207 and electrically connected to the second end of the cable.

[0037] The claimed system 101 has the advantage that it can be used to determine into which direction the knob 207 is rotated (clockwise or counterclockwise) and it can be determined by which angle the knob 207 is rotated, i.e. to which position, as will be explained in the following. In a starting or default position, the spring 202 has a certain length, e.g. its minimum length and is fully contracted, and thus the spring 202 exhibits a certain electrical resistance which can be ultimately registered by the processor 102 via the electrical connections (e.g. as illustrated in the configuration of figure 2). Rotating the knob 207 to a different position will also move the second end of the spring 202 attached to the knob 207 (e.g. to the configuration of figure 5). Thus, the length of the spring 202 is changed, for example, extended, and thus the electrical resistance of the spring 202 changes, too. Each re-

sistance value may be associated with a certain degree of rotation corresponding in turn to a function of the device 100 or configuration module 103 that the user may want to activate or deactivate. The function provided configuration module may be indicated, for example, on the front side of the panel 201 by a textual expression or an icon. The processor 102 can be connected to a memory in which a look-up table is stored indicating which electrical resistance corresponds to which degree of rotation or/and function of the device 100.

[0038] As illustrated in figures 3 and 4 the system 101 also allows to determine into which direction the knob 207 is rotated. The system 101 is configured in a way that when the spring 202 is fully contracted the flexible material 204 is positioned in a region at the border between the first group of protrusions 208 and the second group of protrusions 208. Preferably, the flexible material 204 and the border are positioned approximately on an extension of the (hypothetical) longitudinal axis of the spring 202 in fully contracted configuration with the flexible material 204 being located between the border and spring 202 on an extension of the longitudinal axis (see figure 2).

[0039] When the knob 207 is rotated in one direction (for example, counterclockwise) and the flexible material 204 is deformed by the arcuate protrusions 208, the resistance values slowly change due to the sliding of the flexible material 204 on the (smooth) arcuate protrusions 208 (see figure 3). These resistance changes being due to the interaction of the protrusions 208 with the flexible material 204 overlay the resistance values which are due to the extension or contraction of the spring 202 and can be registered by the processor 102 via the ohmmeter. On the other hand, as illustrated in figure 4, when the knob 207 is rotated in the opposite direction (for example, clockwise) and the flexible material 204 is deformed by the acute protrusions 208, the resistance values steeply change due to the sliding of the flexible material 204 on the (pointed) acute protrusions 208. Again, these resistance values changes being due to the interaction of the protrusions 208 with the flexible material 204 overlay the resistance values, which are due to the extension or contraction of the spring 202 and can be registered by the processor 102 via the ohmmeter.

[0040] Accordingly, the system 101 provides the advantage that the processor 102 can detect the degree and direction of the rotation of the knob 207.

[0041] The system 101 can be further optimized by adapting the distance between the apex of the acute protrusions 208 and the distance between the apex of the arcuate protrusions 208 to be different from each other as illustrated in figures 3 and 4. In this way, the flexible material 204 will undergo different degrees of deformation when the protrusions 208 slide past the flexible material 204 which will translate into respective different resistance values, which can be registered by the processor 102. Alternatively, the distance between the apex of the acute protrusions 208 and the distance between the

apex of the arcuate protrusions 208 is the same.

[0042] After the knob has been rotated the position of the knob as determined by the processor can be stored in a memory of the system. In this way, the present position of the knob is stored and can be considered when the knob is rotated the next time allowing to interpret the changes of the resistance values correctly when the knob is again rotated.

[0043] The first subset of protrusions 208 can be a continuous set of protrusions 208 and the second subset of protrusions 208 can be a continuous set of protrusions 208. This means that the protrusions 208 are not arranged to be alternating, but from closed groups of respective protrusions 208.

[0044] The protrusions 208 in the set of protrusions 208 can be equidistant to each other with respect to their position on the circle. In this way, the read-out by the processor 102 is simplified.

[0045] The protrusions 208 having an acute shape 208b and the protrusions 208 having an arcuate shape 208a can have a base with a shape complimentary to the interior surface of the knob 207. This allows a simple and rigid adhesion to the surface of the knob 207.

[0046] The protrusions 208 having an acute shape 208b and the protrusions 208 having an arcuate shape 208a can have a base with a shape complimentary to the surface of the shaft 206. This allows a simple and rigid adhesion to the surface of the shaft 206.

[0047] All the protrusions 208 of the first subset of protrusions 208 can have the same height. All protrusions 208 of the second subset of protrusions 208 can have the same height. The protrusions 208 of the first subset of protrusions 208 and the second subset of protrusions 208 have the same or a different height, i.e. within one subset the height is the same, but the height between the different subsets can be the same or different. The protrusions 208 can have the same width at the base of the protrusions 208.

[0048] The height of the protrusions 208 to the width of the protrusions 208 can be between 0.5:3, 0.8: 2.5 or is 1:2.

[0049] The protrusions 208 having an acute shape 208b have sidewalls forming an apex where they meet opposite to the base and the angle between the sidewalls can be between 40° and 170°.

[0050] The protrusions 208 having an arcuate shape 208a may approximately form a half sphere.

[0051] The protrusions 208 having an acute shape 208b and the protrusions 208 having an arcuate shape 208a and the shaft 206 or the knob 207 can be made from a continuous material, i.e. are made from the same material, e.g. by molding or shaping an appropriate material.

[0052] A first distance in the space between the shaft 206 and the interior surface of the knob 207 is the closest distance between the surface of the shaft 206 and the interior surface of the knob 207 and the height of the protrusions 208 and the pliable material is independently at least 60%, 70%, 80% of the first distance.

[0053] The electrically conductive pliable and flexible material 204 can be a polymer. The electrically conductive pliable and flexible material 204 may comprise conducting particles. The polymer can also comprise a foam or a gel, for example, a carbon gel. The particles can be carbon particles, carbon nanotubes, or/and metal particles. The electrically conductive pliable and flexible material 204 may comprise a conductive coating, e.g. made of metal or an alternative conducting material.

[0054] In summary, a system 101 is described comprising a knob 207, a spring 202 and electrical conductive pliable and flexible material 204 configured to change an electrical resistance in response to the rotation of the knob 207. A processor 102, e.g. a microprocessor 102, registers this change of electrical resistance and based on this determined change can adapt a configuration module or actuator 103 of the device 100, e.g. activate or deactivate a program, e.g. washing program of a device 100.

REFERENCE NUMERALS

[0055]

100	Device
101	Control system
102	Processor
103	Configuration module
201	Panel
202	Spring
203	second end of spring, first end of conductive cable
204	Flexible material
205	Surface of flexible material
206	Shaft
207	Knob
208	Protrusions
208a	Protrusions with arcuate shape
208b	Protrusions with acute shape
209	Instrument for measuring electrical resistance
301	Resistance path
302	Distance between apex of protrusion and with arcuate shape and interior surface of knob
402	Distance between apex of protrusion and with acute shape and interior surface of knob

Claims

1. Control system (101) comprising
 - a. a panel (201)
 - b. an electrically conductive spring (202) with a first and a second end, the first end fixed to the panel (201);
 - c. a rotatable knob (207), the knob (207) comprising an exterior surface and a bore forming an interior surface in the knob (207);

- d. an electrically conductive cable having a first end fixed to the exterior surface of the knob (207) and electrically connected to the second end of the spring (202) and having a second end fixed to the interior surface of the knob (207);
- e. an electrically conductive shaft (206) fixed to the panel (201), the circumference of the shaft (206) being a surface at a distance to the interior surface of the knob (207) and thus providing a space between the shaft (206) and the interior surface of the knob (207);
- f. an electrically conductive pliable and flexible material (204) in the space between the shaft (206) and the interior surface of the knob (207); and
- g. a set of circularly arranged electrically conductive protrusions (208) in the space between the shaft (206) and the interior surface of the knob (207), where a first subset of the protrusions (208) has a arcuate shape (208a) and a second subset of the protrusions (208) has an acute shape (208b), wherein the protrusions (208) are configured to deform the pliable material when the knob (207) is rotated providing an electrical connection between the spring (202) and the shaft (206).
2. Control system (101) of claim 1, wherein the pliable material is fixed to the interior surface of the knob (207) and electrically connected to the second end of the cable and the protrusions (208) are fixed to the shaft (206).
 3. Control system (101) of claim 1, wherein the pliable material is fixed to the shaft (206) and the protrusions (208) are fixed to the interior surface of the knob (207) and electrically connected to the second end of the cable.
 4. Control system (101) of claim 1, wherein the first subset of protrusions (208) is a continuous set of protrusions (208) and the second subset of protrusions (208) is a continuous set of protrusions (208).
 5. Control system (101) of claim 1, wherein the protrusions (208) in the set of protrusions (208) are equidistant to each other with respect to their position on the circle.
 6. Control system (101) of claim 2, wherein the protrusions (208) having an acute shape (208b) and the protrusions (208) having an arcuate shape (208a) have a base with a shape complimentary to the surface of the shaft (206).
 7. Control system (101) of claim 3, wherein the protrusions (208) having an acute shape (208b) and the protrusions (208) having an arcuate shape (208a) have a base with a shape complimentary to the interior surface of the knob (207).
 8. Control system (101) according to any of claims 1-7, wherein the protrusions (208) of the set of protrusions (208) have the same height and the protrusions (208) of the set of protrusions (208) have the same width at the base of the protrusions (208).
 9. Control system (101) according to any of claims 1-8, wherein the ratio of the height of the protrusions (208) to the width of the protrusions (208) is between 0.5:3, 0.8: 2.5 or is 1:2.
 10. Control system (101) according to any of claims 1-9, wherein the protrusions (208) having an acute shape (208b) have sidewalls forming an apex and the angle between the sidewalls is between 40° and 170°.
 11. Control system (101) according to any of claims 1-10, wherein the protrusions (208) having an arcuate shape (208a) have the shape of a half-sphere.
 12. Control system (101) according to any of claims 1-11, wherein the protrusions (208) having an acute shape (208b) and the protrusions (208) having an arcuate shape (208a) and the shaft (206) or the knob (207) are made from a continuous material.
 13. Control system (101) according to any of claims 1-12, wherein a distance in the space between the shaft (206) and the interior surface of the knob (207) is the closest distance between the surface of the shaft (206) and the interior surface of the knob (207) and the height of the protrusions (208) and the pliable material is at least 60%, 70%, 80% of the first distance.
 14. Control system (101) according to any of claims 1-13, wherein the electrically conductive pliable material is a polymer comprising conducting particles.
 15. Control system (101) to claim 14, wherein the particles are carbon particles, carbon nanotubes, or metal particles.

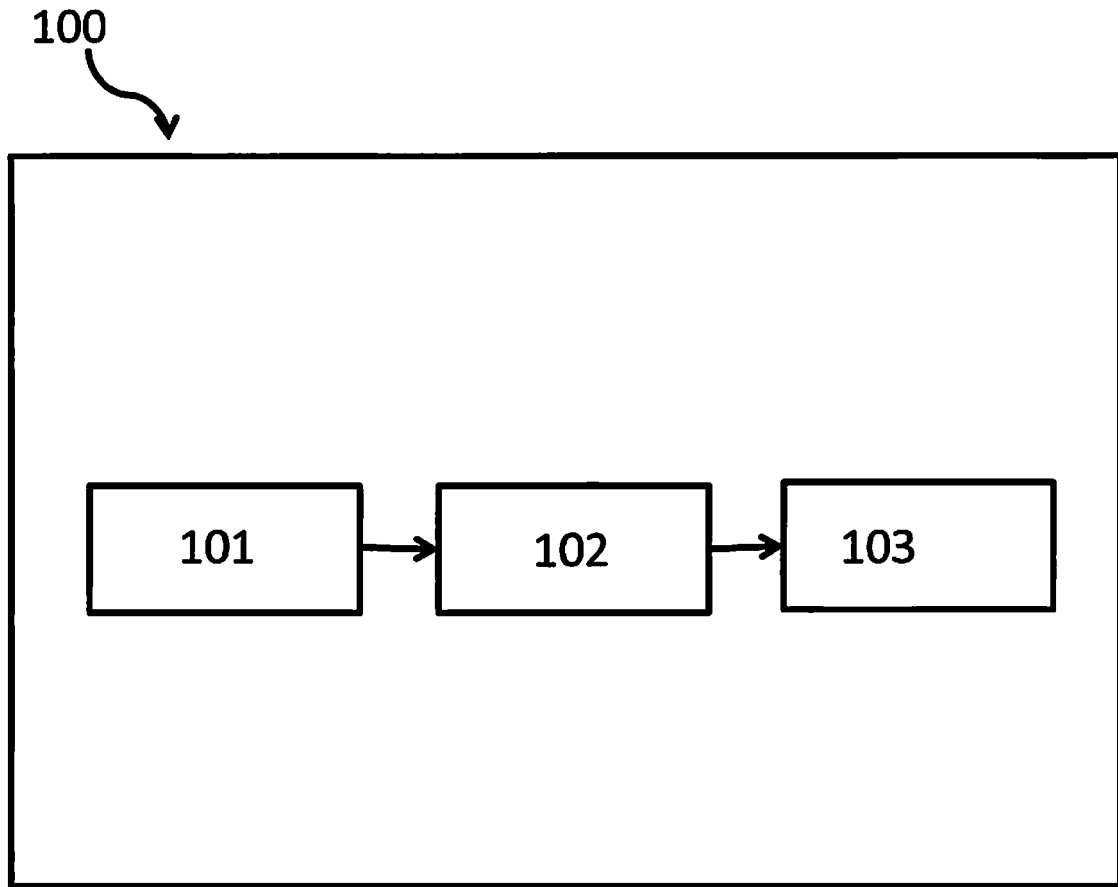


Figure 1

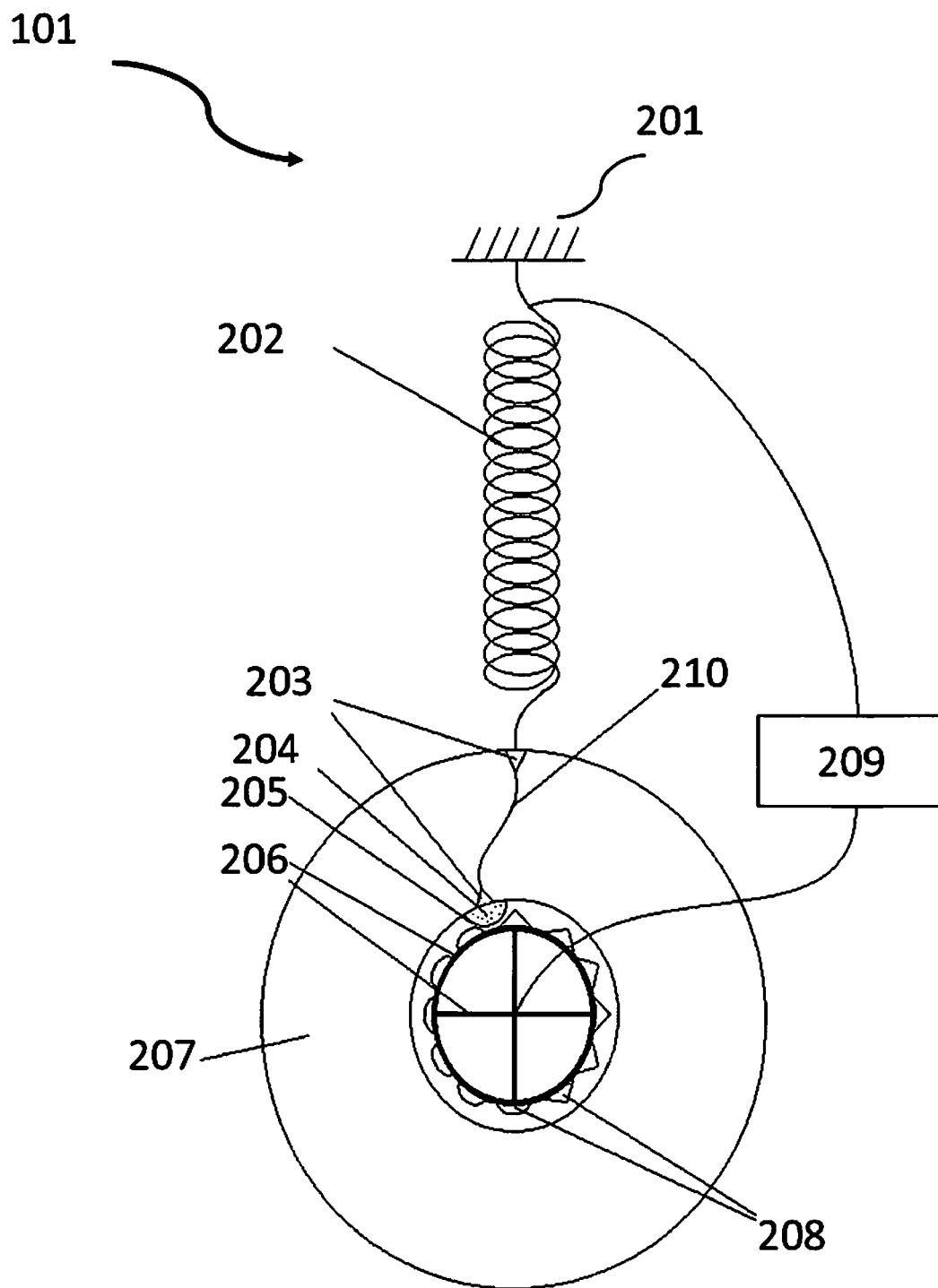


Figure 2

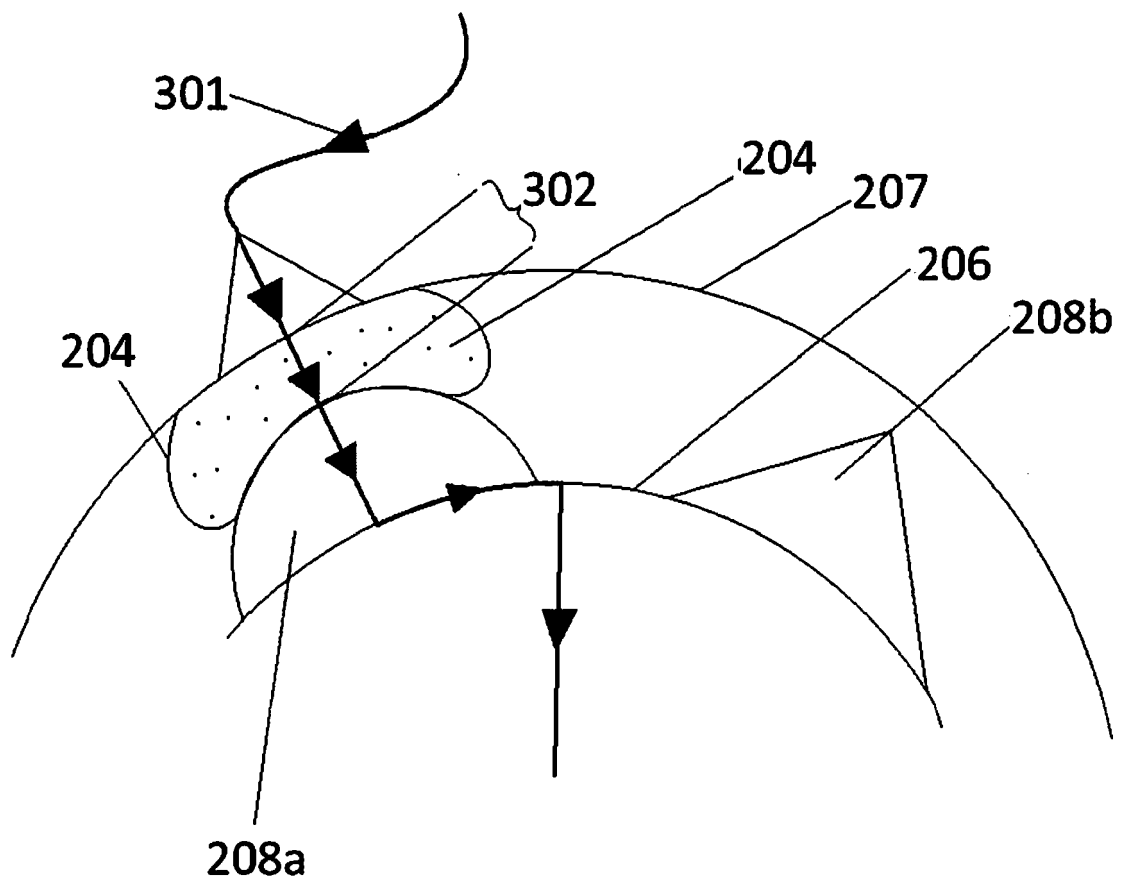


Figure 3

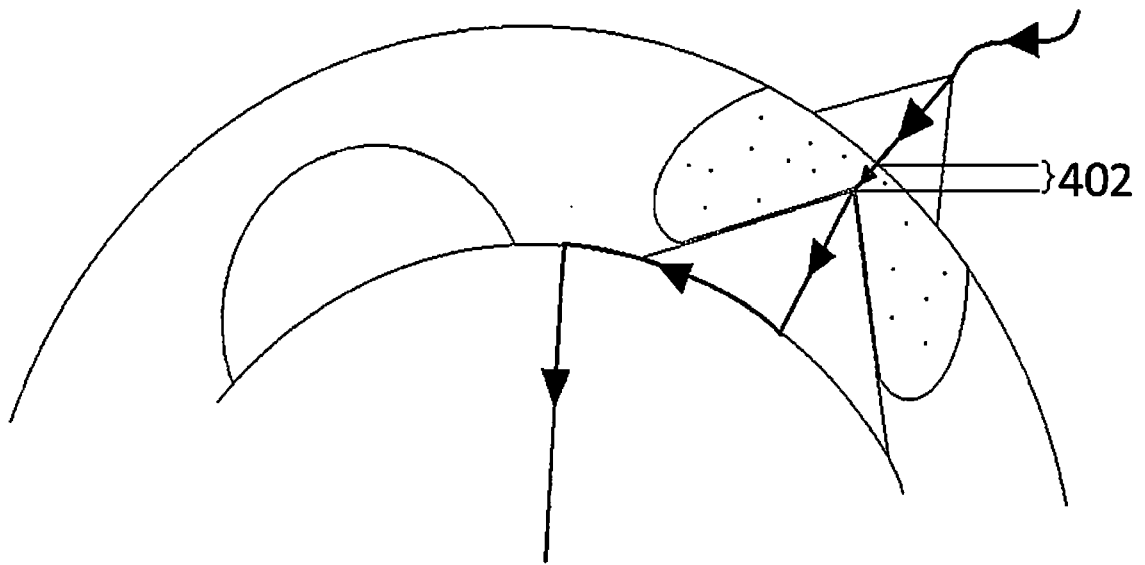


Figure 4

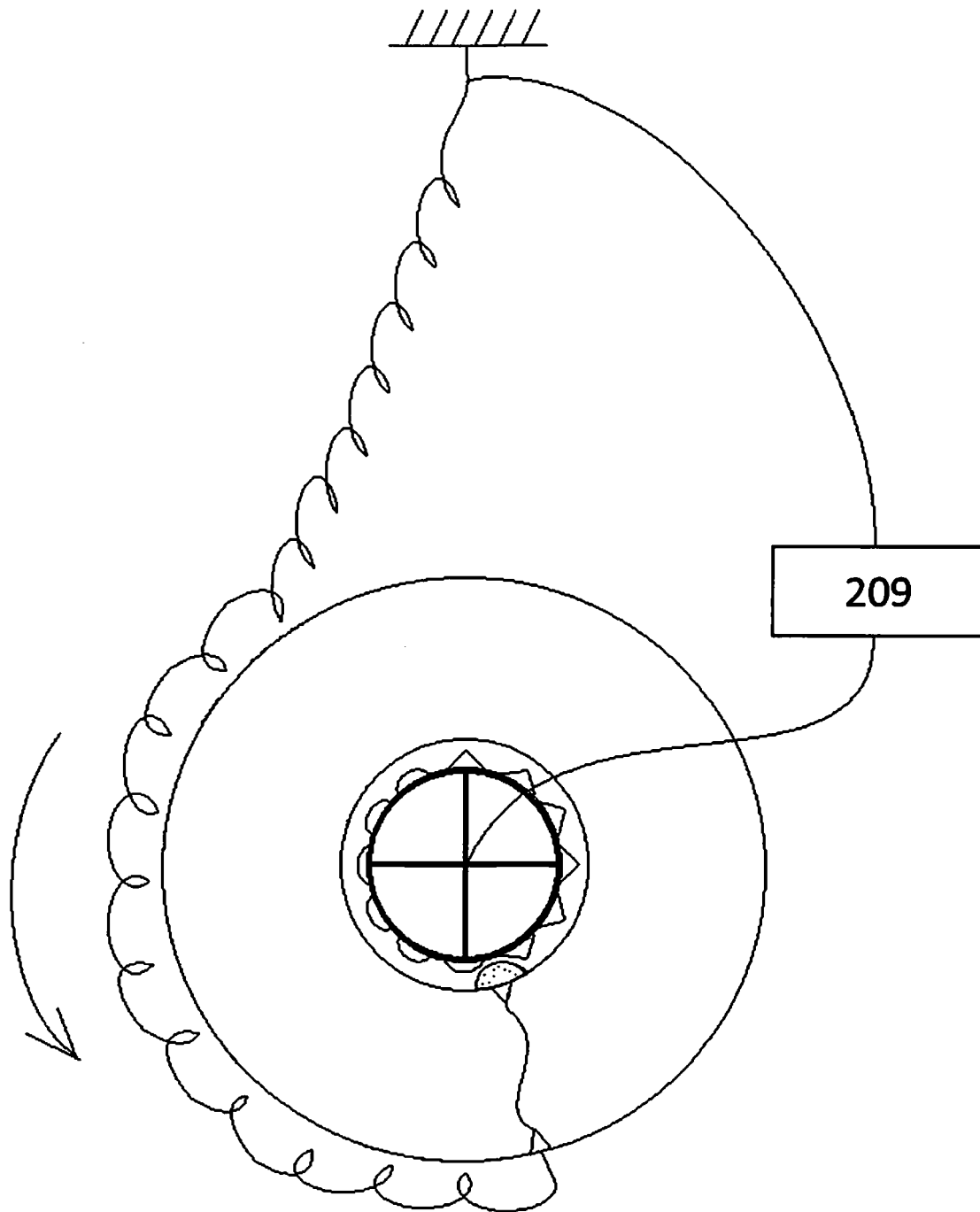


Figure 5



EUROPEAN SEARCH REPORT

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 EP 18 21 5101

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 August 2019	Examiner Dessaux, Christophe
CATEGORY OF CITED DOCUMENTS		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	
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EPO FORM 1503 03.02 (P04C01)



EUROPEAN SEARCH REPORT

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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	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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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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