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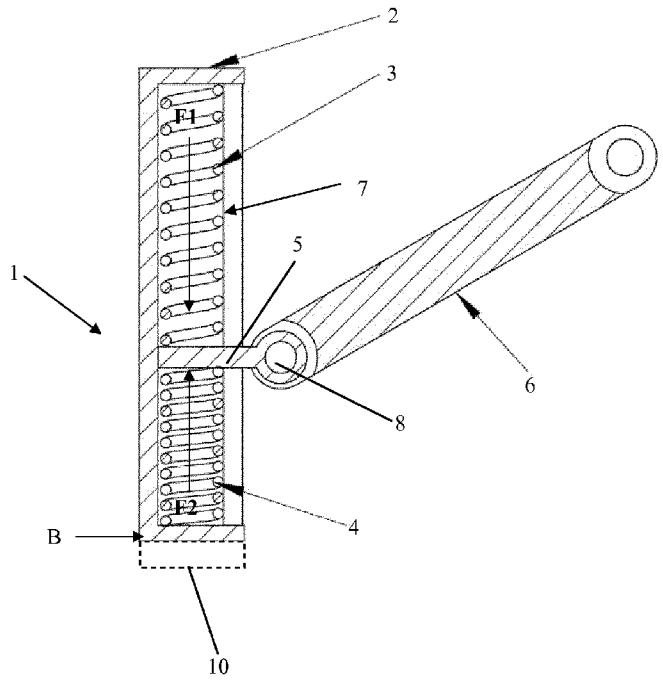


Figure 1

(57) Abstract: The present invention relates to an actuator (1) for device having heat source (10), comprising a housing (2), a first elastomer (3) and a second elastomer (4) accommodated in the housing (2), an actuating element (5) and a driving element (6), wherein the actuating element (5) is arranged between the first and second elastomers (3, 4) and has one end in movable connection with one end of the driving element (6), characterized in that the first elastomer (3) and/or the second elastomer (4) is capable of changing an elastic force depending upon temperature to cause the actuating element (5) to move linearly in the housing (2) so as to control a position of the driving element (6). The actuator (1) has a small size, a high reliability, a simple structure and a low cost, and produces a low noise during operation. In addition, the present invention further provides a cover-plate assembly having the actuator and an illuminating device mounted with the cover-plate assembly.

WO 2013/104491 A2

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Description

Actuator, Cover-plate Assembly Having the Actuator and Illuminating Device

Technical Field

The present invention relates to an actuator for device having heat source, a cover-plate assembly having the actuator and an illuminating device mounted with the cover-plate assembly.

Background Art

As more and more electronic devices, especially illuminating devices, are widely used in people's daily life, heat dissipation becomes an important factor exerting an influence on the developments in the art. The heat dissipating effect can directly affect the service lifetime and optical effect of the illuminating device. Generally, part of illuminating devices, such as high-power LED illuminating devices, have an external heating body, but this heating body will be limited by ID (industrial design) or external profile and is not conveniently maintained. Another part of illuminating devices have a heating body integrated inside a housing, but the housing at the same time will block air convection and reduce the heat dissipating effect.

In order to solve the above problems, an automatic control system for illuminating devices is provided in the prior art. With such system, the housing of the illuminating device can be closed when the illuminating device is in a non-operative

state so that the illuminating device is protected and the appearance is pleasing; and when the illuminating device enters into an operative effect, the automatic control system opens the housing, and thereby the heat dissipation is favorably performed. This automatic control system is installed on one side of a light-emitting module away from the housing, a control module in the automatic control system sends a control signal to a motor, and a transmission rod for opening and closing the cover plate can open the cover plate when receiving the control signal, thus, the heating body closed by the cover plate can directly exchange heat with the external environment. However, the IP performance of such illuminating device is not high, and the system has a high cost, a complex structure and thus is more probable to be failed. In addition, when the cover plate is open and closed, unavoidable noise will be generated due to operation of the motor.

Summary of the Invention

In order to solve the problems above, the present invention provides an actuator for device having heat source. The actuator has a small size, a simple structure and a low cost, and can operate reliably with a low noise.

An actuator for device having heat source is provided according to the present invention, comprising a housing, a first elastomer and a second elastomer accommodated in the housing, an actuating element and a driving element, wherein the actuating element is arranged between the first and second elastomers and has one end in movable connection with one end of the driving element, characterized in that the first elas-

tomer and/or the second elastomer is capable of changing an elastic force depending upon temperature to cause the actuating element to linearly move in the housing so as to control a position of the driving element.

The concept of the present invention lies in discarding the prior design of actuating via a circuit and preferably realizing the automatic control of the position of the driving element through a mechanical control process depending upon temperature. The actuator of the present invention is a bias actuator, which is favorable for controlling a linear movement of the actuating element in the housing simply merely depending changes of temperature. That is to say, the actuator can automatically change the direction of bias generated when the temperature is changed, thereby, for instance, the actuating element in the actuator, under the action of bias, can move reciprocally in the actuator, as a result, the driving element is driven to move so as to provide a mechanical force to the device. As the motor is removed, the actuator of the present invention produces a low noise during operation.

In one preferred solution of the present invention, the second elastomer is an elastomer capable of being deformed depending upon temperature. Thus, it is assured that, when the temperature is changed, at least the elastic force applied by the second elastomer on the actuating element is changed depending upon the temperature.

In one preferred solution of the present invention, the first elastomer is a pressure spring and the second elastomer is a shape memory spring. Preferably, the second elastomer is

made from a shape memory alloy. The shape memory alloy (SMA) usually is made from nickel-titanium alloy, and such alloy can be made into a spring having a suitable elastic coefficient at high temperature and then subjected to compression or deformation after cooling; and when the temperature of the alloy again reaches a determined temperature, the initial spring can be recovered and there is a sufficient elastic coefficient. Apart from the nickel-titanium alloy, there are still new nickel-titanium-series shape memory alloys such as titanium-nickel copper, titanium-nickel iron and titanium-nickel chromium; in addition, there are also other types of shape memory alloys such as copper-nickel-series alloys, copper-aluminum-series alloys, copper-zinc-series alloys and iron-series alloys (Fe-Mn-Si, Fe-Pd).

In one preferred solution of the present invention, at least part of region of the housing is made from a thermal conducting material, and one end of the second elastomer pressed against the region is in thermal contact with the heat source. Accordingly, heat from the heat source can be well conducted to the second elastomer so that the second elastomer changes its own deformation according to the changes of heat, especially temperature, so as to provide different elastic forces.

In one preferred solution of the present invention, a first elastic force generated by deformation of the first elastomer and a second elastic force generated by heated deformation of the second elastomer are jointly applied to the actuating element, and the first elastic force and the second elastic force are applied on the same straight line in opposite directions. Thus, the actuating element in a pressurized state

can be assured to move linearly.

In one preferred solution of the present invention, the actuator has a first state and a second state, wherein the second elastic force is bigger than the first elastic force in the first state, and the second elastic force is smaller than the first elastic force in the second state. Resultant forces of the first and second elastomers in different states are different, and then the actuating element can be caused to move in the housing. Besides, there is still a transition state between the first state and the second state, and an absolute value of the first elastic force and that of the second elastic force can be temporarily equivalent in the transition state.

In one preferred solution of the present invention, the housing is a sleeve opened with a groove in a longitudinal direction, one end of the actuating element extends beyond the groove to be hinged with one end of the driving element. By configuring the housing to be a sleeve with a groove, the first and second elastomers can be fixedly held therein, and the groove particularly serves a guiding function to the actuating element to guarantee the actuating element to partially extend beyond the housing and merely move linearly reciprocally.

In one preferred solution of the present invention, the driving element is configured to be a rod-shape driving element having one end mounted with a rotating shaft, and one end of the rod-shape driving element is rotatably connected to the actuating element by means of the rotating shaft. A force transmission can be realized between the actuating element

and the driving element with a low loss.

Another object of the present invention is accomplished via a cover-plate assembly comprising a cover plate. The cover-plate assembly further comprises the actuator above, wherein the other end of the driving element of the actuator is movably connected to the cover plate. Accordingly, movement of the cover plate can be controlled with the actuator having a simple structure when the temperature is changed. For example, the cover plate is closed when the temperature of the heat source is low, and the cover plate is open when the temperature of the heat source is high. Preferably, the other end of the driving element is mounted with a rotating shaft, by means of which, the driving element and the cover plate are movably connected.

Another object of the present invention is accomplished via an illuminating device. The illuminating device comprises a light-emitting module as a heat source and a body for carrying the light-emitting module, characterized in that the illuminating device further comprises the above cover-plate assembly installed insider the illuminating device, wherein at least part of region of the housing of the cover-plate assembly is in thermal contact with the heat source, and the cover plate is capable of covering at least part of an outer surface of the illuminating device.

The illuminating device of the present invention can automatically control the cover plate for covering at least part of the surface of the illuminating device through the changes of inner temperature, i.e., according to operative states of the light-emitting module as the heat source. For instance,

when the illuminating device is in an operative state, heat generated by the light-emitting module causes the actuator in the cover-plate assembly to operate to automatically open the cover plate so that inner parts such as heat sink of the illuminating device can directly exchange heat with the outside; and when the illuminating device is in a non-operative state, the light-emitting module generates no heat, the temperature inside the illuminating device is lowered, then the cover plate is automatically closed, so that it prevents external dusts or pollutants from entering into the illuminating device.

In one preferred solution of the present invention, the body comprises a thermal conducting region, wherein a region of the actuator is in thermal contact with the heat source through the thermal conducting region. In this situation, a region of the actuator for thermal conduction is in indirect thermal contact with the heat source through the thermal conducting region. As the thermal conducting region has a good thermal conducting performance, no adverse influence will be exerted on the heat transmission between the heat source and the actuator.

Preferably, the housing is formed in the illuminating device in one piece. Therefore, it is compact inside the illuminating device. An elongated accommodating portion also can be directly opened in the illuminating device to replace the housing for accommodating the first and second elastomers and the actuating element.

Brief Description of the Drawings

The accompanying drawings constitute a part of the present Description and are used to provide further understanding of the present invention. Such accompanying drawings illustrate the embodiments of the present invention and are used to describe the principles of the present invention together with the Description. In the accompanying drawings the same components are represented by the same reference numbers. As shown in the drawings:

Fig. 1 is a longitudinal section view of an actuator of a first embodiment of the present invention;

Fig. 2 is a section view of an illuminating device of a second embodiment of the present invention, wherein a cover-plate assembly shown in Fig. 1 is installed; and

Fig. 3 is an enlarged local view of Fig. 2.

Detailed Description of the Embodiments

Fig. 1 is a longitudinal section view of an actuator of a first embodiment of the present invention. A first elastomer 3, an actuating element 5 and a second elastomer 4 are mounted in sequence in a housing 2 which is preferably configured to be a sleeve, wherein one end of the actuating element 5 extends beyond a groove 7 opened on the housing 2 in a longitudinal direction to be movably connected with a driving element 6. The first and second elastomers 3, 4 are preferably configured to be springs, wherein the first elastomer 3 is pressurized and located between a top surface of the housing 2 and the actuating element 5, and the second elastomer 4 is pressurized and located between a bottom surface of the

housing 2 and the actuating element 5, as a result, the actuating element 5 can be fixedly held between the first and second elastomers 3, 4. In Fig. 1, the first elastomer 3 applies to the actuating element 5 a first elastic force F1 vertically downwardly, and the second elastomer 4 applies to the actuating element 5 a second elastic force F2 vertically upwardly. Directions of the two elastic forces are opposite on the same straight line, then a resultant force can be for formed and applied to the actuating element 5.

At least one of the first and second elastomers 3, 4 (it is the second elastomer 4 below the actuating element 5 in the present embodiment) is made from a shape memory alloy. The second elastomer 4 made from the shape memory alloy has a first elastic coefficient k1 in a first temperature range such as normal temperature, and has a second elastic coefficient k2 in a predetermined second temperature range, for instance, when it is heated, wherein k2>k1. The bottom surface of the housing 2 is configured to be a region B capable of conducting heat, and the second elastomer 4 can be in thermal contact with the heat source 10 through the region B. Therefore, the second elastic force F2 generated by deformation of the second elastomer 4 can be automatically changed according to changes of temperature.

In order to enable the actuating element 5 to automatically drive the driving element 6 to move according to the changes of temperature, the actuator 1 of the present invention is particularly configured to be a bias actuator. Specifically, the second elastomer 4 is configured to be an active part in a bias actuator by making use of the characteristics of the shape memory alloy, and the first elastomer 3 correspondingly

is used as a passive part. For example, when the heat source 10 generates heat, the second elastomer 4 is heated to be deformed, and the second elastic force F2 is bigger than the first elastic force F1, thus the actuator 1 is in the first state, that is, the actuating element 5 under the action of the resultant force F2-F1 moves towards the top surface of the housing 2; and when the heat source 10 generates no heat, the second elastic force F2 is smaller than the first elastic force F1, thus the actuator 1 is in the second state, that is, the actuating element 5 under the action of the resultant force F2-F1 moves towards the bottom surface of the housing 2.

The actuating element 5 and the driving element 6 can be connected advantageously by using a rotating shaft 8, so that the actuating element 5 is enabled to drive the driving element 6 to move jointly, and a force loss therebetween can be reduced as much as is possible. The actuating element 5 and the driving element 6 also can be connected in a hinging manner. In another preferred embodiment, a projection can be formed directly on an end of the actuating element 5 for connection with the driving element 6, and a corresponding annular accommodating portion is formed on an end of the driving element 6 so as to movably connect the actuating element 5 and the driving element 6.

Fig. 2 is a section view of an illuminating device of a second embodiment of the present invention, wherein a cover-plate assembly of the present invention is installed. The cover-plate assembly comprises the actuator 1 shown in Fig. 1 and a cover plate 9 in movable connection with the other end of the driving element 6. The cover-plate assembly is

mounted inside the illuminating device, wherein at least part of region B of the housing of the actuator 1 is in thermal contact with the heat source 10 of the illuminating device. In the present embodiment, a light-emitting module of the illuminating device is regarded as the heat source 10.

With referent to the enlarged local view of the illuminating device shown in Fig. 3, it can be seen that the actuator 1 is mounted inside the illuminating device. In one preferred embodiment, the housing 2 of the actuator 1 can be formed in the illuminating device in one piece. In one embodiment not shown, an elongated accommodating portion can be opened in the illuminating device to replace the housing 2 for accommodating the first and second elastomers 3, 4 and the actuating element 5.

In the inside of the illuminating device, the heat source 10 is mounted on a body 12, and heat generated by the heat source 10 can be transferred to the second elastomer 4 through a part of the body 12, i.e., a thermal conducting region 13, via the region B to form an indirect thermal contact. Therefore, it can be realized that when the illuminating device is operative, heat generated by the heat source 10 causes the actuator 1 in the cover-plate assembly to operate to automatically open the cover plate 9 so that the illuminating device can directly exchange heat with the outside; and when the illuminating device is in a non-operative state, the heat source 10 generates no heat, and temperature inside the illuminating device is lowered, then the cover plate 9 is enabled to be automatically closed, so that external dusts or pollutants are prevented from entering into the illuminating device.

The above is merely preferred embodiments of the present invention but not to limit the present invention. For the person skilled in the art, the present invention may have various alterations and changes. Any alterations, equivalent substitutions, improvements, within the spirit and principle of the present invention, should be covered in the protection scope of the present invention.

List of reference signs

1	actuator
2	housing
3	first elastomer
4	second elastomer
5	actuating element
6	driving element
7	groove
8	rotating shaft
9	cover plate
10	heat source
12	body
13	thermal conducting region
B	part of region of the housing
F1	first elastic force
F2	second elastic force

Patent claims

1. An actuator (1) for a device having heat source (10), comprising a housing (2), a first elastomer (3) and a second elastomer (4) accommodated in the housing (2), an actuating element (5) and a driving element (6), wherein the actuating element (5) is arranged between the first and second elastomers (3, 4) and has one end in movable connection with one end of the driving element (6), characterized in that the first elastomer (3) and/or the second elastomer (4) is capable of changing an elastic force depending upon temperature to cause the actuating element (5) to linearly move in the housing (2) so as to control a position of the driving element (6).

2. The actuator (1) according to Claim 1, characterized in that the second elastomer (4) is an elastomer capable of being deformed depending upon temperature.

3. The actuator (1) according to Claim 2, characterized in that the first elastomer (3) is a pressure spring and the second elastomer (4) is a shape memory spring.

4. The actuator (1) according to Claim 3, characterized in that at least part of region (B) of the housing (2) is made from a thermal conducting material, and one end of the second elastomer (4) pressed against the region (B) is in thermal contact with the heat source (10).

5. The actuator (1) according to Claim 4, characterized in that a first elastic force (F1) generated by deformation of the first elastomer (3) and a second elastic force (F2) generated by heated deformation of the second elastomer (4) are

jointly applied to the actuating element (5), and the first elastic force (F1) and the second elastic force (F2) are applied on a same straight line in opposite directions.

6. The actuator (1) according to Claim 5, characterized in that the actuator (1) has a first state and a second state, wherein the second elastic force (F2) is bigger than the first elastic force (F1) in the first state, and the second elastic force (F2) is smaller than the first elastic force (F1) in the second state.

7. The actuator (1) according to any one of Claims 1-5, characterized in that the second elastomer (4) is made from a shape memory alloy.

8. The actuator (1) according to any one of Claims 1-5, characterized in that the housing (2) is a sleeve opened with a groove (7) in a longitudinal direction, one end of the actuating element (5) extends beyond the groove (7) to be hinged with one end of the driving element (6).

9. The actuator (1) according to any one of Claims 1-5, characterized in that the driving element (6) is configured to be a rod-shape driving element having one end mounted with a rotating shaft (8), and one end of the rod-shape driving element is rotatably connected to the actuating element (5) by means of the rotating shaft (8).

10. A cover-plate assembly, comprising a cover plate (9), characterized by further comprising the actuator (1) according to any one of Claims 1-9, wherein the other end of the driving element (6) of the actuator (1) is movably connected

to the cover plate (9).

11. The cover-plate assembly according to Claim 10, characterized in that the other end of the driving element (6) is mounted with a rotating shaft (8), by means of which, the driving element (6) and the cover plate (9) are movably connected.

12. An illuminating device, comprising a light-emitting module as a heat source (10) and a body (12) for carrying the light-emitting module, characterized in that the illuminating device further comprises the cover-plate assembly according to Claim 10 or 11, the cover-plate assembly is installed insider the illuminating device, wherein at least part of region (B) of the housing (2) is in thermal contact with the heat source (10), and the cover plate (9) is capable of covering at least part of an outer surface of the illuminating device.

13. The illuminating device according to Claim 12, characterized in that the body (12) comprises a thermal conducting region (13), wherein the region (B) is in thermal contact with the heat source (10) through the thermal conducting region (13).

14. The illuminating device according to Claim 13, characterized in that the housing (2) is formed in the illuminating device in one piece.

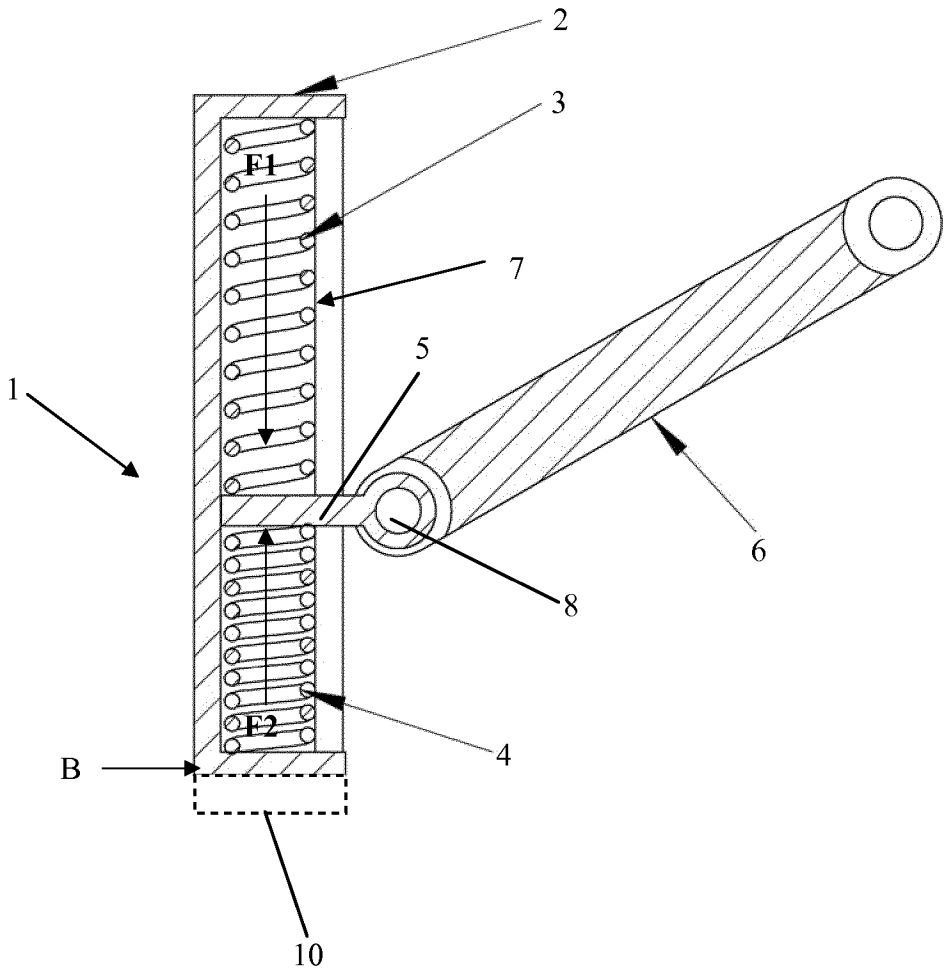


Figure 1

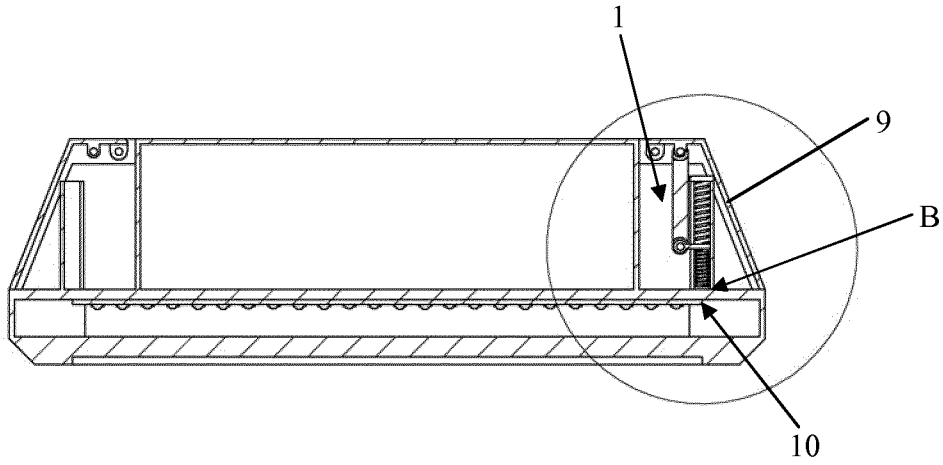


Figure 2

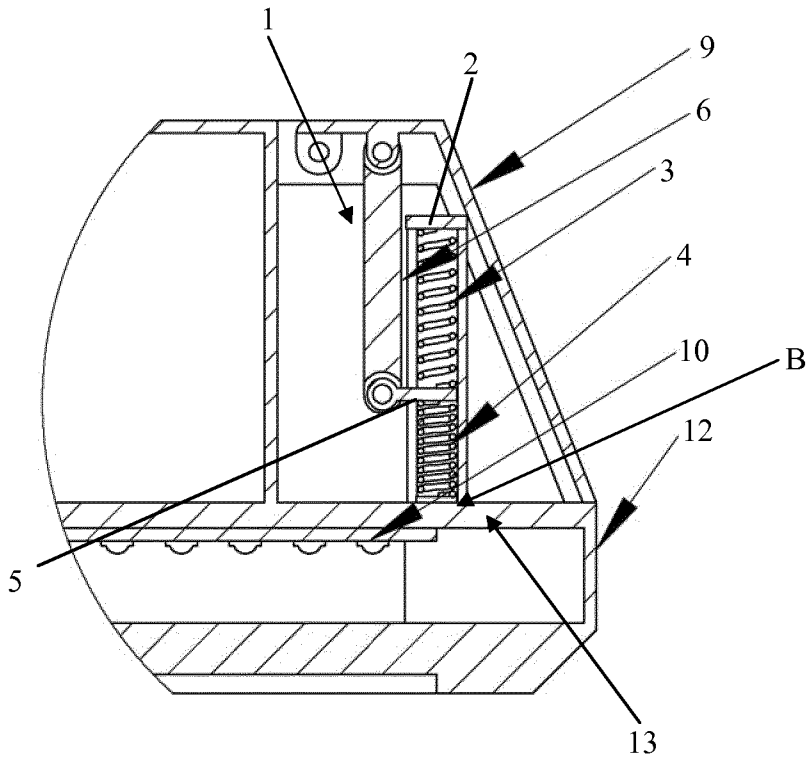


Figure 3