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(54) MECHANICAL SWITCH TO SWITCH A LIGHT EMITTING DIODE OR ANOTHER LOAD AND METHOD OF SWITCHING

(57) The present disclosure describes a mechanical switch (10) to switch a light emitting diode (LED) or another load. The mechanical switch (10) includes a rocker (1) pivotally mounted with respect to a first pivot point (PI), at least one fixed electrical contact (4), and a blade (2) pivotally mounted with respect to a second pivot point (P2). The blade (2) has an electrical contact (3) connectable with the at least one fixed electrical contact (4). The rocker (1) and the blade are mechanically coupled to each other via a cam (5), a plunger and a follower (6).

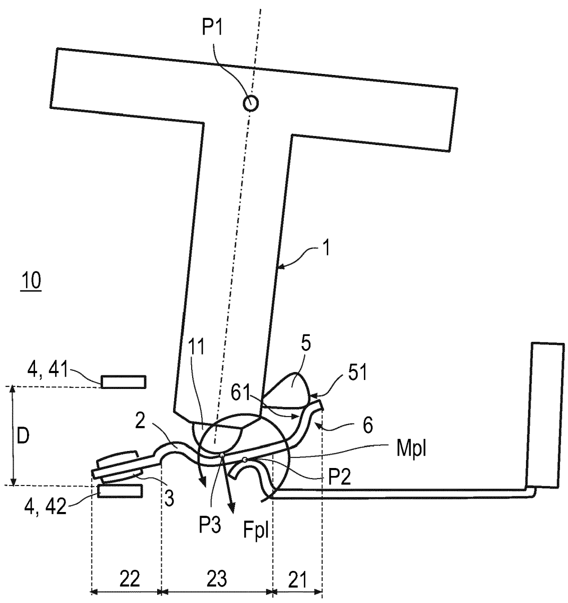

Fig. 4

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Description

TECHNICAL FIELD

[0001] Embodiments of the present disclosure relate to mechanical switches and methods to switch a light emitting diode (LED) or another load. In particular, embodiments of the present disclosure relate to applications of light switches with LED lamps, or any other type of loads with high inrush currents occurring during the making of the current. More specifically, embodiments of the present disclosure relate to rocker switches having a moving electrode configured to form an electrical connection with a further contact or electrode to enable a current flow in a closing phase.

BACKGROUND

[0002] Nowadays LED lamps are replacing the traditional light bulbs for the sake of their more efficient conversion of electricity into light. This change is even enforced by regulation in most of the countries worldwide.

[0003] However, when switching on a LED lamp, a high inrush current occurs during the first milliseconds due to the sudden charge of capacitors located in the LED driver (AC/DC converter), as illustrated in Fig. 2. Typical inrush peak currents are ranging about 10 times higher than then rated current.

[0004] One of the issues of mechanical switches is that there is a certain bouncing of the moving electrode during the closing phase. The kinetic energy of the moving electrode cannot be dissipated efficiently, which generates a bouncing.

[0005] The main problem occurs, when mechanical switches are used to switch on LEDs, for instance. Since the bounces occur while the current flows, then an arc forms between the two contacts. The very high inrush current that can be reached in switching on LEDs can lead to an accelerating contact ageing, or even cause welding of the contacts.

[0006] Hence, in view of the above, there is a demand for improved mechanical switches which overcome at least some of the problems of the state of the art. In particular, embodiments of the present disclosure aim at reducing the arcing duration during the inrush current phase of the switching on phase or even avoid any arcing.

SUMMARY

[0007] In light of the above, a mechanical switch to switch a light emitting diode (LED) or another load as well as a method of switching a LED or another load according to the independent claims are provided. Further aspects, advantages, and features are apparent from the dependent claims, the description, and the accompanying drawings.

[0008] According to an aspect of the present disclosure, a mechanical switch to switch a LED or another load is provided. The mechanical switch includes a rocker pivotally mounted with respect to a first pivot point, at least one fixed electrical contact, and a blade pivotally mounted with respect to a second pivot point. The blade has an electrical contact connectable with the at least one fixed electrical contact. The rocker and the blade are mechanically coupled to each other via a plunger, a cam and a follower. In particular, the plunger includes a spring provided inside the rocker and an element connected the spring. In the present disclosure, the element connected to the spring may be referred to as tip of the rocker. Accordingly, it is to be understood that the tip of the rocker can be a movable element which is connected to the spring. The rocker may also be referred to as plunger holder. Typically, the cam is connected with the plunger holder. A motion of the blade can be controlled by the geometry of the cam and an adapted geometry of the blade that follows the cam movement. Accordingly, the follower can be understood as a blade having a geometry which is adapted to the geometry of the cam, such that the blade can follow the cam movement. In other words, the plunger holder includes a cam that is configured to drive the motion of the blade in a controlled way by providing a follower design on the blade, so that the cam and the follower designs are adapted to get a desired moving contact motion. The cam may be a part, particularly an integral part, of the plunger holder. For example, the cam can be provided by a portion of the plunger holder which is shaped specifically to guide the blade (follower). Accordingly, it is to be understood, that the contour of the plunger holder can be designed to control the blade motion and act as a cam.

[0009] Accordingly, compared to the state of the art, an improved mechanical switch to switch a LED or another load is provided by a controlled motion of the moving contact. In particular, the mechanical switch as described herein beneficially provides for reducing the arcing duration during the inrush current phase of the switching on phase, or even for avoiding any arcing. Further, the mechanical switch as described herein beneficially provides for controlling the contact motion during the arcing phase of the breaking operation.

[0010] According to an aspect of the present disclosure, a method of switching a LED or another load is provided. The method includes moving a pivotally mounted blade by means of a pivotally mounted rocker. The blade has an electrical contact being connectable with at least one fixed electrical contact. The rocker and the blade are mechanically coupled to each other via a plunger, a cam and a follower. Further, the method includes reducing the kinetic energy of the blade at impact of the electrical contact of the blade with the at least one fixed electrical contact by providing a sliding contact between the cam and the follower. The sliding contact shape, particularly the contour surface or design of the cam and the blade, is adapted to decrease the rotating velocity of the blade when the electrical contact approaches the at least one fixed electrical contact.

[0011] Accordingly, compared to the state of the art, an improved method of switching a LED or another load is provided. In particular, the method as described herein beneficially provides for reducing the arcing duration during the inrush current phase of the switching on phase or even for avoiding any arcing. Additional benefit is a control of the moving contact during the breaking current phase.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized above, may be had by reference to embodiments. The accompanying drawings relate to embodiments of the disclosure and are described in the following:

Fig. 1 shows a schematic view of a mechanical switch according to the prior art;

Fig. 2 shows an inrush current which occurs, when the mechanical switch according to the prior art closes with a LED load, it is shown that a fast transient phase occurs, which is smaller than 2 ms, with a peak inrush current reaching up to about ten times the rated current;

Figs. 3a to 3e show schematic views of a closing sequence of a mechanical switch according to embodiments described herein for illustrating the cam-follower working principle;

Fig. 4 shows a schematic view of a mechanical switch according to embodiments described herein, illustrating the torque (retaining torque M_{pl}) of the plunger force F_{pl} around the axis perpendicular to the plane with respect to the contact point P2 at the moment of electrode contact; and

Fig. 5a und 5b shows a comparison of between a mechanical switch according to the prior art (Fig. 5a) and a mechanical switch according to embodiments describe herein (Fig. 5b).

DETAILED DESCRIPTION OF EMBODIMENTS

[0013] Reference will now be made in detail to the various embodiments, one or more examples of which are illustrated in each figure. Each example is provided by way of explanation and is not meant as a limitation. For example, features illustrated or described as part of one embodiment can be used on or in conjunction with any other embodiment to yield yet a further embodiment. It is intended that the present disclosure includes such modifications and variations.

[0014] Within the following description of the drawings, the same reference numbers refer to the same or to similar components. Generally, only the differences with respect to the individual embodiments are described. Unless specified otherwise, the description of a part or aspect in one embodiment can apply to a corresponding part or aspect in another embodiment as well.

[0015] In Fig. 1 a schematic view of a mechanical switch 10 according to the prior art is shown. In particular, the mechanical switch 10 as shown in Fig. 1 is also referred to as rocker switch. The mechanical switch 10 includes a rocker 1, a blade 2 having an electrical contact and at least one fixed electrical contact 4. For operating the rocker switch, the user pushes onto the switch cover in direction of the arrow indicated in Fig. 1. Thereby, the rocker 1 is pivoted about a first pivot point P1. The pivoting of the rocker 1 causes a rotation of the blade 2 about a second pivot point P2. Thereby, the electrical contact 3 of the blade 2 is moved. Accordingly, the electrical contact 3 of the blade 2 may also be referred to as movable electrical contact. Fig. 1 shows an example in which the movable electrical contact 3 is arranged between two fixed contacts 4. From Fig. 1, it is to be understood that depending on the angular position of the rocker and thus depending on the angular position of the blade 2, the movable electrical contact 3 makes contact with one of the two fixed contacts 4. In this regard, it is to be noted that the term "fixed contact" can be understood in that the "fixed contact" is fixed in relation to the movable electrical contact. In particular, a contact allowing for small movements or position variations may fall within the meaning of the term "fixed contact".

[0016] Fig. 2 illustrates, that a high inrush current occurs during the first milliseconds due to the sudden charge of capacitors located in a LED driver (AC/DC converter), when switching on a LED lamp. Typical inrush peak currents are ranging about 10 times higher than then rated current. Exact conditions are described in the standard. For instance, IEC 60699-1 Edition 4.0 2017-02 for the International Electrotechnical Commission.

[0017] With exemplary reference to Figs. 3a to 3e, Fig. 4, Fig. 5a and Fig. 5b, embodiments of the mechanical switch of the present disclosure are described.

[0018] According to embodiments which can be combined with any other embodiments described herein, the mechanical switch 10 is configured to switch a light emitting diode (LED) or another load. The mechanical switch 10 includes a rocker 1 pivotally mounted with respect to a first pivot point P1. Additionally, the mechanical switch 10 includes at least one fixed electrical contact 4, for example a first fixed electrical contact 41 and a second fixed electrical contact 42. Further, the mechanical switch 10 includes a blade 2 pivotally mounted with respect to a second pivot point P2. The blade 2 has an electrical contact 3. The electrical contact 3 is connectable with the at least one fixed electrical contact 4, e.g. with the first fixed electrical contact 41 or with the second fixed electrical contact 42. The rocker 1 and the blade 2 are mechanically coupled to each other via a plunger as well as a cam 5 and a follower 6. In this regard, it is to be noted that a mechanically coupling via a cam 5 and a follower 6 can be understood in that a first part, i.e. the cam, in a mechanical linkage is used to control the motion of another part, i.e. the follower.

[0019] Figs. 3a to 3e, show schematic views of a closing sequence of a mechanical switch 10 according to embodiments described herein for illustrating the cam-follower working principle of the mechanical switch 10 of the present disclosure. Fig. 3a shows an open position of the mechanical switch 10 in which the cam 5 does not touch the blade 2. Fig 3b shows a position of the mechanical switch 10 shortly before the contacts, i.e. the movable contact 3 and the at least one fixed contact 4, get closed. As shown in Fig. 3b, the cam 5 is in contact with the blade 2 and pushes on the blade. Thereby, the motion of the blade is slowed down. Figs. 3c and 3d, show positions of the mechanical switch 10, where the blade 2 is almost not moving while the rocker 1 continues its rotation and a distance between the tip 11 of the rocker and the second pivot point P2 increases. Fig. 3e shows a position of the mechanical switch 10 in which the movable contact 3 and the at least one fixed contact 4 form contact. Due to the design of the cam 5 and the follower 6, the movable contact 3 and the at least one fixed contact 4 close slowly with a highly reduced bounce duration.

[0020] In particular, from Figs. 3a to Fig. 3e, it is to be understood that the cam 5 and the follower 6 are configured, particularly designed, such that a motion of the electrical contact 3 of the blade 2 (i.e. the movable contact 3) is controllable during closing a contact with the at least one fixed electrical contact 4. More specifically, the cam 5 and the follower 6 are configured such that the kinetic energy of the blade 2 at impact of the electrical contact 3 of the blade 2 with the at least one fixed electrical contact 4 is reduced.

[0021] Accordingly, compared to the state of the art, an improved mechanical switch to switch a LED or another load is provided. In particular, the mechanical switch as described herein beneficially provides for reducing the arcing duration during the inrush current phase, or even for avoiding any arcing. Accordingly, contact ageing can be delayed or even be avoided. Further, with embodiments as described herein, welding of contacts due to arcing can beneficially be avoided.

[0022] In particular, it has been found that the reason for bounces in the mechanical switches is due to the impact between the moving electrode (3) and the fixed electrode (4) when the moving electrode closes . In this regard, it is to be noted that at least one or a combination of the following two physical parameters are responsible for the bounces: The First parameter is the kinetic energy of the closing blade at impact of the movable contact with the at least one fixed contact, i.e. the velocity of the movable contact at impact with the at least one fixed contact. The second parameter is the torque exerted by the plunger force on the blade at the moment of impact (so called "retaining torque" in the following). The plunger force F_{pl} and the retaining torque M_{pl} about the pivot point P2 are exemplarily indicated in Fig. 4.

[0023] With the embodiments as described herein, the number of bounces and their duration are significantly reduced, because, due to the provision of a cam and a follower, the blade closing velocity and retaining torque can be better controlled and optimized. In particular, compared to the state of the art, a lower closing velocity and a higher retaining torque can be provided. The retaining torque opposes the reopening of the contacts. The higher the retaining torque, the shorter the bounces. Further, it is pointed out that the provision of a cam and a follower as described herein is a low cost and easy to implement solution on the product.

[0024] Fig. 4 shows a schematic view of a mechanical switch according to embodiments described herein, illustrating the torque (retaining torque M_{pl}) of the plunger force F_{pl} around the axis perpendicular to the plane with respect to the second pivot point P2 at the moment of electrode contact (in Fig.4 contact of the movable contact 3 with the second fixed contact 42).

[0025] With exemplary reference to Fig. 4, according to embodiments which can be combined with any other embodiments described herein, the cam 5 has a first contour 51 being slidably in touch with a second contour 61 of the follower 6. The first contour 51 and the second contour 61 are configured such that a velocity of the electrical contact 3 decreases when the electrical contact 3 approaches the at least one fixed electrical contact 4. In this regard, it is to be understood that by correctly adjusting the shape of the cam 5 and of the follower 6, particularly the contours of the cam and the follower, it is possible to control the motion of the blade 2. In particular, the first contour 51 and the second contour 61 are configured such the force that the cam 5 exerts on the follower to control the motion of the blade is released shortly before the movable contact closes with the at least one fixed electrical contact 4. Thereby, beneficially a high retaining torque can be insured.

[0026] In particular, the first contour 51 and the second contour 61 are configured such that, when a contact between the electrical contact 3 of the blade 2 and the at least one fixed electrical contact 4 is established, a retaining torque M_{pl} of M_{pl} > 5 Nmm, particularly M_{pl} > 10 Nmm, more particularly M_{pl} > 15 Nmm, is provided.

[0027] According to embodiments which can be combined with any other embodiments described herein, the cam 5 is connected with the rocker 1 and the follower 6 is connected with the blade 2. In particular, the cam 5 can be part of the rocker 1 and the follower 6 can be part of the blade 2. For instance, the cam 5 can be integrally formed with the body of the rocker 1. The follower 6 may be provided by a portion of the blade 2.

[0028] With exemplary reference to Fig. 4, according to embodiments which can be combined with any other embodiments described herein, the follower 6 is provided at a first end portion 21 of the blade 2. The first end portion 21 is opposite to a second end portion 22 of the blade 2. The second end portion 22 of the blade includes the electrical contact 3 of the blade 2. Additionally or alternatively, the follower 6 can be provided at the second end portion 22, particularly for decreasing the rotating velocity of the electrical contact 3 when the electrical contact 3 approaches the first fixed contact 41, e.g. the upper fixed contact shown in the figures. Accordingly, it is to be understood that when the follower 6 is provided at the first end portion 21 and/or the second end portion 22 of the blade, correspondingly associated cams may be provided at the respective sides of the plunger holder. In other words, cams may be provided on opposite sides of the plunger holder to interact with the follower 6 provided at the first end portion 21 of the blade 2 and with the follower 6 provided at the second end portion 22 of the blade 2. Further, a symmetrical or an asymmetrical design can be provided between the cam on one side of the plunger holder and the opposite side of the plunger holder. Moreover, it is to be understood, that the blade may be provided with two electrical contacts, e.g. on opposite ends of the blade, and the associated fixed contacts can be provided on respective sides. Typically, the rocker 1 has a tip 11, for example a rounded tip, slidably in touch with a middle portion 23 of the blade 2. The middle portion 23 is provided between the first end portion 21 and the second end portion 22. As described in the beginning, the tip 11 tip of the rocker can be a movable element which is connected to a spring provided inside the plunger holder. Accordingly, the plunger includes the spring and the movable element, i.e. the tip 11, attached thereto. In other words, the tip 11 is the end of the plunger and the spring gives rise to the plunger force F_{pl} (and by consequence to the torque M_{pl}).

[0029] As exemplarily shown in Fig. 4, the at least one fixed electrical contact 4 can comprise a first fixed contact 41 and a second fixed contact 42 provided at a distance D from the first fixed contact 41. According to embodiments which can be combined with any other embodiments described herein, the cam 5 and the follower 6 are configured such that a switching time period T between a contact of the movable electrical contact 3 with the first fixed contact 41 and a contact of the movable electrical contact 3 with the second fixed contact 42 is $2 \text{ ms} \leq T \leq 50 \text{ ms}$, particularly $4 \text{ ms} \leq T \leq 45 \text{ ms}$; and more particularly $6 \text{ ms} \leq T \leq 40 \text{ ms}$.

[0030] Figs. 5a and 5b show a comparison of between a rocker switch according to the prior art (Fig. 5a) and a rocker switch according to embodiments describe herein (Fig. 5b), both at a closed position, immediately when the moving contact 3 and the fixed contact 4 touch each other. As shown in Fig. 4, the plunger force F_{pl} acts at the contact between the tip 11 of the rocker 1 and the blade 2. Typically, the contact of the tip 11 of the rocker 1 with the blade 2 is a sliding contact. The sliding contact point P3 between the tip 11 of the rocker 1 and the blade is exemplarily indicated in Figs. 4, 5a and 5b. The retaining torque M_{pl} when the movable contact 3 touches the at least one fixed contact 4 is defined by the plunger force (spring) times the lever arm of force relative to the second pivot point P2, here the distance of the plunger, i.e. the tip 11 of the rocker 1, relative to the pivot point of the blade 2, i.e. the second pivot point P2. As can be seen by comparing Fig. 5b with Fig. 5a, in the closed state the distance between the sliding contact point P3 and the second pivot point P2 is larger for mechanical switch with the cam 5 (Fig. 5b: distance between P3 and P2 = x_2) compared to the state of the art (Fig. 5a: distance between P3 and P2 = x_1). Accordingly, the mechanical switch as exemplarily shown in Fig. 5b provides for a larger retaining torque M_{p1} than the mechanical switch according to the prior art shown in Fig. 5a. The difference in plunger position is also visible in the difference of the relative position of the top covers. The angle β in Fig. 5b is larger than the angle α in Fig. 5a.

[0031] Accordingly, in view of the above, it is to be understood that by employing a mechanical switch according to embodiments described herein an improved method of switching can be provided.

[0032] Thus, according to another aspect of the present disclosure, a method of switching a LED or another load is provided. According to embodiments which can be combined with any other embodiments described herein, the method includes moving a pivotally mounted blade 2 by means of a pivotally mounted rocker 1. The blade 2 has an electrical contact 3 connectable with at least one fixed electrical contact 4. The rocker 1 and the blade 2 are mechanically coupled to each other via a plunger, a cam 5 and a follower 6. Further, the method includes reducing the kinetic energy of the blade 2 at impact of the electrical contact 3 of the blade 2 with the at least one fixed electrical contact 4 by providing a sliding contact between the cam 5 and the follower 6. The sliding contact being adapted to decrease the velocity of the blade 2 when the electrical contact 3 approaches the at least one fixed electrical contact 4. In particular, the method of switching a LED or another load is conducted by using a mechanical switch 10 according to any embodiments described herein.

[0033] Accordingly, in view of the embodiments described herein, it is to be understood that compared to the state of the art, an improved mechanical switch as well as an improved method to switch a LED or another load are provided with which the arcing duration during the inrush current phase, the switching on phase, can be reduced or even be avoided.

[0034] Further, in view of the above, it is to be understood that by appropriately applying a cam-follower principle to a mechanical switch as described herein, the motion of the blade can be controlled such that the kinetic energy at impact of two electrodes forming electrical contact can substantially be decreased. Accordingly, compared to the state of the art significantly shorter bounces (< 250μs) occur with the mechanical switch according to embodiments described herein.

[0035] The concept of using the cam-follower principle has been described with respect to Figs. 3a -5b. However, it is to be understood that the cam-follower principle may also be applied to other mechanical switches with different designs. For instance, alternatively the blade motion can be controlled by using an external cam, linked directly on the blade (e.g. on a side of the blade) or indirectly via an intermediate body between the plunger and the blade.

[0036] As described herein, the use of a cam allows for control on the rotating velocity of the blade. The decrease in blade rotating velocity allows the plunger of the rocker to travel a longer distance on the blade (compared to the state of the art, see Figs. 5a and 5b), such that the retaining torque M_{pl} when the contacts touch is higher. Therefore, it is more difficult for the blade to reopen such that bouncing can be reduced.

[0037] Further, it is to be noted that embodiments as described herein have been explained with respect to the bottom contact, i.e. the second fixed contact 42 of the at least one contact 4. However, it is to be understood that principle cam-follower concept also applies to the top contact, i.e. the first fixed contact 41 of the at least one contact 4.

[0038] While the foregoing is directed to embodiments, other and further embodiments may be devised without departing from the basic scope, and the scope is determined by the claims that follow.

REFERENCE NUMBERS

[0039]

10	mechanical switch to switch a LED or another load
1	rocker
11	tip of rocker
2	blade
21	first end portion of blade
22	second end portion of blade
23	middle portion of blade
3	electrical contact
4	at least one fixed electrical contact
41	first fixed contact
42	second fixed contact
5	cam
51	first contour of cam
6	follower
61	second contour of follower
P1	first pivot point
P2	second pivot point
P3	sliding contact point
M_{pl}	retaining torque
F_{pl}	plunger force

Claims

1. A mechanical switch (10) to switch a light emitting diode (LED) or another load, comprising:

   - a rocker (1) pivotally mounted with respect to a first pivot point (PI);
   - at least one fixed electrical contact (4); and
   - a blade (2) pivotally mounted with respect to a second pivot point (P2), the blade (2) having an electrical contact (3) connectable with the at least one fixed electrical contact (4), wherein the rocker (1) and the blade (2) are mechanically coupled to each other via a plunger, a cam (5) and a follower (6).

2. The mechanical switch (10) of claim 1, wherein the cam (5) and the follower (6) are configured, particularly designed, such that a motion of the electrical contact (3) of the blade (2) is controllable during closing a contact with the at least one fixed electrical contact (4).

3. The mechanical switch (10) of claim 1 or 2, wherein the cam (5) has a first contour (51) being slidably in touch with a second contour (61) of the follower (6), wherein the first contour (51) and the second contour (61) are configured such that a velocity of the electrical contact (3) decreases when the electrical contact (3) approaches the at least one fixed electrical contact (4).

4. The mechanical switch (10) of claim 3, wherein the first contour (51) and the second contour (61) are configured such that when a contact between the electrical contact (3) of the blade (2) and the at least one fixed electrical contact (4) is established a retaining torque M_{pl} of M_{pl} > 5 Nmm, particularly M_{pl} > 10 Nmm, more particularly M_{pl} > 15 Nmm, is provided.

5. The mechanical switch (10) of any of claims 1 to 4, wherein the cam (5) is connected with, particularly part of, the rocker (1), and wherein the follower (6) is connected with, particularly part of, the blade (2).

6. The mechanical switch (10) of any of claims 1 to 5, wherein the follower (6) is provided at a first end portion (21) of the blade (2) being opposite to a second end portion (22) comprising the electrical contact (3) of the blade (2), and/or wherein the follower (6) is provided at the second end portion (22).

7. The mechanical switch (10) of any of claims 1 to 6, wherein the plunger includes a tip (11) of the rocker, the tip (11) being slidably in touch with a middle portion (23) of the blade (2).

8. The mechanical switch (10) of any of claims 1 to 7, wherein the at least one fixed electrical contact (4) comprises a first fixed contact (41) and a second fixed contact (42) provided at a distance D from the first fixed contact (41), and wherein the cam (5) and the follower (6) are configured such that a switching time period T between a contact of the electrical contact (3) of the blade (2) with the first fixed contact (41) and a contact of the electrical contact (3) of the blade (2) with the second fixed contact (42) is 2 ms $\leq$ T $\leq$ 50 ms, particularly 4 ms $\leq$ T $\leq$ 45 ms; more particularly 6 ms $\leq$ T $\leq$ 40 ms.

9. Method of switching a light emitting diode (LED) or another load, comprising:

- moving a pivotally mounted blade (2) by means of a pivotally mounted rocker (1), the blade (2) having an electrical contact (3) connectable with at least one fixed electrical contact (4), wherein the rocker (1) and the blade (2) are mechanically coupled to each other via a plunger, a cam (5) and a follower (6), and
- reducing the kinetic energy of the blade (2) at impact of the electrical contact (3) of the blade (2) with the at least one fixed electrical contact (4) by providing a sliding contact between the cam (5) and the follower (6), the sliding contact shape being adapted to decrease the rotating velocity of the blade (2) when the electrical contact (3) approaches the at least one fixed electrical contact (4).

10. The method of claim 9, wherein the method is conducted by using a mechanical switch (10) according to any of claims 1 to 8.

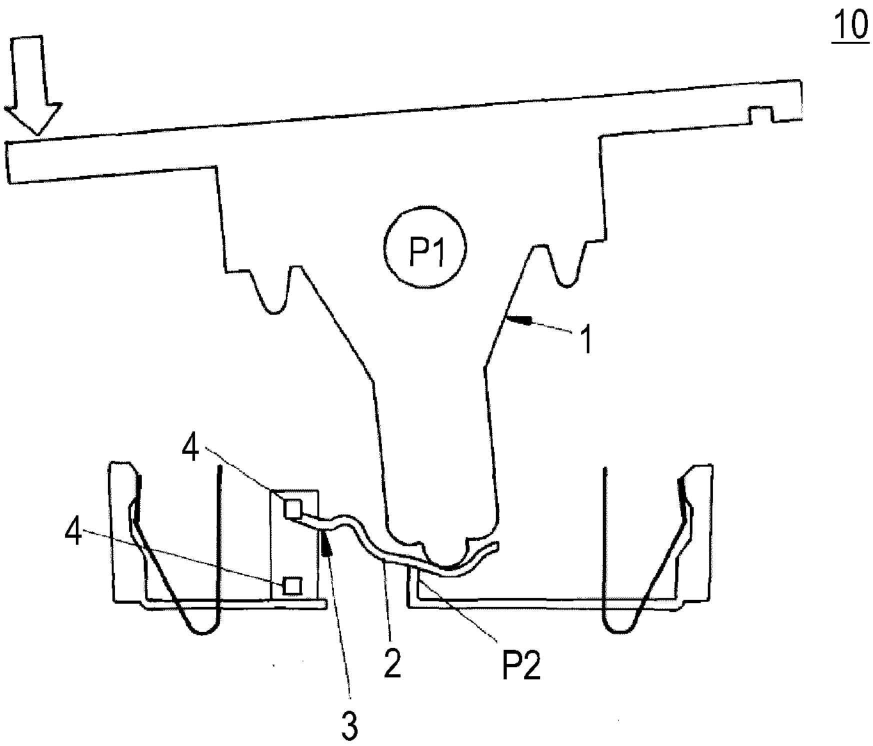


Fig. 1
(State of the art)

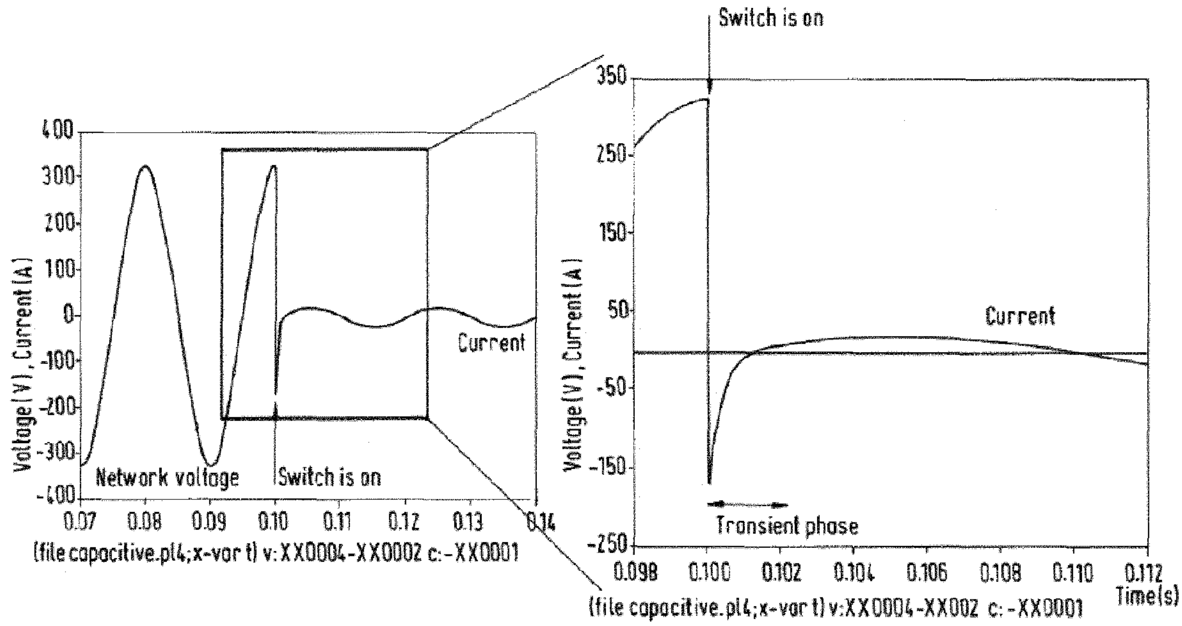


Fig. 2

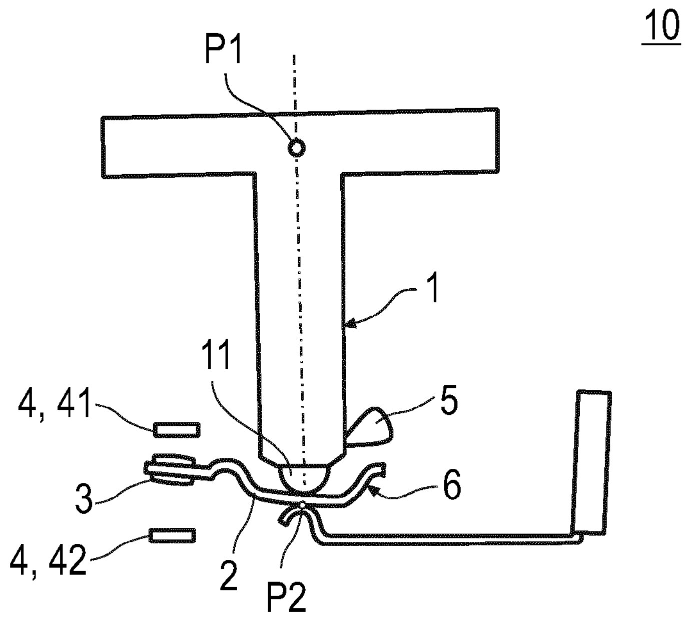


Fig. 3a

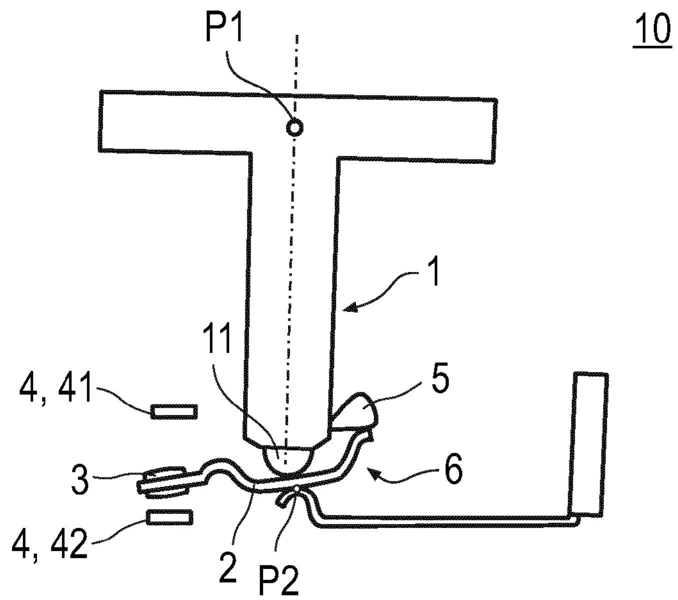


Fig. 3b

Fig. 3c

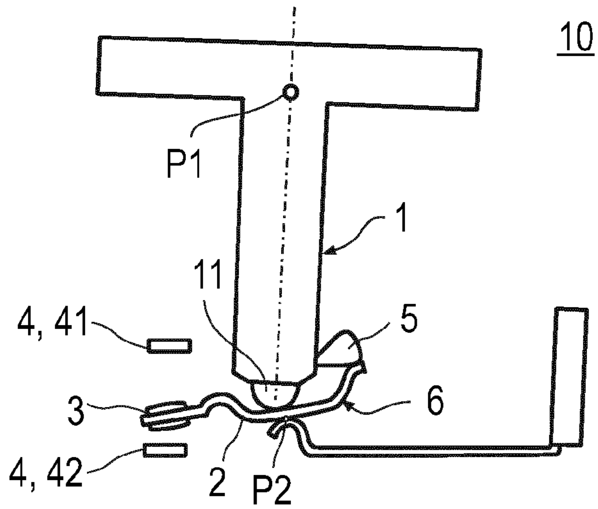


Fig. 3d

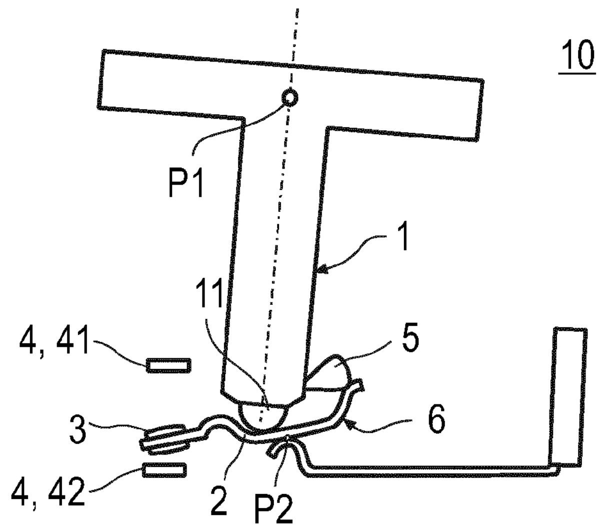
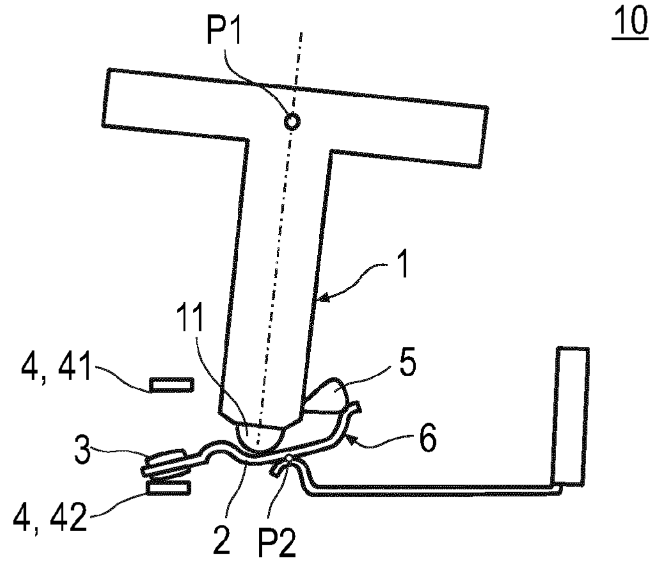


Fig. 3e



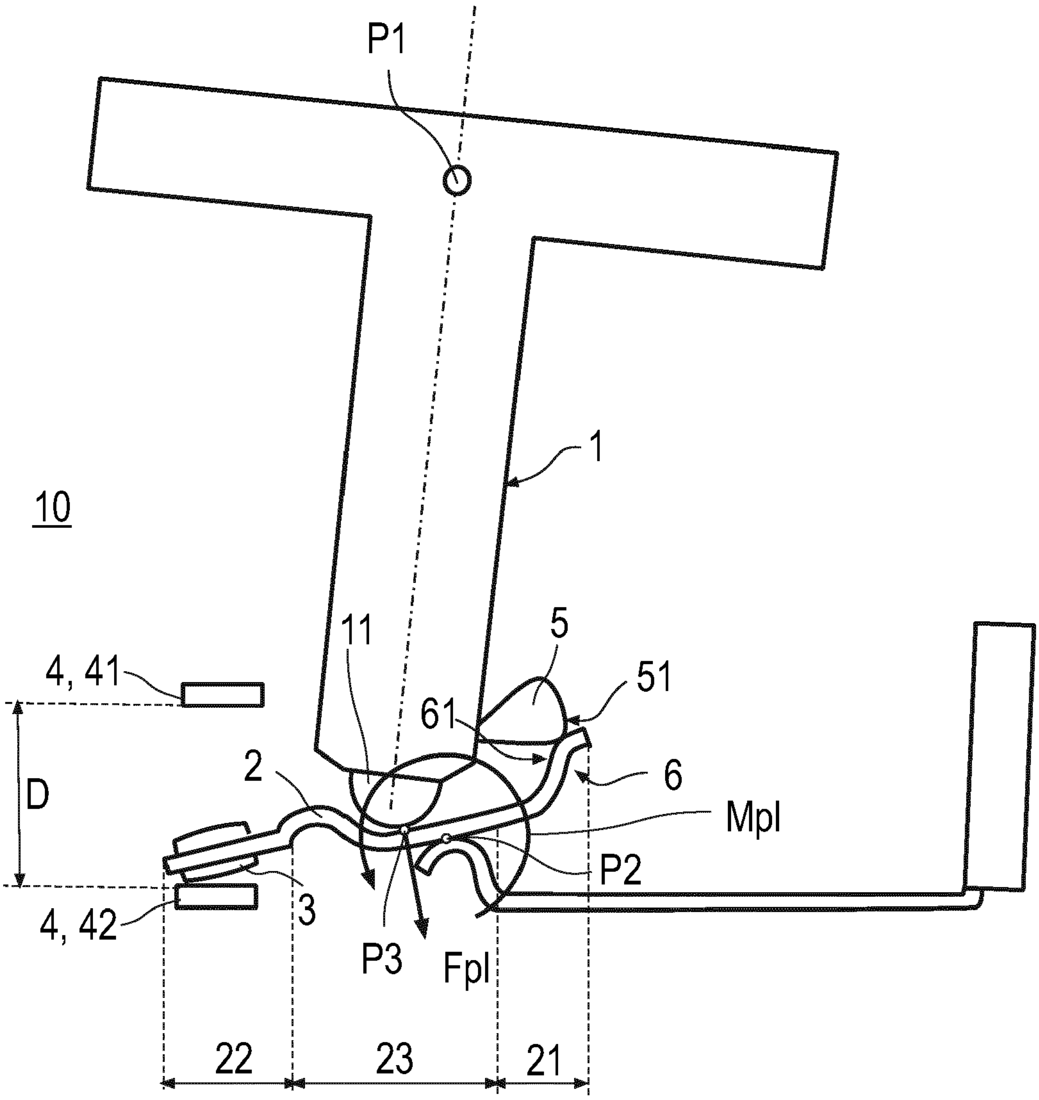


Fig. 4

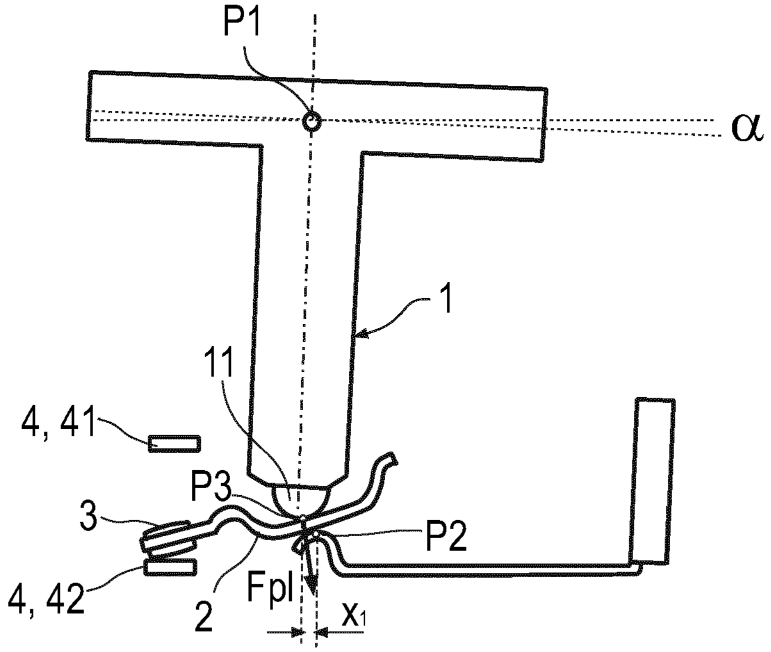
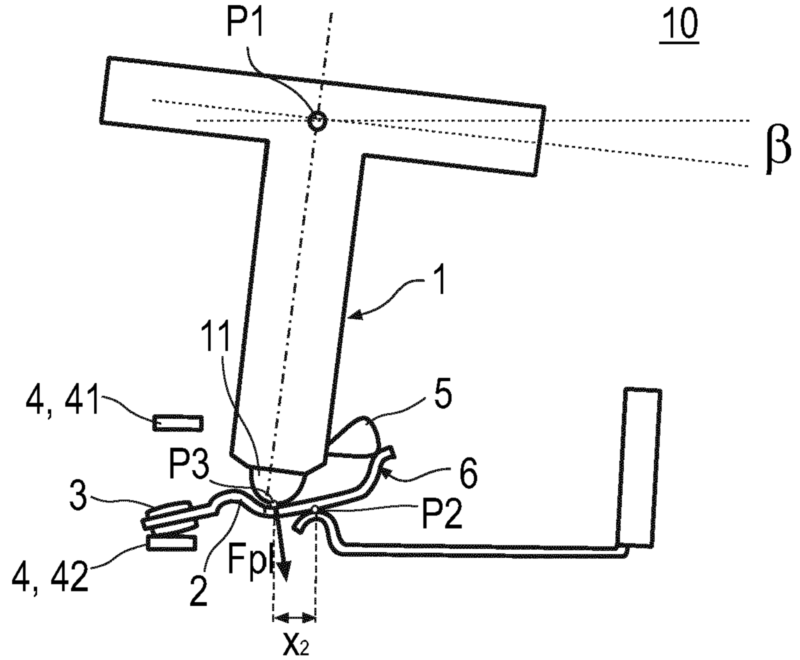

P1
α
1
11
4, 41
P3
3
P2
4, 42
Fpl
2
x1

Fig. 5a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β
1
11
5
4, 41
P3
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3
P2
4, 42
Fpl
2
x2

Fig. 5b

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EUROPEAN SEARCH REPORT

Application Number
EP 20 17 6920

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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
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CATEGORY OF CITED DOCUMENTS

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