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(54) **Key-controlled safety switch**

(57) A key-controlled safety switch includes a box-like case (2) with a longitudinal axis (L) which internally accommodates a series of fixed electric contacts (4, 5) and moving electric contacts (6, 7) which are suitable to interact in order to change the state of the switch, and an actuation head with a prism-shaped cap (3) which has, on opposite sides of an end edge (14), two slots (12, 13) for the insertion of a key-type actuator (15) along two mutually perpendicular directions (α , β), wherein the head (3) supports a cam (16) for the actuation of the moving contacts (6, 7) which can rotate about a substantially transverse pin (H), and locking devices for the cam (16) which include at least one slider (39) which can slide substantially at right angles to the rotation axis of the cam. The slider (39) and the cam (16) can be actuated exclusively with the key-type actuator (15). The direction of the sliding of the slider (39) is substantially perpendicular to the rotation axis (18) of the cam and is inclined with respect to both of the insertion directions of the actuator. The slots (12, 13) for the insertion of the actuator are substantially equidistant from the end edge (14).

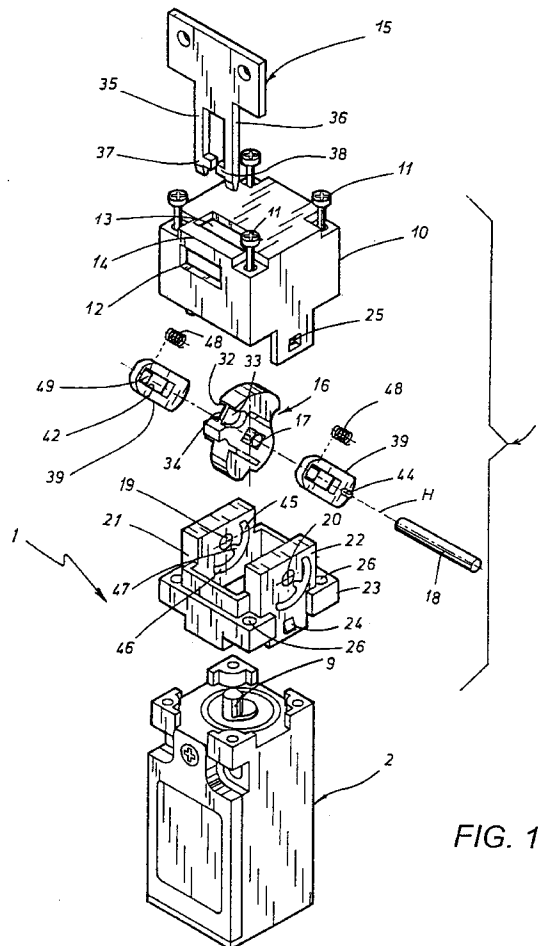


FIG. 1

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Description

The present invention relates to a key-controlled safety switch for controlling protections of machines and industrial plants, such as for example doors of control cabinets and moving barriers for accessing work areas. The function of this kind of switch is to send a stop signal when the protection is opened or tampered with.

Conventional switches of the above described type essentially include a case which can be anchored to the fixed part of the protection of the machine and internally accommodates at least one fixed electrical contact and at least one moving electric contact; these contacts can interact selectively in order to open or close the external electrical circuit of the machine.

A cap or head is detachably installed on the case and contains a mechanism for locking and actuating the moving electric contact. The head is also provided with a slot for the insertion of a key-type device which can be anchored to the moving part of the protection of the machine. The insertion of the key in the slot releases and changes the position of the head actuation mechanism, causing the selective movement of the moving electric contact and the consequent opening or closure of the electric circuit.

By virtue of the patterned shape of the key, the contacts can be actuated only with the key, while actuation is practically impossible by using screwdrivers, wires or other conventional tools.

Safety switches are known in which the moving contact is fitted on a stem which can slide along a longitudinal axis of the body and on which there acts a wheel or cam which is part of the actuation mechanism. The cam is installed on supports of the head, so that it rotates about an axis which lies transversely to the axis of the stem, and is provided with locking devices which prevent its rotation unless the key has been inserted for at least a certain part of its stroke.

In a conventional type of safety switch, the locking devices are constituted by one or more blocks located to the sides of the cam and provided with protrusions which cooperate axially with complementary hollows formed on the lateral faces of the cam. The blocks are mounted so that they can slide but cannot rotate on the axis of the cam and are normally moved toward the cam by virtue of compression springs so as to lock the rotation of the cam. Upon insertion, the chamfered end of the key-type actuator axially moves the blocks away from the cam, so as to allow the free rotation thereof, switching the switch.

In another kind of switch, the blocks that can slide axially with respect to the cam are replaced with sliders which can move at right angles to its rotation axis. The sliders have protrusions or stop members which are meant to engage complementarily shaped parts provided in the cam in order to prevent rotation thereof until the key-type actuator is inserted and pushed in the head.

US-A-5,587,569 (EJA) describes a key-controlled switch with two apertures, with two sliders which can slide along guides which are formed on the lateral supports of the actuation cam and interact with complementary parts formed on the cam.

US-A-5,516,993 (BERNSTEIN) describes a switch with two apertures and with two sliders which can slide along guides formed in the side walls of the actuation cam and rotate together with the cam.

International publication WO95/24726 describes a single-aperture switch with two locking sliders which slide with respect to the key along its entire insertion stroke.

In all these conventional switches, the sliding direction of the locking sliders is substantially perpendicular to the direction in which the key is inserted and made to slide. Accordingly, the movement of the locking sliders occurs by virtue of inclined planes provided on the key and on the sliders. The key-type actuator furthermore slides along the sliders over most of its insertion stroke.

Furthermore, the parts of the locking mechanism are very small, are composed of multiple components, are fragile and are subject to sudden movements.

The drawback of relative complexity and fragility of the locking and actuation mechanisms combines with the presence of considerable friction and wear, which reduce their reliability and life, increasing the risk of jamming especially in the presence of impurities and in highly polluted environments.

Another drawback of double-aperture switches is that the slots for the insertion of the key are located asymmetrically with respect to the head, that is to say, their distances from an end edge are different; this reduces the flexibility of the orientation of the switch if the head is rotated in order to adapt it to the machine.

An aim of the present invention is to eliminate the above drawbacks, providing a key-controlled safety switch which is constructively very simple, highly reliable, mechanically strong and flexible in assembly.

A particular object is to eliminate, or at least minimize, sliding and therefore mechanical wear, increasing life and reliability.

A further object is to provide a key-controlled safety switch constituted by a minimal number of very strong parts.

A further object is to facilitate the positioning of the switch, keeping the distances between its fixed and moving parts substantially unchanged.

This aim, these objects and others which will become apparent hereinafter are achieved by a key-controlled safety switch according to the invention and according to claim 1, which includes a case with a longitudinal axis which internally accommodates fixed and moving electric contacts which are suitable to interact in order to change the state of the switch, a prism-shaped head which has, on opposite sides of an end edge, two slots for the insertion of a key-type actuator along two mutually perpendicular directions, the head internally

accommodating a cam for the actuation of the moving contacts which can rotate about a substantially transverse axis and locking devices which include at least one slider with a stop member which is arranged laterally to the cam, the locking devices and the cam being actuable exclusively with the key-type actuator, characterized in that the direction of the sliding of the slider is substantially perpendicular to the rotation axis of the cam and is inclined with respect to both of the insertion directions of the actuator, and in that the slots for the insertion of the actuator are substantially equidistant from the end edge.

By virtue of the inclination of the locking slider or sliders with respect to the key insertion direction, sliding friction caused by inclined planes is practically eliminated, increasing the reliability and durability of the switch.

Furthermore, the position of the slots simplifies the placement of the switch if the head is rotated in order to adapt it to the machine.

Further characteristics and advantages of the invention will become apparent from the detailed description of a preferred but not exclusive embodiment of a key-controlled safety switch according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a general exploded perspective view of a switch according to the invention;

Figure 2 is a front view of a detail of Figure 1;

Figure 3 is a front view of another detail of Figure 1;

Figure 4 is a partially sectional side view of another detail of Figure 1;

Figure 5 is a partially sectional side view of the switch according to the invention in a first step of its operation;

Figure 6 is a partially sectional side view of the switch according to the invention in a second step of its operation;

Figure 7 is a partially sectional side view of the switch according to the invention in a third step of its operation.

With reference to the above figures, the key-controlled safety switch according to the invention, generally designated by the reference numeral 1, includes a case 2 which is shaped approximately like a parallelepiped and can be anchored to the fixed part of a protection of a machine, for example the frame of a control cabinet, and an actuation head 3 which can be detachably anchored to the case 2 in different positions to adapt it to the specific requirements of installation on the

machine.

The case 2 accommodates pairs of fixed contacts 4 and 5 and respective pairs of moving contacts 6 and 7. The contacts are fixed to bridges which are rigidly coupled to a shank 8 which can move inside the case 2 along a longitudinal axis L and has an end 9 which protrudes outside the case 2. With reference to Figures 5 to 7, when the shank 8 is in the left stroke limit position, the contact bridge 6 closes the pair of contacts 4, whilst in the right stroke limit position the contact bridge 7 closes the pair of contacts 5, correspondingly varying the switching state of the switch.

The number of contacts and their relative positions can of course also be different without thereby changing the essence of the invention.

The head 3 is formed by a prism-shaped cap 10 which is anchored to the case 2 by virtue of screws 11. Two slots 12 and 13 are formed on the cap 10, respectively on two faces which are adjacent to an end edge 14. Through the slots 12 and 13 it is possible to insert a key-type actuator member 15, which is fixed to the moving part of a protection of a machine, for example the door of the previously mentioned control cabinet.

The key-type actuator 15 has a special shape, described in detail hereafter, in respective directions α and β which are mutually perpendicular and are respectively parallel and transverse with respect to the longitudinal axis L of the case 2. According to the invention, the two slots 12 and 13 have the same distance from the lateral edge 14, so as to facilitate installing the switch with its head rotated.

The cap 10 of the head 3 internally accommodates an actuation cam 16, which has a central hub 17 whose cross-section is approximately square; a pin 18 whose axis is designated by the reference letter H is inserted in the hub. The ends of the pin 18 are keyed in two holes 19 and 20 formed in respective lateral supports 21 and 22 which protrude from a connecting plate 23.

The connecting plate 23 is provided with two lateral tabs 24 which can be inserted in a snap-together fashion in corresponding openings 25 of the cap 10, and is provided with holes 26 which are aligned with the screws 11 for the detachable anchoring of the head 3 to the case 2, keeping the cam mounted on the pin 18.

When the head 3 is fitted on the case 2, the rounded end 9 of the shank 8 is in contact with the external profile of the cam 16 by virtue of the elastic compression of a compression spring 27 which is interposed between the bottom of the case 2 and the adjacent end of the shank 8.

The external profile of the cam 16 has a protrusion 28 with a local recess 29 in order to keep the shank stably in the stroke limit position shown in Figure 5, in which the moving contacts 6 short-circuit the fixed contacts 4 when the key-type actuator 15 is not inserted in the head. On the external profile of the cam 16 there is also a first concavity 30 which is meant to keep the shank 8 in the stroke limit position shown in Figure 6, in

which the moving contacts 7 short-circuit the contacts 5 when the key-type actuator 15 is inserted in the slot 12. Finally, there is a second concavity 31 which keeps the shank 8 in the same stroke limit and electrical switching position shown in Figure 6, but does so when the key-type actuator 15 is inserted in the other slot 13.

In order to promote the rotation of the cam, on the external profile of the cam there are two facing seats 32 and 33 which are separated by a central partition 34. Correspondingly, the actuator 15 has, toward the free ends of two arms 35 and 36, respective mutually opposite lugs 37 and 38 which are separated by a gap which is slightly greater than the thickness of the partition 34; the lugs can engage the seats 32 and 33 of the cam 16.

There are locking devices to prevent the rotation of the cam 16 unless the key-type actuator 15 is used for this purpose.

In particular, the locking devices are constituted by at least one, preferably two sliders or blocks 39 which are arranged to the sides of the cam 16 and can slide along guiding devices which are perpendicular to the rotation axis of the cam. Each slider is constituted by a single monolithic component which is considerably tough and wear-resistant.

According to the invention, the direction of the sliding of each slider 39 upon insertion of the key-type actuator 15 is inclined with respect to the directions of insertion of the actuator in both slots 12 and 13.

In particular, the inclination angles μ of each slider with respect to the insertion directions α and β of the key-type actuator are substantially identical and equal to approximately 45°.

For this purpose, devices for guiding the sliders 39 are formed on the opposite side walls of the cam 16. The guiding devices are constituted by two lateral ridges 40 and 41 which guide the longitudinal sides of each slider 39 and by the central hub 17 itself of the cam 16, which guides a central longitudinal opening 42 provided in most of the length of each slider 39.

The end 43 of each slider 39 which is close to the slots 12 and 13 is rounded in order to reduce friction against the key-type actuator 15, whilst the opposite end has a stop tooth 44 which is directed laterally outward.

Each stop tooth 44 is inserted in, and guided by, a corresponding groove 45 formed on the internal faces of the lateral supports 21 and 22 of the connecting plate 23 during the rotation of each slider 39 together with the cam 16.

In particular, each groove 45 has a main portion 46 which is shaped like a circular sector and is concentric with respect to the holes 19 and 20 of the rotation axis of the cam 16 and has an aperture angle of approximately 90°; a short central portion 47 protrudes from the main portion, is directed radially toward the center and is slightly flared in a V-like shape in order to facilitate the repositioning of the stop tooth 44 in the initial position shown in Figure 5. In order to keep the stop tooth 44 of

each slider 39 normally engaged in the groove portion 47, there are elastic devices which are constituted by a compression spring 48 which is inserted in the longitudinal cavity 42, is retained by a protrusion 49 and acts on the hub 17.

During use, the key-type actuator 15 can be inserted in one of the slots 12 and 13 of the head 3, as shown in Figure 5; its mutually opposite lugs 37 and 38 enter the seats 32 and 33, pushing the sliders 39 in the direction of the guides 40 and 41 on the cam 16 by an extent of the stroke which is sufficient to disengage the stop tooth 44 from the groove portion 47. Up to this point, the cam 16 cannot rotate and therefore performs no electrical switching of the switch. It is noted that the mutual sliding of each slider 39 with respect to the cam 16 is limited only to the radial extension of the groove portion 47, minimizing friction, wear and jamming which are typical of locking devices according to the prior art.

If the actuator 15 has been inserted in the slot 12, as shown in Figure 6, the lugs 37 and 38, in the second part of the insertion stroke of the actuator 15, engage the seats 32 and 33, causing the rotation of the cam 16 counterclockwise and causing the electrical switching of the switch.

If the actuator 15 has been inserted in the slot 13, as shown in Figure 7, the lugs 37 and 38, in the second part of the stroke of the actuator 15, cause the clockwise rotation of the cam 16, thus causing the electrical switching of the switch in this case as well.

Claims

1. Key-controlled safety switch, comprising a case (2) with a longitudinal axis (L) which internally accommodates fixed electric contacts (4, 5) and moving electric contacts (6, 7) which are suitable to interact in order to change the state of the switch, and an actuation head (3) with a prism-shaped cap (10) which has, on opposite sides of an end edge (14), two slots (12, 13) for the insertion of a key-type actuator (15) along two mutually perpendicular directions (α , β), wherein said head (3) supports a cam (16) for the actuation of the moving contacts (6, 7) which can rotate about a substantially transverse axis (H), and locking devices for said cam (16) which comprise at least one slider (39) which can slide substantially at right angles to the rotation axis of said cam (16), said slider (39) and said cam (16) being actuatable exclusively with said key-type actuator (15), characterized in that the direction of the sliding of said slider (39) is substantially perpendicular to the rotation axis (H) of said cam and is inclined with respect to both of the insertion directions of the actuator, and in that said slots (12, 13) for the insertion of said actuator are substantially equidistant from said end edge (14).

2. Safety switch according to claim 1, characterized in

that the inclination angles (μ) of said slider (39) with respect to the insertion directions (α , β) of said key-type actuator are substantially identical and are equal to approximately 45°.

3. Safety switch according to the preceding claims, characterized in that it has two sliders (39) which are arranged on both sides of said cam (16). 5
4. Safety switch according to claim 3, characterized in that each slider (39) can slide along guiding devices (40, 42, 17) which are rigidly coupled to said cam and has a lateral stop tooth (44) which is directed outward. 10
5. Safety switch according to claim 4, characterized in that said guiding devices are formed on the lateral faces of said cam (16). 15
6. Safety switch according to claim 4, wherein said head (3) has two lateral supports (21, 22) with holes for the insertion of the rotation axis (H) of said cam, characterized in that each lateral support (21, 22) has, on its internal surface, an appropriately shaped groove (45) for accommodating and guiding said lateral stop tooth (44) of each slider (39). 20
25
7. Safety switch according to claim 6, characterized in that said groove (45) comprises a curved portion (46) which is concentric with respect to the rotation axis (H) of the cam (16) in order to guide said stop tooth (44) during the rotation of the slider (39) rigidly with the cam (16). 30
8. Safety switch according to claim 7, characterized in that said groove (45) comprises a central portion (47) which protrudes radially from said curved portion (46) toward the axis of said cam in order to lock the rotation of said slider (39) rigidly with said cam. 35
40
9. Safety switch according to claim 8, characterized in that it has elastic devices (48) which interact between said cam (16) and each slider (39) in order to keep said stop tooth (44) normally engaged in said central portion (47) of said groove (45). 45
10. Safety switch according to claim 9, characterized in that said central portion (47) of said groove (45) is flared in order to facilitate the automatic repositioning of the stop tooth (44) of each slider (39). 50
11. Safety switch according to claim 10, characterized in that said key-type actuator (15) has, toward its insertion end, two mutually opposite lugs (37, 38) which are adapted to actuate, during the first part of the insertion stroke, said sliders (39) with a force component which is substantially parallel to their sliding direction. 55
12. Safety switch according to claim 11, characterized in that said cam (16) has, on its lateral faces, two shaped seats (32, 33) for accommodating said pair of mutually opposite lugs (37, 38) of said key-type actuator (15) in order to promote the rotation of said cam (16) in the second part of the insertion stroke of said key-type actuator (15).

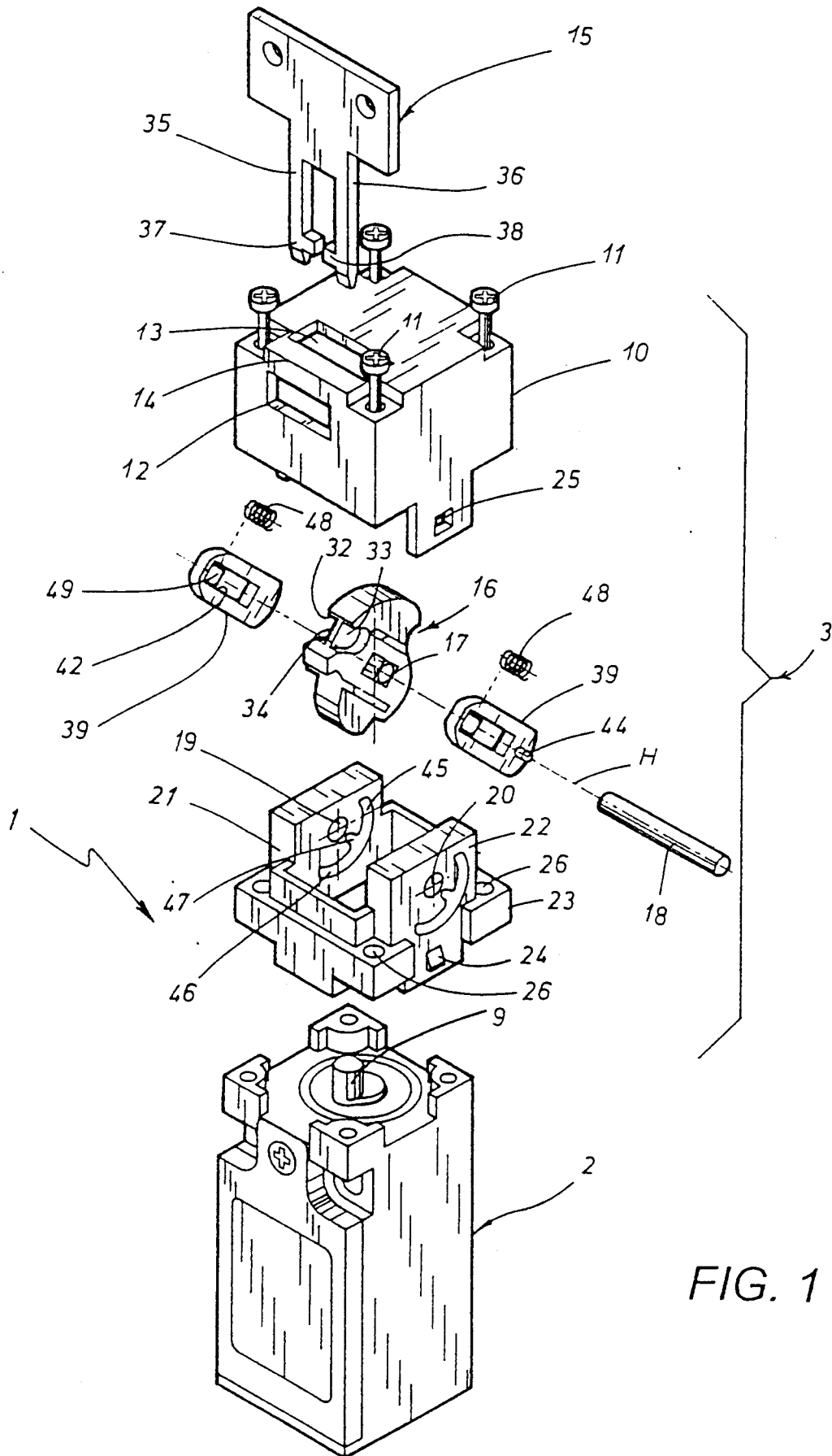


FIG. 1

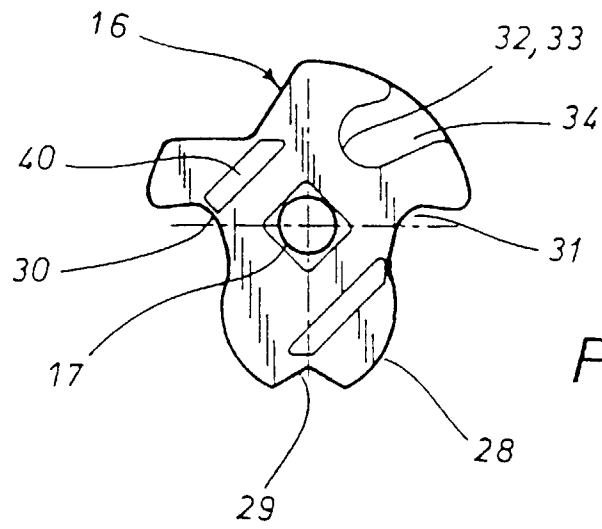


FIG. 2

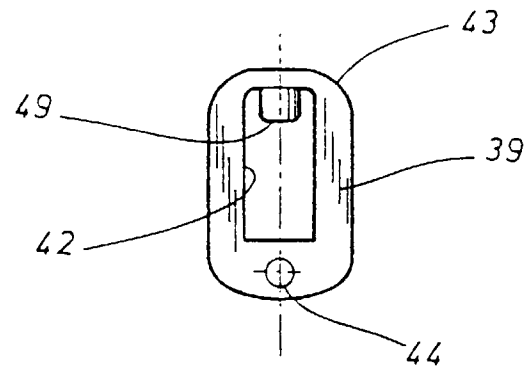


FIG. 3

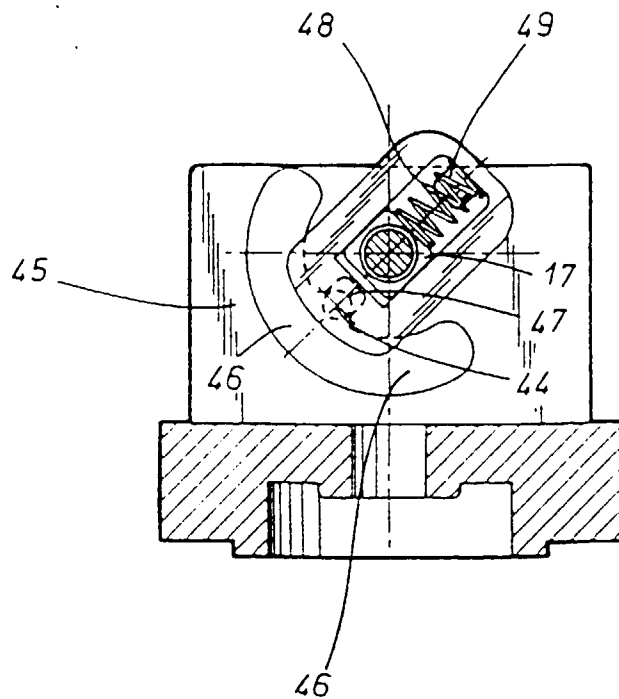
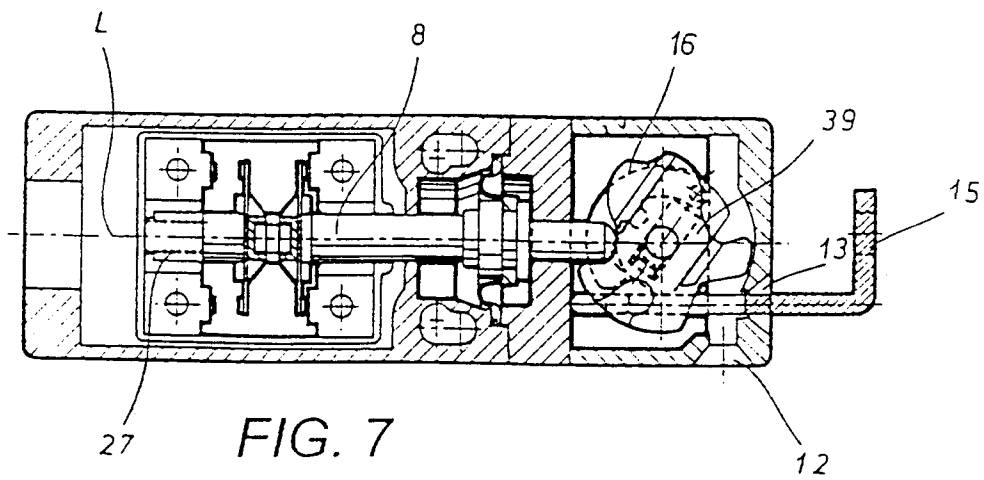
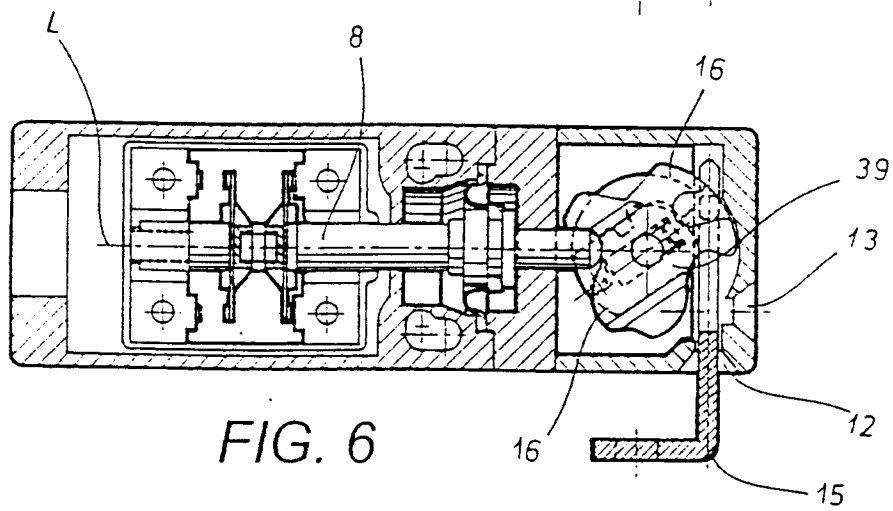
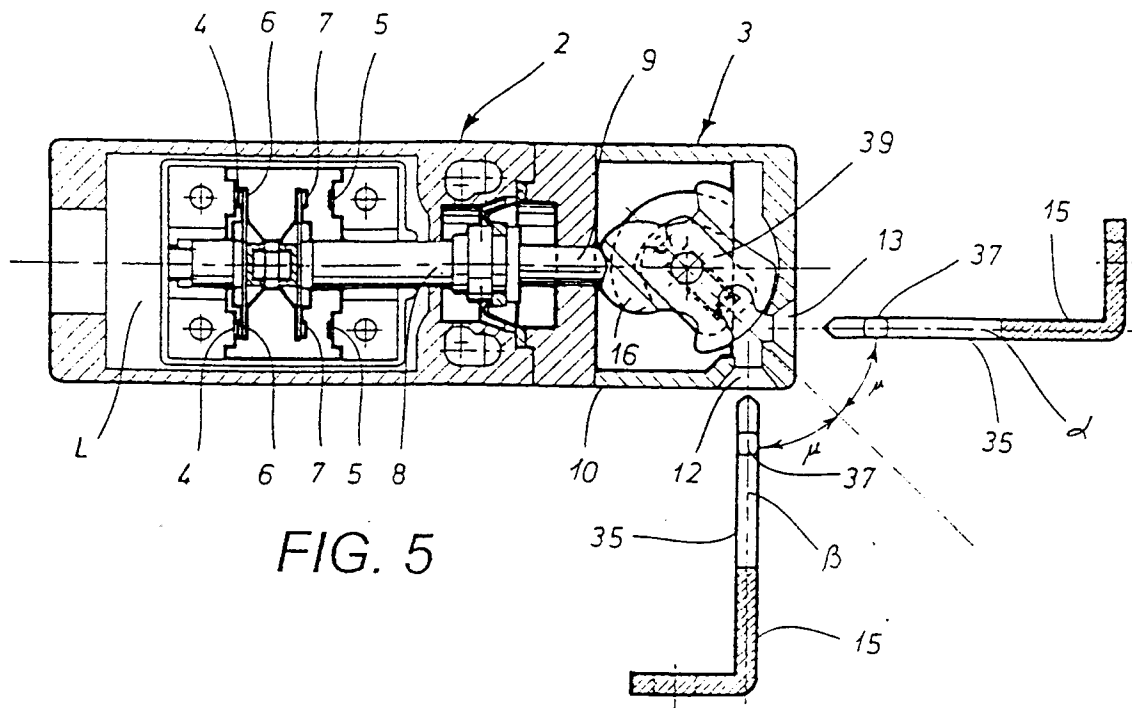


FIG. 4





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 97 11 7694

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevance to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D,A	US 5 587 569 A (MOHTASHAM MEHDI) 24 December 1996 * abstract; figure 7 * ---	1	H01H27/00
D,A	US 5 516 993 A (WECKE ROLF ET AL) 14 May 1996 * abstract; figure 2 * ---	1	
D,A	WO 95 24726 A (EUCHNER & CO ; RAPP WERNER (DE); SCHMIDT PETER (DE)) 14 September 1995 * abstract; figure 2 * -----	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6) H01H
Place of search THE HAGUE		Date of completion of the search 25 June 1998	Examiner Overdijk, J
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