



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
28.10.2009 Bulletin 2009/44

(51) Int Cl.:
H01H 27/00 (2006.01)

(21) Application number: **08010513.3**

(22) Date of filing: **09.06.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(30) Priority: **24.04.2008 IT VI20080101**

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(54) **Safety switch apparatus**

(57) A safety switch apparatus for a work zone protection barrier, comprising a box-like body (B) designed to be mounted to the stationary part (F) of the barrier (B) and having a first slit (5), a switching circuit located in said box-like body (4) and designed to be connected to the power supply circuit of the machine or equipment, the switching circuit being operatable through said first slit (5), an actuator (6) designed to be associated with the door (P) of the barrier (B) and to be introduced in the first slit (5) for interaction with the switching circuit, a second slit (7) formed in the box-like body (4), and adapted to receive a pin (8) attached to the door (P), for centering and guiding it into the first slit (5). Means (9) are provided for blocking said second slit (7) in open door (P) conditions, with the actuator (6) not inserted in the first slit (5) and the power supply circuit being open.

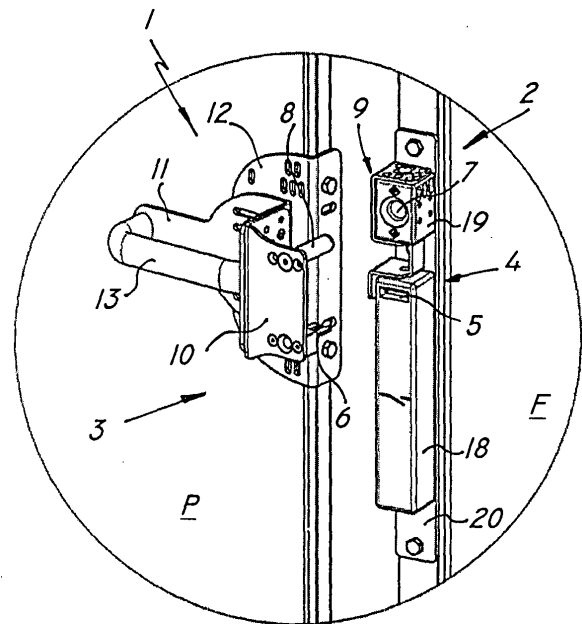


FIG. 2

Description

Field of invention

[0001] The present invention generally finds application in the field of electric safety switches and particularly relates to a safety switch apparatus especially adapted to be mounted to safety barriers for protection of industrial machines or plants.

Background of the invention

[0002] It is known to use safety switch apparatus mounted to movable accesses, such as rebated or leaf doors, in peripheral safety barriers for protection of machines and plants involving potential risks for operators.

[0003] These known apparatus have the purpose of monitoring and ensuring safe access to dangerous zones of the machine or plant, by stopping the latter whenever intentional or accidental opening of the movable access of the barrier occurs.

[0004] Typically, these apparatus include an actuator, integral with a door-mounted handle, and a safety switch attached to the frame of the safety perimeter within which the switching circuit is located for causing the plant to be actuated and locked.

[0005] In closed-door conditions, the actuator is held in a special receptacle within the safety switch body, for operating on the switching circuit and causing the power supply circuit to close and start the machine or plant within the perimeter.

[0006] On the other hand, by opening the door, the actuator comes out of the switch body and causes a change of state of one or more electric contacts in the switch, which is followed by the transmission of a safety stop signal.

[0007] For safe operation of the apparatus, the part that is attached to the door, comprising the actuator, and the remaining part that is attached to the frame shall be aligned with the utmost precision as the door is closed, so that the actuator of the safety switch can fit in its receptacle within the switch, thereby preventing any collision that might damage the most brittle parts of the apparatus.

[0008] In several known solutions, the part that is designed to be attached to the door has one or more brackets with position adjustment slots.

[0009] Nonetheless, one drawback of these solutions is the apparent difficulty of achieving proper alignment between the stationary and movable parts. Furthermore, the accuracy requested during mounting of both the movable and stationary parts requires long times and high professional skills of the operator, with the risk that the alignment might still be insufficient.

[0010] In an attempt to obviate these drawbacks, a number of the above mentioned safety switch apparatus solutions have been proposed, which have a centering system for actuator and switch alignment.

[0011] The German utility model DE29717313 discloses a safety switch in which alignment of the actuator with its receptacle is provided by a center pin associated with the movable part and designed to pass through an alignment hole formed in a metal sheet mounted to the stationary part of the perimeter.

[0012] However, this solution still suffers from a few drawbacks, mainly consisting in that the pin is forced to slip over a surface having sharp edges, as is typical for a hole formed in a metal sheet.

[0013] Therefore, this configuration causes high wear and potential damages to the pin, especially when the movable and stationary parts of the apparatus are not properly aligned beforehand.

[0014] Furthermore, the lack of an appropriate lead-in surface and a guide groove that might assist pin centering may involve difficulties in the assembly and maintenance of the door structure.

[0015] Furthermore, the center pin only operates in facing relationship with the installed switch which makes it difficult or even impossible to mount it to sliding doors or anyway non-hinged doors.

[0016] In other known and currently available safety switch apparatus, the actuator and the switch are coupled together by a first door closing motion and second handle motion along a slide.

[0017] Other handle-operated safety apparatus, disclosed for instance in EP1013985, US2007/205089, DE2031595 and JP2006/140040 have a slide that perform a lateral sliding motion out of the door shape during the locking step.

[0018] An apparent drawback of these known solutions is that, whenever the door accidentally closes with the handle in the ejected position, the latter would hit the safety switch body and would likely damage it.

[0019] Furthermore, environmental dirt might build up in the slide, thereby preventing proper sliding of the movable parts and making it more difficult for the door to be locked by operation of the actuator.

[0020] In certain prior apparatus, as disclosed for instance in JP2004/353849 and EP10013985, a cover is mounted to the movable or stationary part, for obstructing the actuator receiving hole, which is adapted to be stably locked by one or more padlocks with keys.

[0021] This prevents unintentional mechanical door closing when the operator is within the safety perimeter.

[0022] Nevertheless, none of the above solutions affords locked access to the actuator housing while the door is mechanically locked, thereby additionally allowing adequate centering of the actuator.

[0023] Therefore, these solutions would eventually allow the machine or plant to be restarted with the door open, e.g. using a second actuator similar to the first one, thus overriding the protection provided by the handle and causing serious prejudice to the safety of any operator within the perimeter.

Summary of the invention

[0024] The object of this invention is to overcome the above drawbacks, by providing a safety switch apparatus that achieves high efficiency and relative cost effectiveness.

[0025] A particular object is to provide a safety switch apparatus adapted to be mounted to a peripheral safety barrier for protection of industrial machines or plant, that prevents machines or plant from restarting when the safety barrier is open.

[0026] A further object is to provide an apparatus of the above type that prevents accidental or careless closing of the safety barrier onto which it is mounted.

[0027] Another object of the present invention is to provide an apparatus of the above mentioned type that ensures high sturdiness and protects the most critical parts from impacts generated by closing the movable part of the barrier and also requires relatively little maintenance.

[0028] Yet another object of the present invention is to provide an apparatus of the above type that ensures simple and quick centering of the movable and stationary parts and allows the power supply circuit of the machine or equipment to be opened/closed by a single movement.

[0029] Another object of the present invention is to provide an apparatus of the above type that can be mounted to any kind of sliding or hinged door.

[0030] These and other objects, as better explained hereafter, are fulfilled by a safety switch apparatus as defined in claim 1, comprising a box-like body designed to be mounted to the stationary part of a barrier for protection of an industrial machine or plant and having a first slit, a switching circuit located in said box-like body and designed to be connected to the power supply circuit of the machine or equipment, said switching circuit being actuatable through said first slit, an actuator designed to be associated with the door of the barrier and to be introduced in said first slit for interaction with said switching circuit to open/close the latter, a second slit formed in said box-like body, and adapted to receive a pin attachable to said door in a predetermined position relative to said actuator, for centering and guiding the latter in said first slit as the door is closed, by only performing the door closing motion.

[0031] In accordance with a peculiar feature of the invention, means are provided for occluding said second slit in open door conditions, with said actuator not being introduced in said first slit and said power supply circuit being open.

[0032] Thanks to this particular configuration, the barrier will be prevented from being accidentally or carelessly closed, thus preserving the structural integrity of the brittle parts of the apparatus.

[0033] Advantageously, the occlusion means are configured for simultaneously occluding the first and second slits.

[0034] This particular configuration will also prevent the machine or plant from being restarted by the opera-

tion of an additional actuator similar to the first actuator even under open door conditions.

[0035] Advantageously, the occlusion means may include first and second covers pivoted mounted to the box-like body to move from an inoperative position to an operating position, in which said first and second slits are occluded by a single pivotal motion about said longitudinal axis.

Brief description of the drawings

[0036] Further features and advantages of the invention will be more apparent upon reading of the detailed description of a preferred, non-exclusive embodiment of a safety switch apparatus of the invention, which is described as a non-limiting example with the help of the annexed drawings, in which:

FIG. 1 is a first perspective view of an apparatus of the invention mounted to a safety barrier in an open barrier position;

FIG. 2 is an enlarged view of a detail of FIG. 1;

FIG. 3 is a perspective view of the movable part of the apparatus of the invention;

FIG. 4 is a second perspective view of the apparatus of the invention in open barrier conditions and with the occlusion means disabled;

FIG. 5 is a third perspective view of the apparatus of the invention in closed barrier conditions and with the occlusion means disabled;

FIG. 6 shows a detail of the apparatus of the invention during an occlusion means actuating sequence;

FIG. 7 is a perspective view of the apparatus of the invention in open barrier conditions and with the occlusion means enabled;

FIG. 8 is a side view of the apparatus of the invention in open barrier conditions and with the occlusion means disabled;

FIG. 9 is a partially broken away top view of the apparatus of the invention, as taken along a plane II of Fig. 8;

FIGS. 10a, b, c are sectional side views of the apparatus of the invention in three different operating steps;

FIG. 11 is an enlarged view of a detail of Fig. 10a.

Detailed description of a preferred embodiment

[0037] Referring now to the above figures, the apparatus of the invention, generally designated by numeral 1, may be mounted to a safety barrier B which is adapted to be placed at the periphery of an industrial machine or equipment, not shown, to define a safe working zone.

[0038] As shown in FIG. 1, the barrier B may have a stationary part F attachable to the floor and a movable part P defined by a door or the like, which is hinged or anyway connected to the stationary part F to define an access to the working zone.

[0039] While the door P of the figure has a left-hand opening, the apparatus may be mounted to similar doors or movable accesses having a right-hand opening, not necessarily hinged, or to sliding doors.

[0040] As more clearly shown in Fig. 2, the apparatus of the invention comprises a stationary portion 2 which is designed to be mounted to the stationary part F of the barrier B for interaction with a movable portion 3, designed to be mounted to the door P, as the latter is closed and opened.

[0041] The fixed portion 2 is defined by a box-like body 4 having a first slit 5 and a switching circuit, not shown, located therein for connection with the power supply circuit, also not shown, of the machine or equipment located within the working zone.

[0042] The switching circuit is operated by an actuator 6 that is designed to be associated with the door P of the barrier B and to be introduced in the first slit 5 for interaction with the switching circuit.

[0043] The latter may be of well-known type and include, for instance, one or more electric contacts suitably arranged to cause the power supply circuit to open/close as the actuator is ejected/introduced in the first slit 5.

[0044] The actuator 6 may in turn of the key-operated type, like in the annexed figures, with an active portion 6' and a support portion 6'', or may also have other configurations, according to the particular construction requirements and to the particular switching circuit that has been installed.

[0045] A second slit 7 is also provided in the box-like body 4, for receiving a pin 8 attachable to the door P in a predetermined position relative to the actuator 6 for centering and guiding the latter in the first slit 5 by a single door P closing motion.

[0046] In accordance with a peculiar feature of the invention, means 9 are provided for occluding the second slit 7 in open door P conditions, with the actuator 6 not being introduced in the first slit 5 and the power supply circuit being open.

[0047] This will provide the indubitable advantage of preventing the door from being accidentally or carelessly closed, which might cause serious injury to any operator within the work zone.

[0048] Advantageously, the occlusion means 9 may be designed to simultaneously block the first 5 and second 7 slits.

[0049] With this particular configuration of the apparatus 1, the switching circuit cannot be restarted by an additional actuator similar to the one associated to the door P if the latter is open to allow an operator to access the work zone.

[0050] As particularly shown in Figs. 3 to 5, the center pin 8 and the actuator 6 may be formed of one piece with a first bracket 10 for attachment of the movable portion 3 to the door P.

[0051] The assembly defined by the first bracket 10, the pin 8 and the actuator 6 may be mounted to the door P via second and third brackets 11, 12, one of which, e.g.

the second one 11, may also have a handle or a similar grip member 13, to facilitate opening/closing of the door P.

[0052] The brackets 10, 11, 12 may have holes or slots 14, 15, 16 respectively, formed therein, for the passage of pins or screws, generally designated by numeral 17, for fastening the brackets 10, 11, 12 and adjusting their mutual positions also in three distinct axes X, Y, Z.

[0053] Thus, the apparatus 1 may be mounted to barriers B with movable P and stationary F parts of different sections and the brackets 10, 11, 12 may be also suitably shaped for mounting to both hinged and sliding doors P.

[0054] For instance, the third bracket 12 may have either front slots 16 extending along parallel axes with different spacings to allow the third bracket 12 to be mounted to doors with profiles of different sizes, or lateral slots 16' allowing lateral mounting to the profile of the door P, in those conditions in which front mounting is not allowed.

[0055] The three brackets 10, 11, 12 may be fastened together by pins, screws or similar mechanical members, such as screws 17 having a safety locking pin, to prevent any careless disengagement thereof.

[0056] Therefore, by simply changing the relative positions of the brackets 10, 11, 12 and/or the position of the actuator 6 and the pin 8 on the first bracket 10, the apparatus 1 may be adapted to the particular door P closing motion.

[0057] Fig. 4 and Fig. 5 also show that the box-like body 4 may include a first box-like element 18, having the first slit 5, and holding the switching circuit, and a second box-like element 19 having the second slit 7.

[0058] The first and second box-like elements 18, 19 may be separated and mounted to a plate 20 designed to be attached to the stationary part F of the barrier B for the first and second slits 5, 7 to be at a predetermined distance d_1 along a substantially vertical longitudinal axis L for alignment with the actuator 6 and the pin 8 respectively.

[0059] Advantageously, the second box-like element 19 may be symmetrical with respect to the longitudinal axis T to allow mounting thereof to sliding or hinged doors P with either right-hand or left-hand opening.

[0060] Fig. 6 shows a preferred, non exclusive embodiment of the occlusion means 9 of the invention, in a typical operating sequence in which the occlusion means 9 move from a disabled position OFF, as shown both in Fig. 4 and in the first picture of Fig. 6, with both slits 5, 7 clear, to an enabled position ON, as shown both in Fig. 7 and in the last picture of Fig. 6, in which both slits 5, 7 are occluded.

[0061] The sequence of Fig. 6 shows that the occlusion means 9 may include first and second covers 21 and 22 respectively, which are pivotally mounted to the box-like body 4 to rotate about the common longitudinal axis L from the disabled position OFF to the enabled position ON.

[0062] In a particular configuration, not shown, the first and second covers 21, 22 may be independent of each

other to allow separate occlusion of the two slits 5, 7.

[0063] Advantageously, the first and second covers 21, 22 may be integral with each other, with respective longitudinal portions 23, 24 for blocking the first and second slits 5, 7 respectively, to move between the enabled position ON and the disabled position OFF by a single motion, that might be a rotational or translational motion or simply a rotational motion about the longitudinal axis L.

[0064] For instance, the first and second covers 21, 22 may be formed of one piece and joined by an intermediate longitudinal portion 25 and transverse portions 26, 27, 28.

[0065] The second cover 22 may be hinged to the second box-like element 19 to move from the disabled position OFF to the enabled position ON by a first transverse sliding ejection motion, as shown in the second picture of Fig. 6, followed by a clockwise or counterclockwise rotation about the longitudinal axis L and a second transverse sliding positioning and locking motion.

[0066] The above sliding motions are allowed by a pair of longitudinal pins 29, 29' fixed to respective transverse portions 26, 27 of the second cover 22 to slide in two guides, one of which 31, 32 is formed in the second box-like element 19.

[0067] Once the second slit 7 is occluded by the second door 22 moving into the enabled position ON, any attempt to close the door P will cause collision of the center pin 8 with the second cover 22, which will actually prevent the door P from being closed and the actuator 6 from being thus introduced in the first slit 5.

[0068] Furthermore, the first cover 21 will simultaneously close the first slit 5, thereby preventing the switch from being actuated by a second actuator, similar to the first actuator 6, that might be intentionally introduced by an operator in the first slit 5.

[0069] The covers 21, 22 may be made of metal or any other material of adequate rigidity, so that the force with which the pin 8 hits the second cover 22 would discharge on the second box-like element 19 through their respective contact faces, and hence on the stationary structure F of the barrier B, thereby preventing load discharge on parts of lower strength.

[0070] Conveniently, safety means 33 may be provided to prevent any accidental rotation of the occlusion means 9 from the enabled position ON to the disabled position OFF.

[0071] For example, the safety means 33 may include one or more through holes, generally designated by numeral 34, formed in the upper transverse portion 26 of the second cover 22, for alignment with corresponding passages 35 formed in the second box-like element 19.

[0072] Thus, when the occlusion means 9 are in the enabled position ON, they may be stably locked by one or more locking devices S, such as one or more key padlocks, as shown in Fig. 7.

[0073] This additional feature will prevent the occlusion means 9 from being accidentally or carelessly unlocked into the disabled position OFF, while an operator is in the work zone.

[0074] Advantageously, the occlusion means 9 may be associated with counteracting elastic means 36 operating on at least one of the first and second covers 21, 22 to hold them in one of the enabled ON and disabled OFF positions, and prevent any undesired motion thereof possibly due to minor accidental impacts.

[0075] In the configuration as shown in the figures, and particularly in Figs. 10 and 11, the counteracting elastic means 36 may include a snap arrangement composed of two balls 37 held by two springs 38 in two suitable recesses 39 formed in the second box-like element 19.

[0076] The springs 38 may be loaded by the screws 40, 40' that fasten the two longitudinal pins 29, 29' to the second cover 22. A hole 41 may be formed in the transverse portion 28 of the first cover 21 for easier tightening of the lower safety screw 40.

[0077] It can be seen from Fig. 8 that the centering and guiding pin 8 and the actuator 6 may project out of the first bracket 10 in respective substantially parallel and longitudinally offset transverse directions having a predetermined distance d_2 from each other, which will preferably be equal to the longitudinal distance d_1 between the first and second slits 5, 7.

[0078] The second slit 7 may have a substantially cylindrical shape 42 with a substantially cylindrical transverse lateral surface, having an open end 43 for receiving the center pin 8 and an opposite closed end 44 that defines an abutment for such pin 8, which may also have a substantially cylindrical shape and a rounded free transverse end 45.

[0079] Furthermore, the cylindrical lateral surface 42 of the second slit 7 may have an entry portion 46 with an inside diameter ϕ_1 considerably larger than the diameter ϕ_2 of the rest of the lateral surface 42 and diverging towards the closed end 44 thereof to define a relatively wide lead-in portion for the pin 8.

[0080] This will ensure proper centering and alignment of the actuator 6 and its slit 5 even when, during assembly, the axis T of the pin 8 has a relatively high longitudinal misalignment relative to its cylindrical slit 7, as shown in the sequence of Fig. 10.

[0081] In a further advantageous aspect of the invention, the center pin 8 may have a transverse extension l_1 longer than the extension l_2 of the actuator 6, whereas the second slit 7 may have a suitably sized maximum transverse extension l_3 to allow abutment of the pin 8 against the closed end 44 of the second slit 7 prior to contact of the actuator 6 with the bottom of the first slit 5.

[0082] This will prevent the actuator 6 and the switch from being damaged as a result of collisions or interferences. Furthermore, the actuator 6 and the first slit 5 may be formed of such a size that the active part 6' of the actuator 6 cannot abut against the bottom of the first slit 5.

[0083] Furthermore, as shown in Fig. 10c, a predetermined span p is provided between the support 6'' of the actuator 6 and the first box-like element 18 to prevent any impact between the actuator 6 and the box-like body 4, that might damage the brittle parts of the former.

[0084] The above disclosure clearly shows that the invention fulfills the intended objects and particularly meets the requirement of providing a safety switch apparatus that prevents the restart of machines or equipment within the safety zone delimited by the barrier onto which the apparatus is mounted when the barrier is open.

[0085] The apparatus of this invention is susceptible of a numerous modifications and changes following, within the inventive principle disclosed in the appended claims. All the details thereof may be replaced by other technically equivalent parts, and the materials may vary depending on different needs, without departure from the scope of the invention.

[0086] While the apparatus has been described with particular reference to the accompanying figures, the numerals referred to in the disclosure and claims are only used for the sake of a better intelligibility of the invention and shall not be intended to limit the claimed scope in any manner.

Claims

1. A safety switch apparatus for a working zone protection barrier, wherein the barrier (B) comprises a stationary part (F) delimiting a work zone of an industrial machine or plant and at least one door (P) or the like for access to said work zone, wherein the apparatus comprises:

- a box-like body (4) designed to be mounted to the stationary part (F) of the protection barrier (B) and having a first slit (5);
- a switching circuit located in said box-like body (4) and designed to be connected to the power supply circuit of the machine or plant, said switching circuit being designed to be operated through said first slit (5);
- an actuator (6) that is designed to be associated with the door (P) of the barrier (B) and to be introduced in said first slit (5) for interaction with said switching circuit to open/close the latter;
- a second slit (7) formed in said in the box-like body (4), and adapted to receive a pin (8) attached to said door (P) in a predetermined position relative to said actuator (6) for centering and guiding the latter in said first slit (5) by a single door (P) closing motion;

characterized in that it comprises means (9) for occluding said second slit (7) in open door (P) conditions, with said actuator (6) not being introduced in said first slit (5) and said power supply circuit being open.

2. Apparatus as claimed in claim 1, **characterized in that** said occlusion means (9) are designed to oc-

clude said first (5) and said second (6) slits at the same time.

3. Apparatus as claimed in claim 1 or 2, **characterized in that** said occlusion means (9) include first and second covers (21, 22) which are associated with said box-like body (4) to move from a disabled position (OFF) with said first and second slits (5, 7) clear to an enabled position (ON) in which said first and said second covers (21, 22) block said first and said second slits (5, 7) respectively.

4. Apparatus as claimed in claim 3, **characterized in that** said first and said second covers (21, 22) are hinged to said box-like body (4) to pivot between said disabled position (OFF) and said enabled position (ON) about a common longitudinal axis (L).

5. Apparatus as claimed in claim 4, **characterized in that** said first and said second covers (21, 22) are integral to each other to allow said first and said second slits (5, 7) to be occluded by a single rotational motion about said common longitudinal axis (L).

6. Apparatus as claimed in claim 4 or 5, **characterized in that** it comprises safety means (33) designed to prevent any accidental rotation of said first and second covers (21, 22) from said enabled position (ON) to said disabled position (OFF).

7. Apparatus as claimed in claim 6, **characterized in that** said second cover (22) has a longitudinal occluding portion (24) and at least one substantially transverse portion (26) hinged to said box-like body (4) to allow said rotational motion relative to said longitudinal axis (L).

8. Apparatus as claimed in claim 7, **characterized in that** said safety means (33) include at least one through hole (34) formed in said at least one transverse portion (26) of said second cover (22) and at least one passage (35) formed in said box-like body (4), said at least one hole (34) and said at least one passage being adapted to be longitudinally aligned, with said occlusion means (9) in said enabled position (ON), to allow the latter to be locked by a lock device (S) introduced therein.

9. Apparatus as claimed in any one of the preceding claims, **characterized in that** said occlusion means (9) are equipped with counteracting elastic means (36) operating on at least one of said first and said second covers (21, 22) to hold them in one of said enabled (ON) and disabled (OFF) positions.

10. Apparatus as claimed in any one of the preceding claims, **characterized in that** said centering and guiding pin (8) and said actuator (6) are integral to

a first bracket (10) and said movable part (P) to project in respective substantially parallel and longitudinally offset transverse directions (T, T') having a predetermined distance d_2 from each other.

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- 11.** Apparatus as claimed in claim 10, **characterized in that** said first and second slits (5, 7) are longitudinally offset at a distance (d_1) substantially equal to the longitudinal distance (d_2) between said pin (8) and said actuator (6).

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- 12.** Apparatus as claimed in claim 10 or 11, **characterized in that** said second slit (7) has a substantially transverse extension, with a cylindrical lateral surface (42) having an open end (43) for introduction of said center pin (8) and an opposite closed end (44) defining an abutment for such pin (8).

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- 13.** Apparatus as claimed in claim 12, **characterized in that** said center pin (8) has a substantially cylindrical shape and a rounded free transverse end (45), said cylindrical lateral surface (42) of said second slit (7) having an entry portion (46) diverging towards said closed end (44) to define a lead-in surface for said pin (8).

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- 14.** Apparatus as claimed in any one of the preceding claims, **characterized in that** said center pin (8) has a transverse extension (l_1) longer than the extension (l_2) of said actuator (6), said second slit (7) having a suitably sized maximum transverse extension (l_3) to allow abutment of said pin (8) against said closed end (44) prior to contact of said actuator (6) with the bottom of said first slit (5).

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- 15.** Apparatus as claimed in any one of the preceding claims, **characterized in that** said box-like body (4) includes a first box-like element (18), having said first slit (5), and a second element (19) having said second slit (7), said second box-like element (19) being symmetrical with respect to said longitudinal axis (L).

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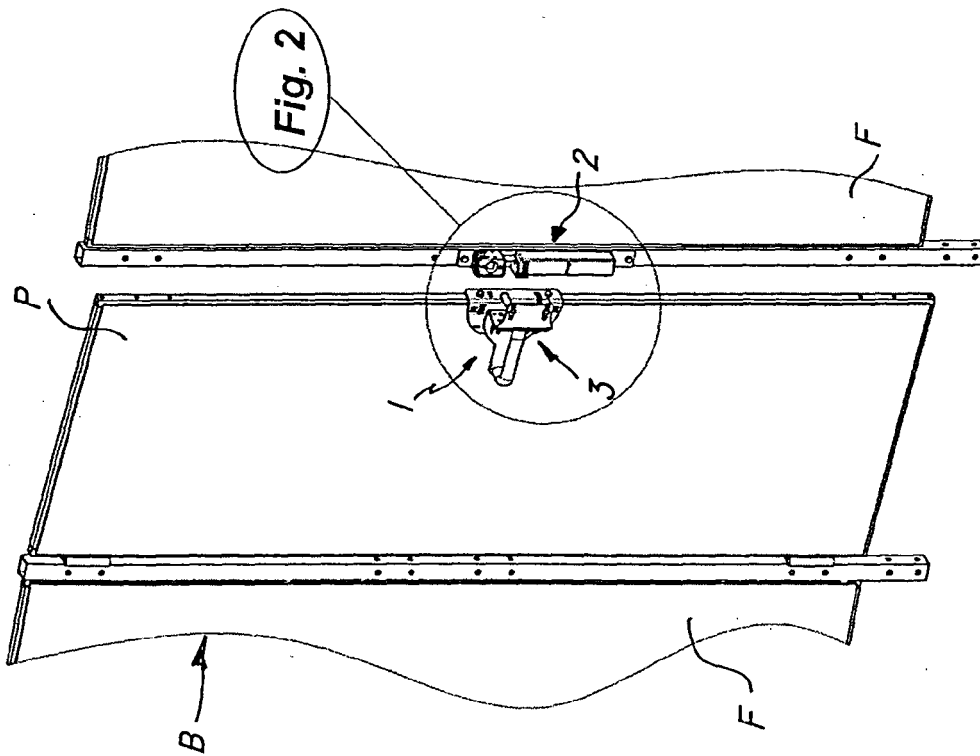


FIG. 1

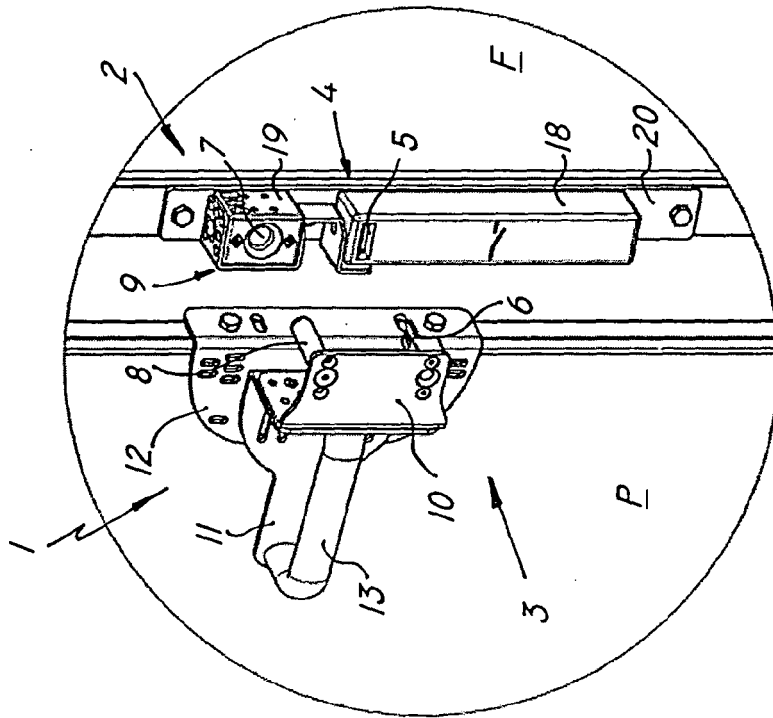


FIG. 2

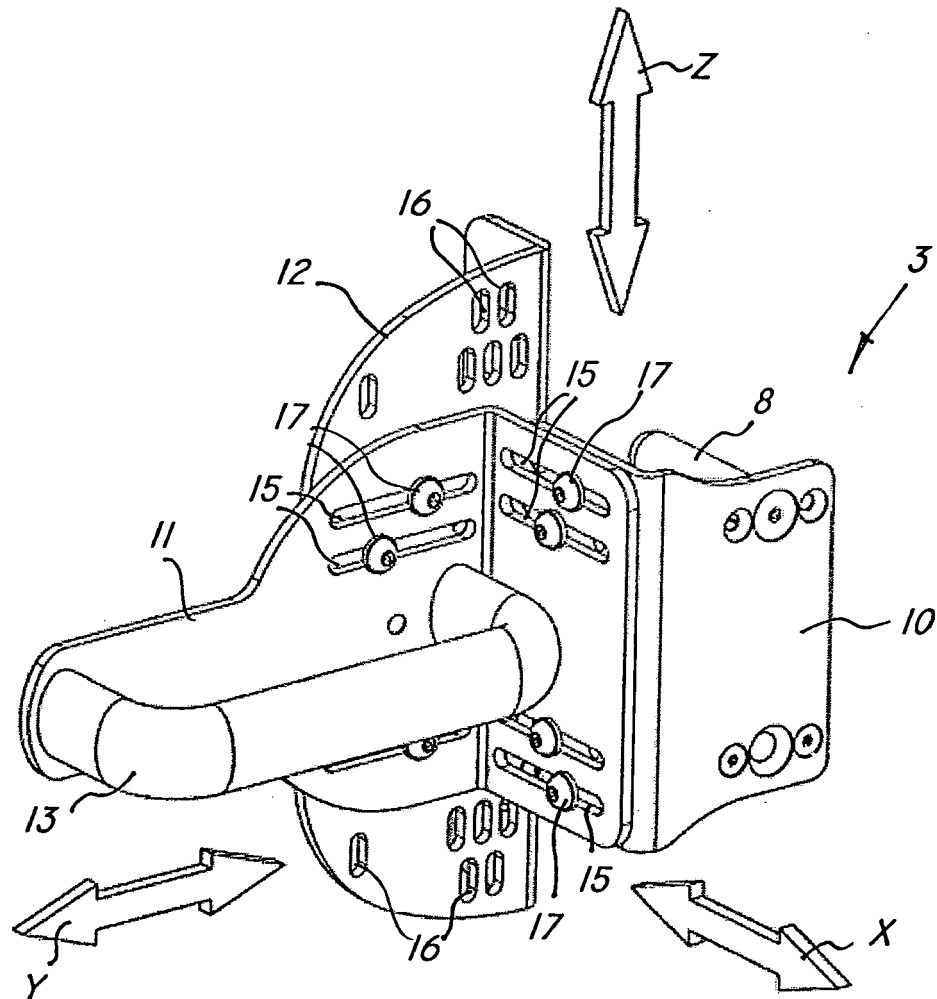
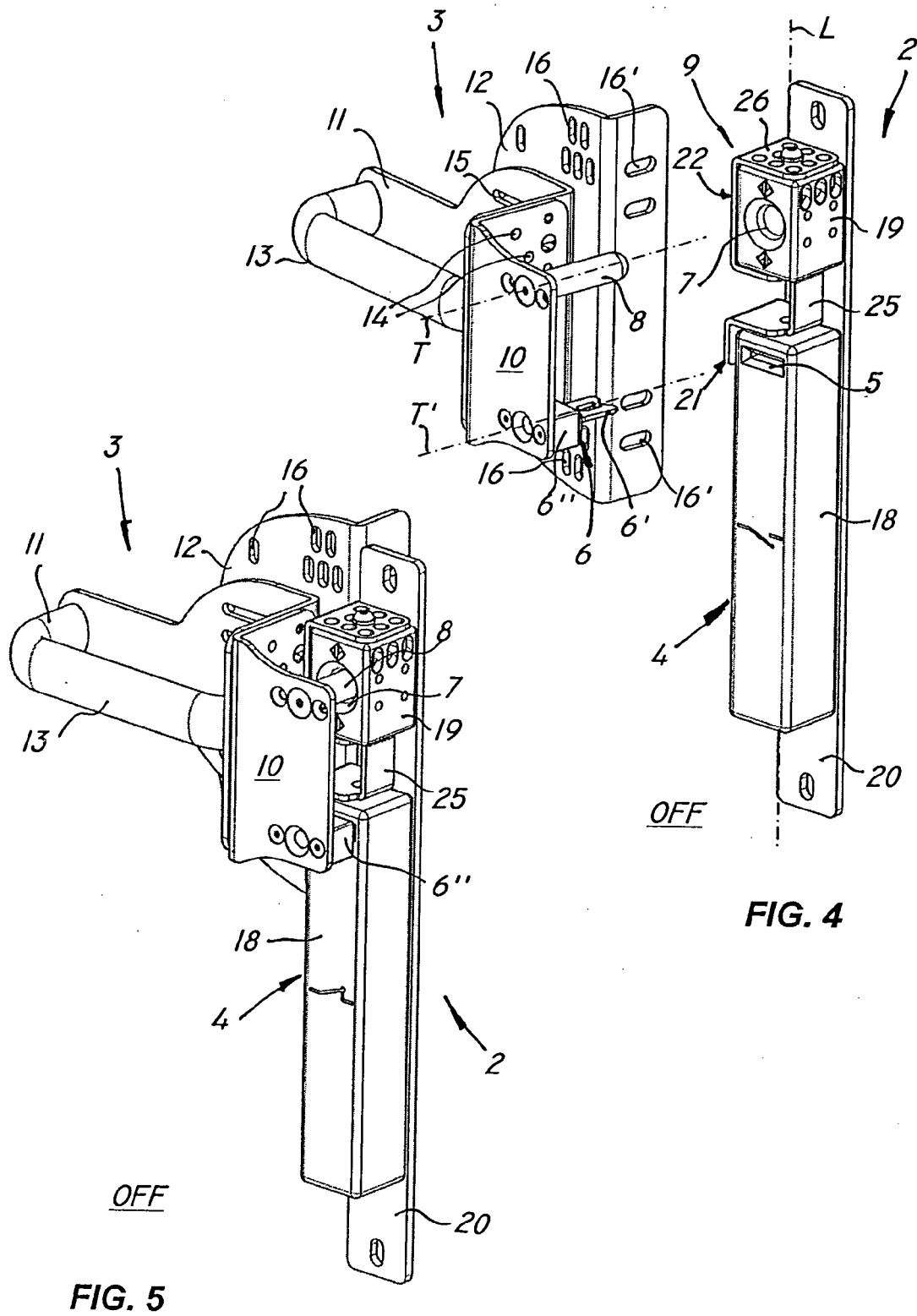


FIG. 3



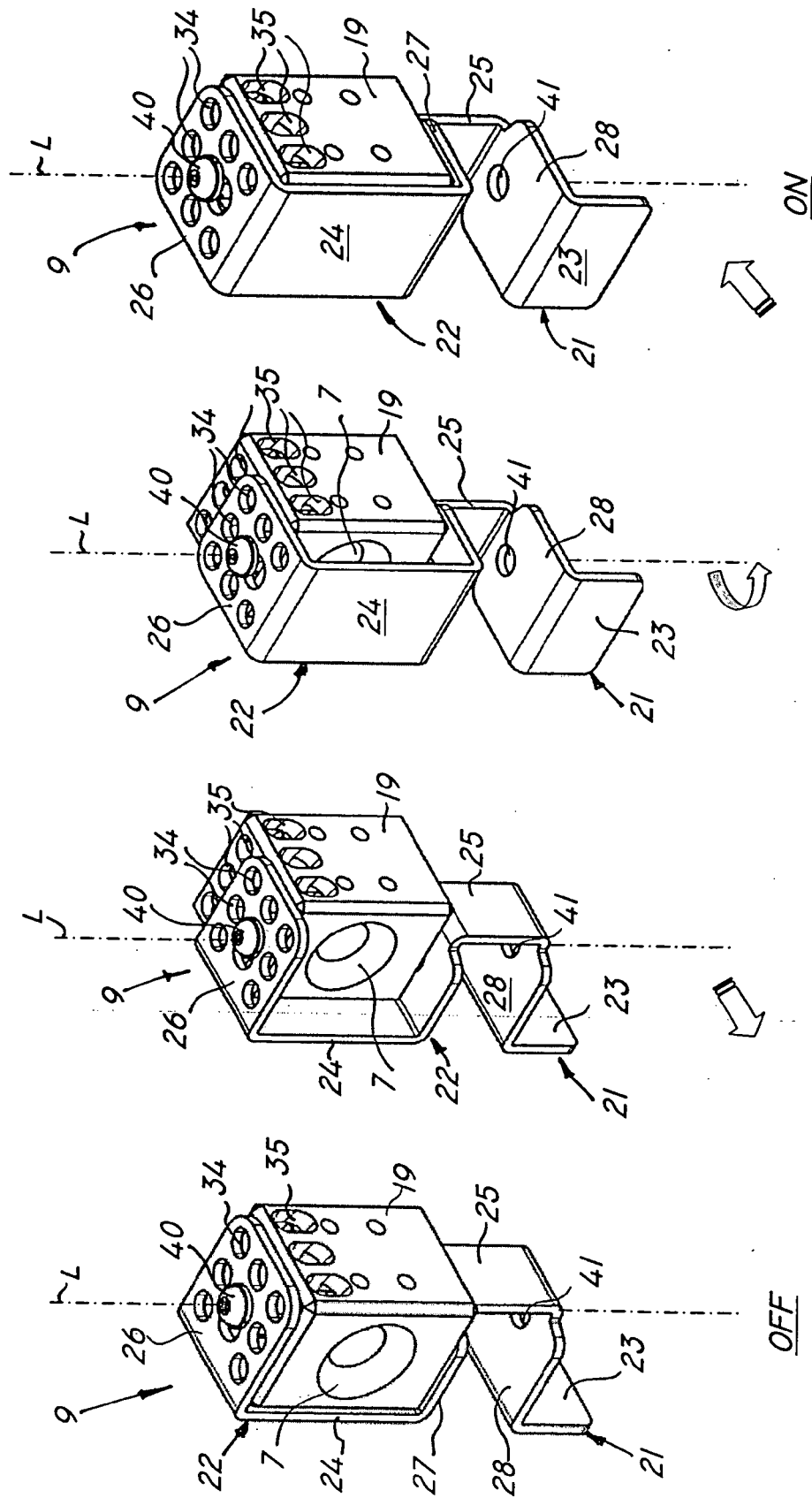
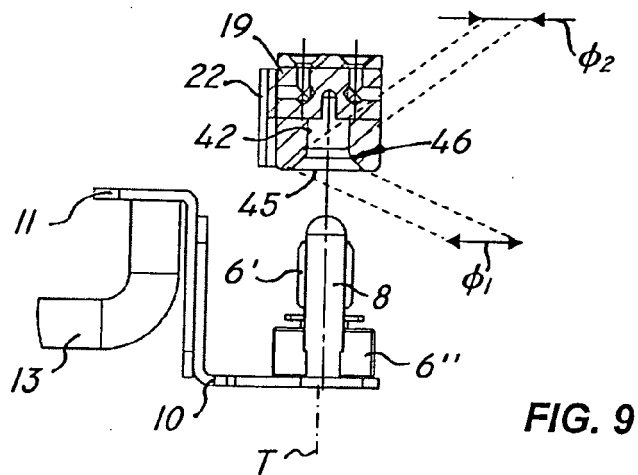
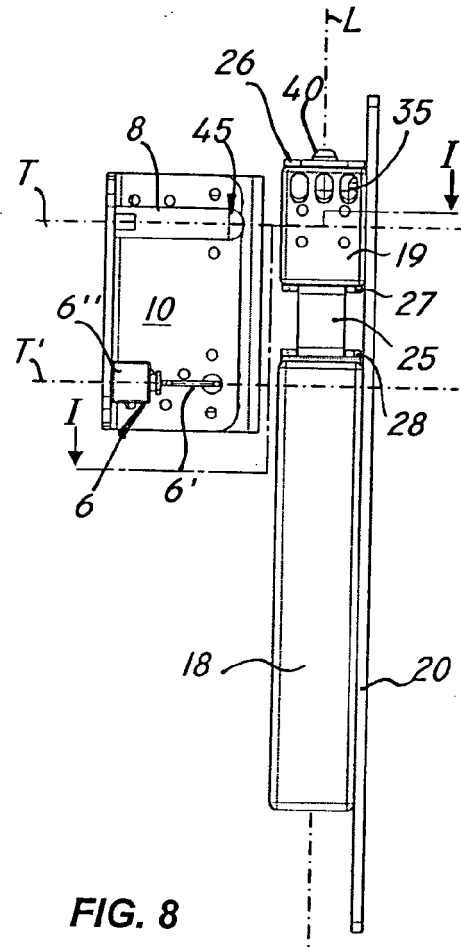
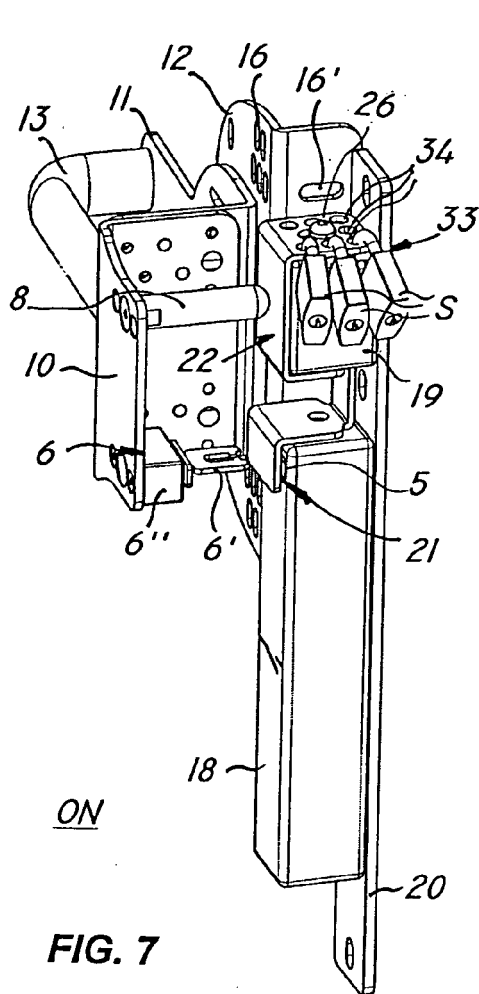


FIG. 6



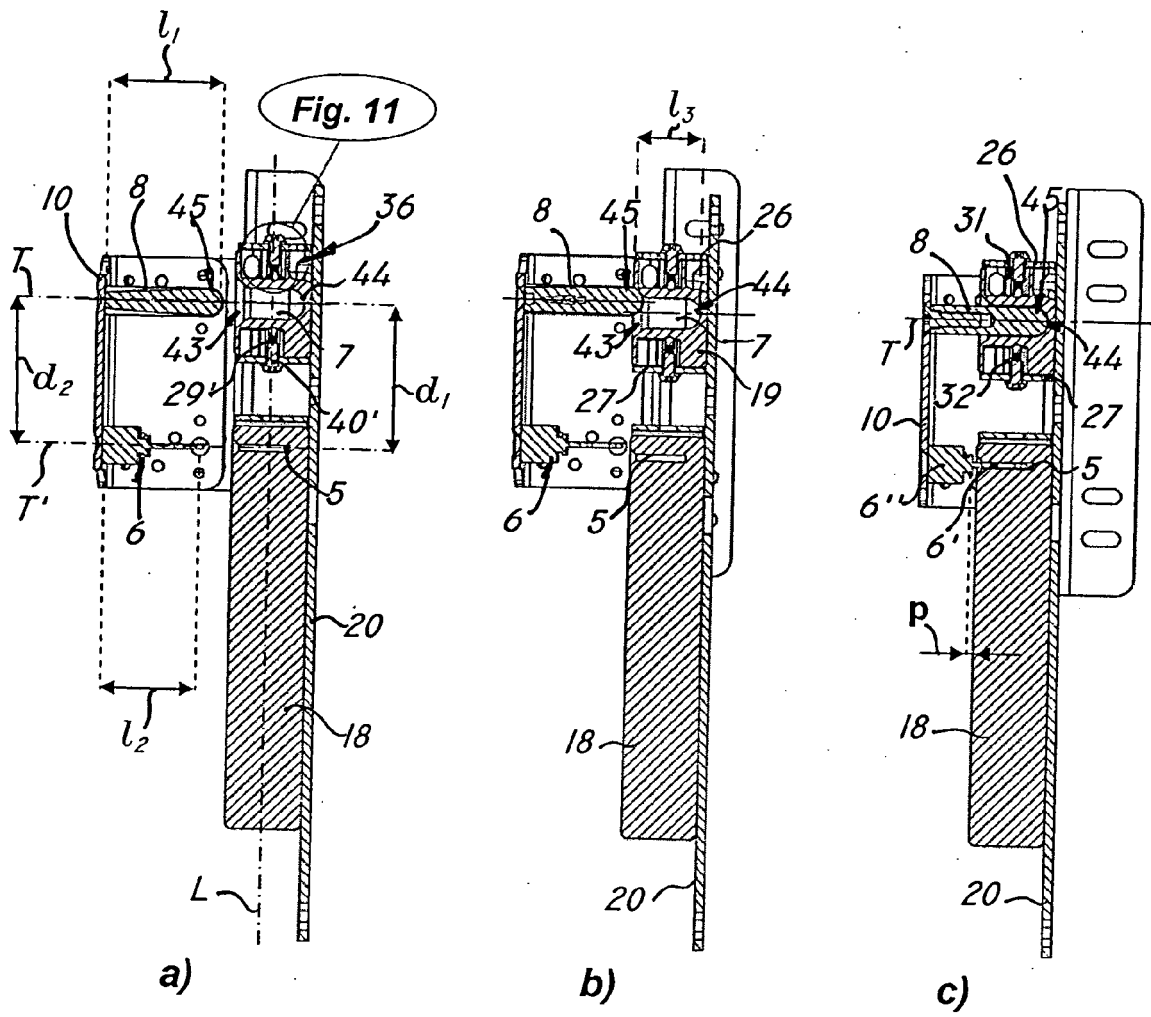


FIG. 10

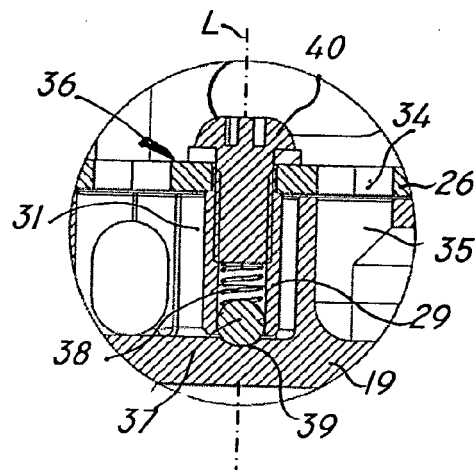


FIG. 11

REFERENCES CITED IN THE DESCRIPTION

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