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(54) Polarized electromagnetic actuator.

(57) Polarized electromagnetic actuator, of the type which comprises a supporting body having cavities suitable for containing a U-shaped magnetic core, a coil, a permanent magnet, a moving keeper contrasted by return springs, and a dome and a closure baseplate; the actuator has a prism-shaped main body (1) which internally forms: a first compartment (7), suitable to contain the axially hollow coil (8); a second compartment (9) for containing the permanent magnet (10); two further separate compartments (2,2a), one (2) of which is tubular and axially formed in a central position with respect to the first compartment (7) for accommodating an arm (3) of the U-shaped core (5) so that it is insulated from the coil (8), the other compartment (2a) being provided to accommodate the second arm (4) of the core (5); and a further cavity (11) for accommodating the keeper return spring (12). The first (7) and second (9) compartments are closed upwardly so as to allow insertion of the coil (8) and of the magnet (10) from the side opposite to the one where the moving keeper (14) acts and thus eliminate any connection between the two compartments (7,9); the dome-shaped lid (22) and the closure baseplate (17) are provided with snap-acting (24,20) or similar means for their removable engagement with the supporting body (1).

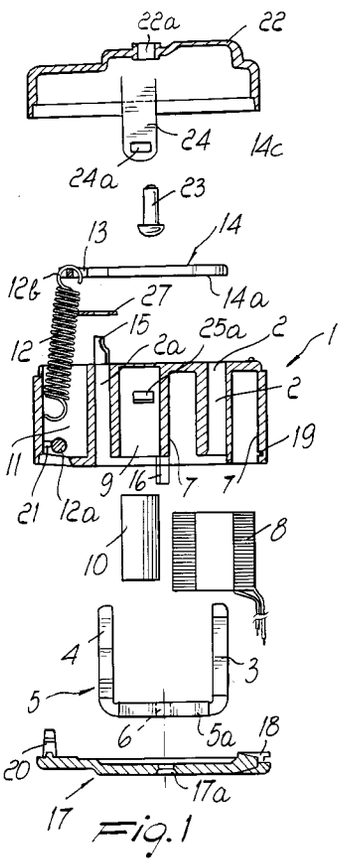

Fig.1

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The present invention relates to a polarized electromagnetic actuator improved from the point of view of both structure and mutual assembly of its various components.

As is known, electromagnet actuators are devices activated by electrical signals of extremely low power, which can actuate mechanisms which use or include much higher power (for example to cause the opening of electrical circuits of high-power equipment) only when said actuation is required.

Current polarized electromagnetic actuators generally comprise a box-like body which includes a fixed ferromagnetic core inserted in a coil of insulated copper wire and supplied with direct or even alternating current; a movable keeper, contrasted by return springs, cooperates with said core. A permanent magnet is arranged in contact with said fixed core, polarizes the magnetic circuit and retains the keeper in contact with the fixed core until the coil is fed so as to create a polarity which is opposite to the polarity of the permanent magnet. At this point the keeper releases the fixed core by virtue of the contrasting action of the return spring.

In practice, it has long been observed that these electromagnetic actuators, despite being valid from the point of view of their operating concept, have a very complicated structure and are difficult or in any case complicated as regards the assembly of the numerous components constituting the actuator, and therefore have a significantly high cost.

In order to eliminate these problems, at least to a significant extent, a polarized electromagnetic actuator has already been proposed; its particular structure is disclosed in the Italian utility model patent No. 209,349, filed and granted in the name of the Applicant of the present application.

More precisely, the actuator disclosed and claimed in said utility model is substantially constituted by a prism-shaped body provided with through cavities, i.e. cavities which are open at their opposite ends, in one of which an arm of a U-shaped core, made of ferromagnetic material, is inserted; the other arm of said core is axially inserted in a coil accommodated in a second cavity of said prism-shaped body.

A permanent magnet is inserted in the cavity formed between said first and second cavities and is placed in contact with the base of said U-shaped core. A metallic keeper is pivoted above said body and is contrasted by a spring for returning it to the open position accommodated in an additional cavity of said prism-shaped body.

Said prism-shaped body which accommodates the coil, the core and the moving keeper, is sealed and closed at the bottom by a baseplate and is sealed and closed at the top by a dome enclosing said moving keeper and is provided with a hole for the passage of a pivot which is placed in contact with the keeper and is intended to actuate a kinematic system which operates at high power.

Said actuator furthermore has means for oscillatably engaging the keeper on the fixed core, fixed studs on the bottom of the prism-shaped body for the stable anchoring of the baseplate and other parts for retaining the coil and other components in a stable position. Reference is made to the description of the above Utility model for a more thorough understanding of the structural characteristics of this actuator.

Although said actuator has a structure which is simpler and easier to assemble than that of prior actuators, it has proved itself to be susceptible to further modifications and improvements aimed at simplifying its structure and at improving, in economical terms as well, the production process and its reliability in the course of time.

Accordingly, the aim of the present invention is to provide an improved polarized electromagnetic actuator which eliminates the drawbacks and limitations of known actuators and above all, to entail further rationalization of the operations for mutually coupling the various components and to simplify and facilitate the steps for the assembly of said components, both manually and by means of automatic assembly equipment, with the result of significantly improving the entire production process.

An object of the present invention is to provide an electromagnetic actuator designed so that it is substantially sealed against infiltration, in the various cavities, of dust and particles which may have detached from the coil and/or from the permanent magnet, with evident advantages as regards the correct operation of the unit and most of all with the assurance of perfect contact between the keeper and the fixed core.

This aim, this object and others which will become apparent from the following description are achieved by a polarized electromagnetic actuator, of the type which comprises a prism-shaped supporting body having separate compartments with through cavities for containing a substantially U-shaped core, a coil of conducting wire, a polarizing permanent magnet and a moving keeper contrasted by a return spring, which actuates an actuation pin of an external mechanism, and a dome-shaped lid and a lower closure baseplate; said actuator being constituted, according to the present invention, by a prism-shaped main body internally provided with: a first compartment, suitable to contain said axially hollow coil of conducting wire; a second compartment for containing said permanent magnet; two further separate compartments, one of which is tubular and axially formed in a central

position with respect to said first compartment for the insulated accommodation of an arm of said U-shaped core, the other compartment being provided to accommodate the second arm of said core; and a further cavity for accommodating said keeper return spring; said first and second compartments being closed upwardly so as to allow insertion of the coil and of the magnet from the side opposite to the one where said moving keeper acts and thus eliminate any connection between said two compartments; said dome-shaped lid which supports the actuation pin and said lower closure baseplate being provided with snap-acting or similar means for their removable engagement with the supporting body.

More particularly, said means for the removable engagement of the dome to the main body are constituted by two flat tabs rigidly coupled to said dome, made of flexible plastic material and provided with holes or openings; said tabs, by entering two guides formed on the internal wall of the main body, are suitable to stably engage their holes on teeth or protrusions which protrude from said guides arranged inside the main body.

Furthermore, each one of said tabs engaging the main body can disengage from said body by using a rod or the like, which is insertable in a hole formed in the wall of said body and can be pushed against the solid part of said tabs until the holes of said tabs disengage from the retention teeth, thus allowing to remove the dome.

In the same manner, said closure baseplate is provided with means for its snap-together engagement with the main body; said means are constituted by flexible studs, shaped like a hook or the like, which can engage in a snap-together manner within holes defined in the wall of said body in order to keep the permanent magnet, the coil and the core which constitutes the magnetic circuit stably in position.

Further characteristics and advantages of the present invention will become apparent from the following detailed description, given only by way of non-limitative example with reference to the accompanying drawings, wherein:

figure 1 is a schematic exploded perspective view of the components of the actuator, according to the present invention;

figure 2 is a vertical median sectional view of the assembled actuator;

figure 3 is a transverse sectional view of the same assembled actuator as in figure 2;

figure 4 is a top plan view of the actuator of the preceding figures; whereas

figure 5 is a perspective view of a detail and specifically of the moving keeper used in the actuator of the preceding figures.

With reference to the above figures, the actuator according to the invention comprises a main body 1 substantially shaped like a parallelepiped; lug-shaped means or the like (not shown) are rigidly coupled to the outer peripheral region of said main body to fix said body 1 to the external mechanism which the actuator must actuate.

Cavities or compartments are formed inside the body 1, and have mutually parallel axes and different dimensions; more precisely, the cavities 2 and 2a are meant to accommodate respectively the arm 3 and the arm 4 of a core 5 made of ferromagnetic material, which is substantially shaped like an uppercase letter U and is provided, in the substantially straight portion 5a, with through holes 6 the purpose whereof will become apparent hereinafter; the cavity 7, which is coaxial to the cavity 2, is meant to accommodate the coil of conducting wire 8, which is axially hollow, so that when it is inserted in the cavity 7 it is guided, so as to be insulated, on the hollow body which forms the cavity 2 within which the arm 3 of the core 5 is inserted.

A permanent magnet 10 is inserted in the cavity 9, whereas the cavity 11 accommodates a return spring 12; one end of said spring is anchored to a pin or hook 12a, and its opposite end 12b is anchored within a hole 13 formed at the end of a moving keeper 14; said keeper has, at the end opposite to the one where it couples to the spring, a flat portion 14a which is meant to be moved into contact with the upper end of the arm 3 of the core 5.

As clearly shown in the figures, the cavity 7 of the coil and the cavity 9 of the magnet are closed upwardly (the side of the keeper) so as to constitute blind compartments capable of stably accommodating the coil and the magnet without requiring elastic retention means.

More particularly, according to the present invention, said cavity 7 accommodates a coil 8 constituted by insulated copper wire of the self-cementing type, i.e. which maintains its shape since the insulation which encloses the copper wire, when heated, welds to the adjacent turns. The coil 8 is thus constituted exclusively by the insulated copper wire, which is inserted astride the insulating compartment 2. In this manner there is no connection between the cavities 7 and 9 and the moving keeper 14 on the side where said keeper will be engaged by the fixed magnetic circuit 5, and thus any impurities which might detach from the magnet 10 and from the coil 8 could not penetrate between the keeper 14 and the magnetic circuit 5.

Said moving keeper is furthermore monolithically provided with two opposite pairs of lateral wings 14b and 14c which form the pivoting region. More in detail, the recesses comprised between said pairs of lateral wings of the keeper engage

shaped teeth 15 formed correspondingly on the main body 1, so that the wings 14b and 14c in practice oscillate on the shaped teeth 15 under the traction applied by the spring 12, which has an axis inclined so as to provide a horizontal component of the force which causes the keeper to adhere to the shaped teeth 15.

This fact allows a floating or oscillating coupling between the core and the keeper, i.e. the rotation of the keeper always occurs acceptably even in case of core size variations, and the coupling between the core and the keeper is always correct.

The body 1 furthermore has, in its lower part, fixed studs 16 which allow coupling to a baseplate 17 which can be anchored to the body 1 by virtue of the snap-acting means described hereafter.

Said baseplate 17, which must close all of the lower part of the main body 1, once the magnet 10, the coil 8 and the fixed magnetic circuit 5 have been positioned, engages the main body 1 on one side through two tabs 18 which enter two cavities 19 of the body 1 from the other side by means of two snap-acting tabs 20 formed by the baseplate 17, the teeth whereof enter the two cavities 21 formed in the main body 1 (figures 2, 3 and 4).

The fixed magnetic circuit 5 is inserted so that its holes 6 are crossed by the studs 16 formed in the body 1 and protruding therefrom. When it is inserted, the baseplate 17 also fits its holes 17a over said studs 16. Said studs, when the baseplate is closed, protrude by a very small extent from the outer plane of the baseplate in order to be subsequently hot-riveted, as will become apparent hereinafter.

The actuator is then closed upwardly by a dome 22 which is centrally provided with a hole 22a for the passage of a conventional actuation pin 23.

Said upper dome 22, after the pin 23 has been accommodated therein, closes onto the main body 1 by means of two tabs 24 which enter the compartments 25 until the rectangular holes 24a of the tabs 24 elastically engage the protrusions 25a, locking themselves in this position. Since the compartments 25 are inside the body 1, it is no longer possible to remove the dome 22.

If technical reasons that force to reopen said dome 22 arise, there are two holes 26 on the side walls of the main body 1; the two tabs 24 are deflected inwards through said holes by pushing toward the inside of the body 1 with appropriate pins, disengaging the tabs from the two retainers 25a and thus releasing the dome.

It is evident that the holes 26, shown as circular in the drawings, may actually have a different shape, so that the pins used to reopen the dome (when necessary) must assume the shape of an actual key. In this manner, only the person who has the key and is authorized for this task can reopen the dome of the actuator.

Therefore, when the actuator is fully closed, it is easy to check that operation is correct; if this is the case, the heads of the studs 16 are stably heat-sealed within the holes 17a of the baseplate.

With particular reference to figure 1, said figure illustrates an arrangement of the components of the actuator which can be used both for manual and automatic assembly. This arrangement is non-limitative, in that any other initial arrangement can be assumed, so long as it achieves the same final result.

In said figure 1, the main body 1 is held still and in inverted position by a fixture of any kind, and then the magnet 10 and the coil 8 are loaded first with a downward movement. This is followed by the assembly of the fixed magnetic circuit 5. A thin rectangular plate 27 is inserted from below in the two shaped teeth 15; said plate is provided with two holes at the teeth, is made of a suitable material, even plastics, and has the purpose of reducing the friction coefficient in the mutual movement between the keeper 14 and the fixed magnetic circuit 5 in addition to constituting, according to the requirements, a gap of said magnetic circuit. The eyelet of the spring 12 is then pulled through the compartment 11 until it engages the transverse bar 21. The other eyelet of the spring 12 has already been engaged in the hole 13 of the keeper 14, the two recesses 14e whereof fit between the shaped teeth 15.

Subsequently, the dome 22, in the hole 22a whereof the actuation pin 23 has already been inserted, is inserted until the tabs 24, inserted in the compartments 25 of the main body 1, reach and pass beyond the two retention teeth 25a, anchoring themselves to said teeth.

Finally, with a downward movement and with a slight rocking, the two tabs 18 are inserted in the cavities 19, while the entire baseplate 17 is pressed so as to allow the elastic tabs 20 to snap within the compartments 21.

Finally, once positive checking has been performed, the studs 16 are hot-riveted.

Obviously, in its practical execution the invention as described is susceptible to further structural and functional equivalent modifications and variations without abandoning the protective scope of the invention itself.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference

signs.

Claims

1. Polarized electromagnetic actuator, of the type which comprises a supporting body (1) provided with side-by-side cavities (2,2a,7,9) for containing a U-shaped core (5) or the like, a coil (8), a polarizing permanent magnet (10) and a keeper (14) contrasted by a return springs (12), which actuates an actuation pin (23) of an external mechanism, as well as a dome (22) and a closure baseplate (17); characterized in that it comprises a prism-shaped main body (1) which internally forms: a first compartment (7), suitable to contain said axially hollow coil of conducting wire (8); a second compartment (9) for containing said permanent magnet (10); two further separate compartments (2,2a), one (2) of which is tubular and axially formed in a central position with respect to said first compartment (7) for the insulated accommodation of an arm (3) of said U-shaped core, the other compartment (2a) being provided to accommodate the second arm (4) of said core (5); and a further cavity (11) for accommodating said keeper return spring (12); said first (7) and second (9) compartments being closed upwardly so as to allow insertion of the coil (8) and of the magnet (10) from the side opposite to the one where said moving keeper (14) acts and thus eliminate any connection between said two compartments (9,7); said dome-shaped lid (22) which supports the actuation pin (23) and said lower closure baseplate (17) being provided with snap-acting (20,24) or similar means for their removable engagement with the supporting body (1).

2. Actuator according to claim 1, characterized in that said means for the removable engagement of the dome with the main body are constituted by two oppositely arranged flat tabs (24) rigidly coupled to said dome (22), said tabs (24) being made of flexible plastic material, being provided with holes (24a) or openings, and being suitable to enter two guides (25) formed on the internal wall of the main body (1) and to stably engage their holes (24a) on teeth (25a) or raised portions protruding from said guides (25) arranged inside the main body.

3. Actuator according to claims 1 and 2, characterized in that each one of said tabs (24a) rigidly coupled to the dome (22) and engaged with the teeth (25a) formed in the main body (1) can be detached from said body (1) by using a rod or the like which is insertable in a hole (26) formed in the wall of said body (1) and is pushed against the solid part of the tab (24) until the holes (24a) of the tab disengage from the respective retention tooth (25a), thus allowing to remove the dome (22) for checking and inspecting the operation of the actuator.

4. Actuator according to claim 1, characterized in that said means for engaging the baseplate (17) are constituted by flexible studs (20), shaped like a hook or the like, which can engage with a snap action within holes (21) formed in the wall of said body (1), in order to keep the permanent magnet (10), the coil (8) and the core (5) which constitutes the magnetic circuit stably in position within the respective cavities (7,9,2,2a).

5. Actuator according to one or more of the preceding claims, characterized in that said holes (26) for the passage of said rods for the disengagement of the tabs (24) of the dome (22) from the body (1) have a circular, prism-like or irregular shape suitable to allow only the passage of a rigid tool the cross-section whereof matches that of said holes (26), i.e. a key-like tool or the like.

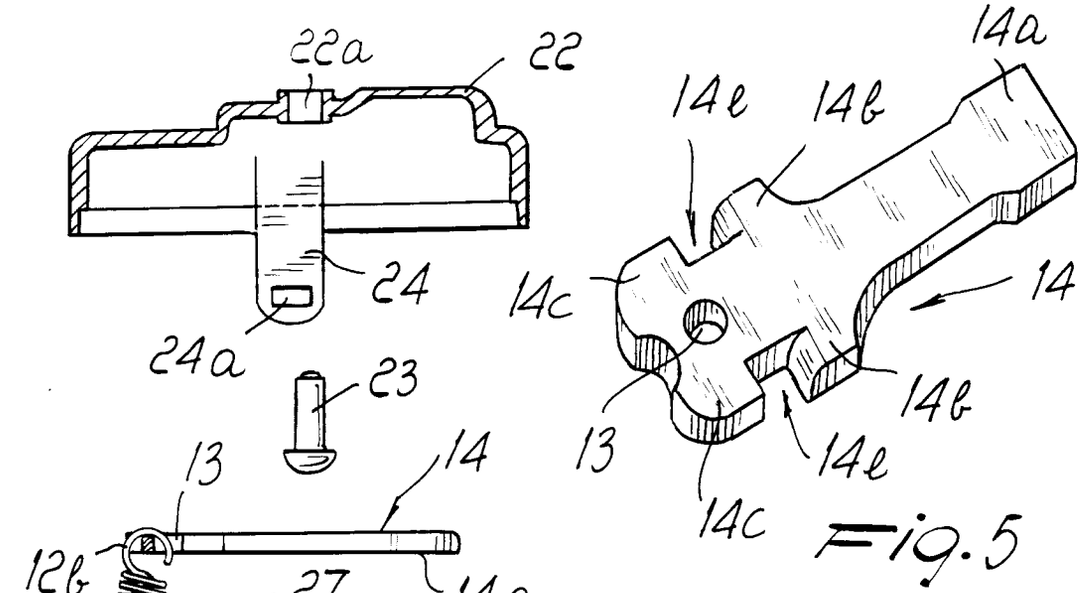

Fig. 5

Fig. 1

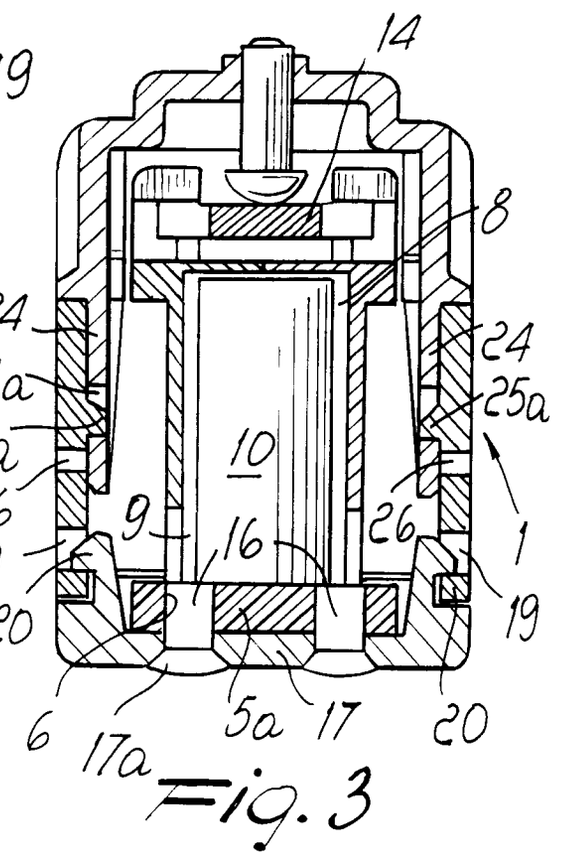

Fig. 3

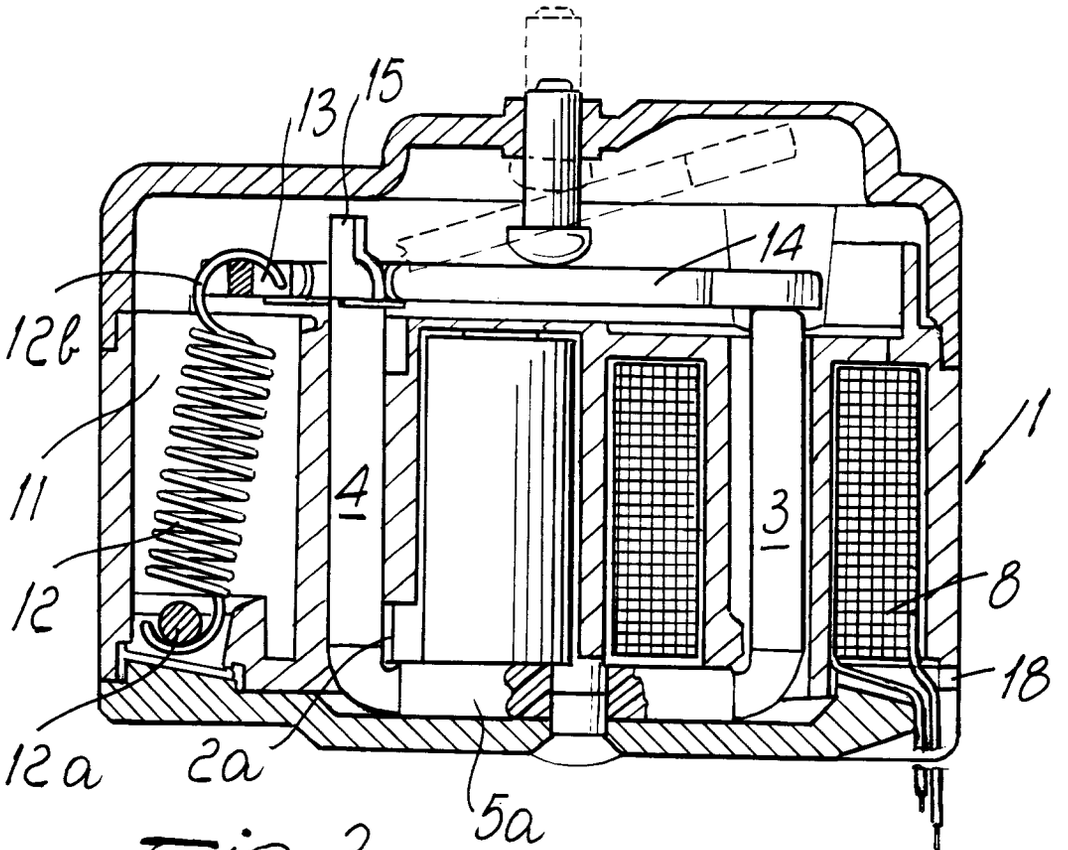
13
15
14
12b
11
4
3
1
8
18
12
12a
2a
5a

Fig. 2

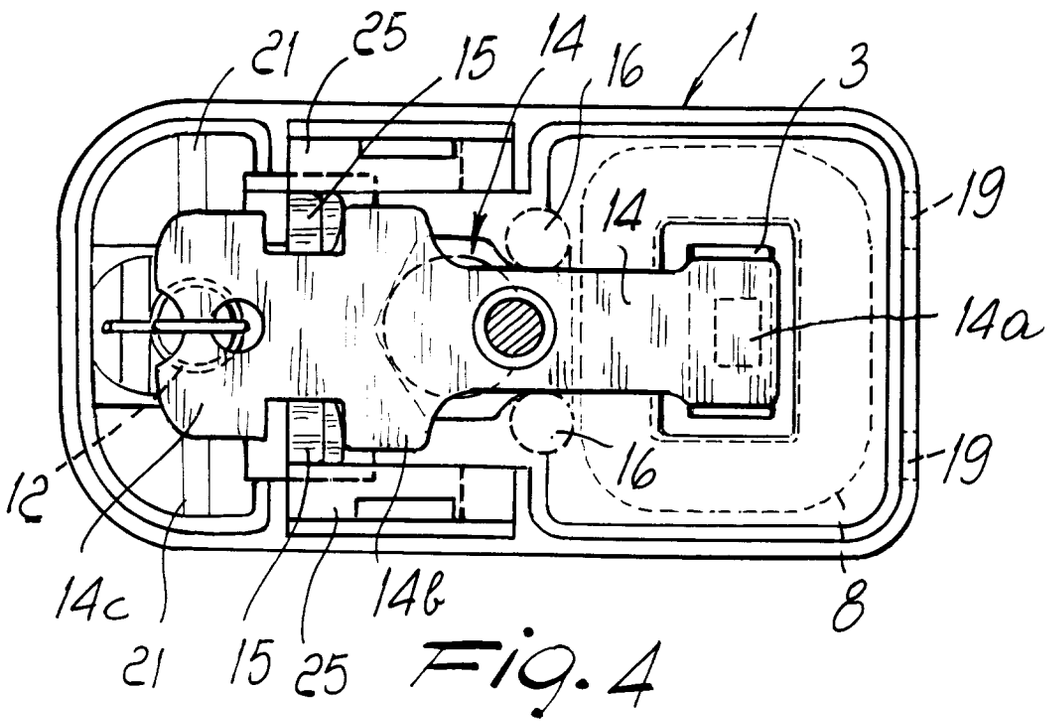
21
25
15
14
16
1
3
19
14
14a
12
16
19
14c
14b
8
21
15
25

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number

EP 93 11 0018

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	EP-A-0 337 900 (MERLIN GERIN) * the whole document *	1	H01H50/04 H01H51/22
A	EP-A-0 332 181 (OMRON TATEISI ELECTRONICS) * claim 1; figure 1 *	1	
A	EP-A-0 463 884 (TAKEMISAWA ELECTRIC) * claim 1; figure 1 *	1	
A	US-A-3 833 869 (CASSARLY) * column 1, line 46 - line 68; figures 1,5 *	1	
A	AT-B-307 558 (SIEMENS) * page 2, line 7 - line 33; figures *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	03 SEPTEMBER 1993	NIELSEN K.G.

CATEGORY OF CITED DOCUMENTS

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