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(54) Mechanical snap-fast multi-contact switch

(57) A snap-fast switch, comprising a push-button 2 adapted to rotate about a fulcrum "○", a housing structure 3, at least one rod 4 constrained to one end of the push-button 2 and countered by an elastic means 41.

The switch comprises an actuating mechanism comprising a first oscillating snap means 61, alternatively acting upon one contact (5A, 5B) of at least one module "M", and a second oscillating snap means 62, which is acted upon by said rod 4.

Said second snap means 62 acts upon the first snap means 61 and causes it to switch, so that means 61 acts upon the opposite contact (5A or 5B).

The switch comprises an interlock means adapted to lock the first snap means 61 at the end-of-travel points, and a release element adapted to disengage first snap means 61 when push-button 2 reaches a predetermined angle of inclination "α".

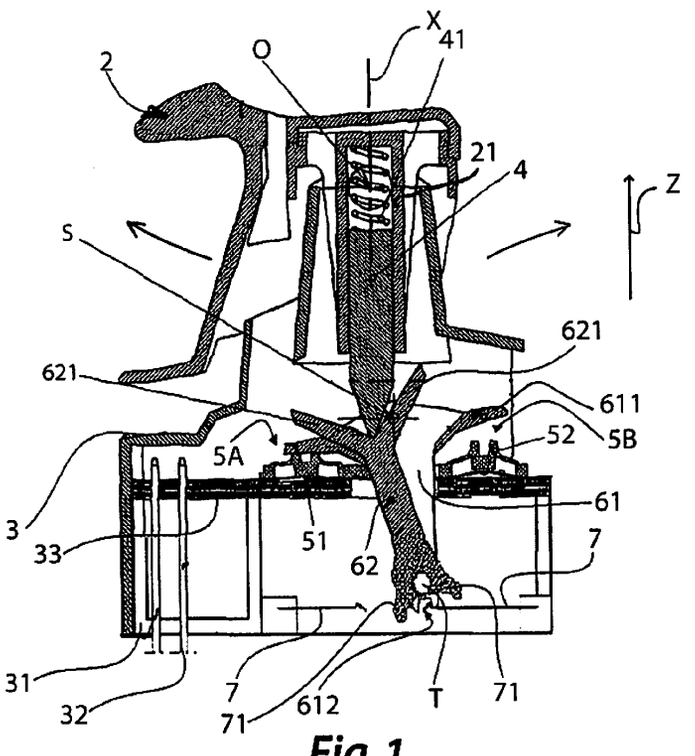

Fig.1

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Description

[0001] The present invention relates to multi-contact mechanical switches, in particular to snap-fast switches, preferably applied to low-power circuits.

[0002] In the low-power and high-power electronics/electrotechnology field, switches are required whose switching time is as short as possible.

[0003] Snap-fast switches are known in the low-power electronics field which reduce the switching time to a minimum and which prevent the risk that, due to slow actuation or excessively light force applied to a lever thereof, the switch might return to the initial position.

[0004] This latter characteristic, which must necessarily be present in a quick-snap switch, is a technical problem which is difficult to solve.

[0005] In fact, snap-fast switches must avoid that, upon the exertion of an actuation force, the switch might return to the initial position without switching.

[0006] A further technical problem of snap-fast switches applied to low-power electronics is bounce elimination, in particular in digital electronic circuits.

[0007] Multi-contact snap-fast switches are known which comprise complex systems of springs and elastic elements which are very costly and difficult to implement, in addition to increasing the dimensions of the switch itself.

[0008] Switches of this kind are described, for example, in patent applications EP1615249 and EP0743664.

[0009] Such solutions, which mainly make use of elastic force, are unreliable because variations over time of the elastic constant of the system may reduce and even cancel the snap-fast effect, which is the fundamental characteristic of the switch itself.

[0010] One solution to the above-mentioned problem is described in patent application ITT020080675A by the present Applicant.

[0011] A further unsolved problem of the prior art concerns the risk that the switch might switch or a contact might open, even for a very short time, because of vibrations or forces, even very light ones, applied to the switch push-button.

[0012] Yet another problem suffered by known switches is the determination of the instant at which switching starts between the contacts, which depends on the elastic constant of the contact itself, because the contact opening speed, when force is no longer applied to the contact itself, is strongly dependent on the material used and on the elastic constant thereof.

[0013] Similar switches manufactured by using contacts made of different materials with different elastic constants will have different switching times, although the principle of operation is the same.

[0014] It is therefore advantageous to know the exact switching instant, since the performance of the switch can be improved by reducing switching and execution time uncertainty.

[0015] It is the object of the present invention to provide a multi-contact mechanical snap-fast switch adapted to solve the above-mentioned problems.

[0016] One aspect of the present invention relates to a multi-contact snap-fast switch having the features set out in the appended claim 1.

[0017] Accessory features of the present invention are set out in the appended dependent claims.

[0018] The features and advantages of said switch will become apparent from the following description of an embodiment thereof with reference to the annexed drawings, wherein:

- Figures 1A and 1B show sectional views of the switch according to the present invention in two respective operating states;
- Figure 2 is an exploded view of the switch according to the present invention;
- Figure 3 shows a detail of a contact of the switch according to the present invention;
- Figure 4 shows a detail of the interlock means according to the present invention;
- Figures 5A and 5B illustrate an alternative embodiment of the switch according to the present invention, Fig. 5A showing a sectional view of the switch and Fig. 5B showing a perspective view of the inside of the switch, respectively;
- Figures 6A and 6B show the switch according to the present invention in different operating configurations, Fig. 6A showing the switch in the pull configuration and Fig. 6B showing the switch in the push configuration, respectively.

[0019] With reference to the above-listed drawings, the multi-contact mechanical snap-fast switch, preferably for low-power circuits, comprises a push-button 2 secured to a housing structure 3 in order to be able to rotate about, preferably being horizontally pivoted to, a fulcrum "○"; at least one rod 4, constrained at one end to push-button 2 and moving integrally therewith, so as to slide along an axis "X" of push-button 2 itself within a guide 21 comprised in push-button 2, countered by at least one elastic means 41.

[0020] Said housing structure 3, which is adapted to ensure mechanical protection of the switch components, comprises the rod and at least one flared structure, which is preferably adapted to define the angle of oscillation of push-button 2. The structure further comprises a support portion 31 whereto a printed circuit 33 is secured, which is acted upon by at least one module "M" comprising at least a first contact 5a and a second contact 5b, preferably opposite to each other.

[0021] Said at least one module "M" is acted upon by at least one actuating mechanism, which is electrically insulated from each module "M" and which comprises a first oscillating snap means 61, preferably rotatable about a first fulcrum "S" depending on the inclination of push-button 2, and a second oscillating snap means 62, secured to a second fulcrum "T" and comprising an activa-

tion portion 621 acted upon by the same rod 4.

[0022] Said second snap means 62, as it is made to oscillate about fulcrum "T", acts upon the first snap means 61, thereby causing it to oscillate about fulcrum "S", so that said first means 61 will act upon contact 5a or 5b as a function of the inclination of push-button 2, the switching of contacts 5a, 5b occurring only when a predetermined angle of inclination "α" of push-button 2 is reached.

[0023] The switch also comprises at least one interlock means adapted to lock the first snap means 61 at at least one end-of-travel point thereof, thereby preventing any unintentional movement of the same, and at least one release element adapted to disengage the first snap means 61 from the interlock means when push-button 2 reaches a predetermined angle of inclination "α", thereby allowing it to move again. This solution allows determining the exact instant of switching between the two contacts (5a, 5b).

[0024] The switch according to the present invention is preferably employed in terrestrial and naval vehicles for actuating electric circuits adapted to activate/deactivate electromechanical devices installed in said vehicles.

[0025] As shown in Fig. 2, support portion 31 comprises a plurality of electric connectors 32 adapted to be electrically connected to a further electronic circuit.

[0026] Printed circuit 33, secured to support portion 31, comprises a plurality of conductive tracks electrically connected to said electric contacts 32, in accordance with a predetermined circuit diagram, through a low-impedance path.

[0027] As shown in Figs. 1A, 1B and 2, said printed circuit 33 is acted upon by a plurality of modules "M", each comprising at least a first contact 5a and a second contact 5b arranged opposite to each other, and an insulating pad, e.g. made of silicone-based material, incorporating said contacts 5a and 5b.

[0028] Each one of said first and second contacts 5a, 5b comprises at least one conductive portion 51, e.g. made of metallic material, and at least one dome 52, to which said contact portion 51 is secured.

[0029] Each dome 52 is adapted to act upon the associated conductive portion 51 when dome 52 itself is pressed, so as to lower conductive portion 51 until it comes in contact with the surface of printed circuit 33, thereby creating a low-impedance path where electric current can flow, thus closing the associated contact 5a, 5b.

[0030] In a second embodiment of the switch according to the present invention, shown in Figs. 3A and 3B, module "M" comprises contacts 5A and 5B which comprise a foil 53, preferably made of metal, which is so shaped that, when the first snap means reaches its end of travel, said foil 53 will press against the surface of printed circuit 33, thereby closing a contact 5a, 5b.

[0031] A first end of said foil 53 is constrained to the first snap means 61, preferably to contact portion 611, whereas a second end is free and is adapted to press against the surface of printed circuit 33.

[0032] As shown in Figs. 1A and 1B, first snap means 61 is positioned between first contact 5a and second contact 5b, rotatable about fulcrum "S", which is preferably located above the plane described by the surface of printed circuit 33.

[0033] In the present embodiment, fulcrum "S" is offset relative to a vertical straight line parallel to an axis "Z" passing through fulcrum "○", thereby generating, for each module "M", a normally closed contact, preferably 5a, and a normally open contact, e.g. 5b.

[0034] In an alternative embodiment, fulcrum "S" and fulcrum "○" are aligned with the vertical straight line parallel to axis "Z", thereby generating a changeover switch capable of switching between two contacts 5a, 5b.

[0035] Said first snap means 61, comprised in the actuating mechanism, preferably has a "V" flared shape, e.g. hollow inside, wherein at each lateral end of said snap means 61 there is a contact portion 611 adapted to act upon said domes 52.

[0036] First fulcrum "S", about which first snap means 61 rotates, is arranged transversally with respect to both a vertical axis "Z" and the plane defined by printed circuit 33, visible in Figs. 1A and 1B.

[0037] Second fulcrum "T", about which second snap means 62 rotates, is preferably built in first snap means 61 through, for example, a pin mounted transversally relative to vertical axis "Z" and parallel to the axis of fulcrum "S".

[0038] Said fulcrum "T" is preferably located under the plane described by the surface of printed circuit 33, changing its relative position within structure 3 of the switch as a function of the oscillation of the first snap element 61 about fulcrum "S".

[0039] Second snap means 62, as aforementioned, is rotatably secured to fulcrum "T" and is preferably positioned inside the flared structure of first snap means 61, which defines the angle within which second snap means 62 can rotate about fulcrum "T".

[0040] Activation portion 621 of second snap means 62 comprises two inclined planes opposite to each other, thus generating, in the embodiment shown in the drawings, a second snap means 62 shaped like a "Y".

[0041] The operating configurations or steps of the switch according to the present invention are listed below, and essentially comprise:

- an idle configuration, wherein push-button 2 is positioned in a balanced condition in which an axis "X" of rod 4 is parallel to vertical axis "Z", shown in Fig. 1A;
- a push configuration, wherein push-button 2 is rotated about fulcrum "○", thus going down and activating the actuating mechanism as soon as push-button 2 exceeds a certain angle of inclination "α" relative to axis "Z", thereby changing, from the idle configuration, the state of contacts 5a, 5b comprised in a module "M", as shown in Fig. 5B.

- a pull configuration, wherein push-button 2 is rotated about fulcrum "○", thus going up and activating the actuating mechanism as soon as push-button 2 exceeds a certain angle of inclination "α" relative to axis "Z", thereby changing, from the idle configuration, the state of contacts 5a, 5b comprised in a module "M", as shown in Fig. 5A.

[0042] As shown in the drawings, the second fulcrum "T", when in the idle operating condition, is in an offset position with respect to the mean point between contacts 5a, 5b, e.g. in the proximity of the normally open contact 5b.

[0043] During a push or pull operating step, the second fulcrum "T" changes its relative position in housing structure 3, positioning itself preferably in the proximity of contact 5a, 5b. Due to the switching of the contacts themselves, it thus becomes an open contact, since it is secured to the first snap means 61, which in turn rotates about fulcrum "S", as shown in detail in Figs. 1B and 6B, during the push operating step.

[0044] In the push or pull operating configuration, activation portion 621 is acted upon by rod 4, which tends to slide on the inclined plane comprised in activation portion 621, corresponding to the direction opposite to that in which push-button 2 moves.

[0045] When the angle of inclination "α" of push-button 2 relative to a vertical axis "Z" is approximately equal to a limit angle, the switching mechanism takes a configuration wherein fulcrum "T" arranges itself in substantial alignment with fulcrum "S", with a vertical axis parallel to axis "Z".

[0046] For the purposes of the present description, the phrase 'fulcrum "T" arranges itself in substantial alignment with fulcrum "S"' means that, with reference to a vertical axis crossing fulcrum "T", fulcrum "S" is not intersected, being at a short distance from the same axis.

[0047] The limit angle of inclination of push-button 2 beyond which contacts 5a, 5b are switched is smaller than 20°.

[0048] If push-button 2 is released before the limit angle is exceeded, the actuating mechanism will return to its initial idle operating configuration without switching any contact 5a, 5b present in module "M" shown in the drawings because, before the limit angle is reached, the position of fulcrums "T" and "S" is such that the force applied by rod 4 to activation portion 621 is conveyed in the direction of the initial closed contact to be switched.

[0049] By continuing to push or pull push-button 2, as soon as said limit angle is exceeded the contacts of module "M" will switch their operating state, and the actuating mechanism will position itself in a point of stability where fulcrum "T" and fulcrum "S" will be offset relative to axis "Z".

[0050] When said limit angle is exceeded, the position of fulcrums "T" and "S" is such that the force applied by rod 4 to activation portion 621 is conveyed in the direction of contact 5a, 5b that after switching has become a closed contact.

[0051] More in detail, the additional displacement of push-button 2 past the limit angle allows second snap means 62 to abut and act upon first snap means 61, which in turn will change its position because of the thrust received from elastic means 41 facing rod 4, by rotating about fulcrum "S" towards second contact 5b.

[0052] The rotation of first snap means 61 allows it to, when it reaches the end of its travel, act upon dome 52 of second contact 5b through contact portion 611, thereby closing contact 5a or 5b by means of conductive portion 51.

[0053] The preferred embodiment of the switch according to the present invention, shown in Figs. 6A and 6B, comprises at least two modules "M", each comprising contacts 5a and 5b, which are arranged in an alternate fashion, so that two adjacent modules "M" have reversed contacts 5a and 5b, i.e. two adjacent contacts of two adjacent modules "M" are in opposite operating states when the switch is in the idle operating configuration.

[0054] An actuating mechanism is associated with each module "M"; the mechanisms are arranged opposite to each other, in a manner such that fulcrums "S" of adjacent actuating mechanisms are offset.

[0055] Preferably, each actuating mechanism can switch contacts 5a, 5b of the associated module only in one operating configuration of the switch.

[0056] With push-button 2 in a push or pull configuration, once the limit angle is exceeded only those contacts will switch which belong to module "M" associated with the actuating mechanism adapted to move in that configuration, i.e. the actuated mechanism will be the one in which, in the idle configuration, the normally closed contact is in the direction of inclination of push-button 2; on the contrary, the adjacent actuating mechanism will not cause the switching of the contacts included in associated module "M", as shown in Figs. 6A and 6B.

[0057] On this latter actuating mechanism, associated rod 4 will slide along the inclined plane of second snap means 62, continuing to press against the normally closed contact and accumulating potential energy that will contribute to bring push-button 2 back into the idle configuration as soon as no force is applied to the push-button.

[0058] For each module "M" comprised therein, the switch according to the present invention comprises an interlock means and a release element, respectively adapted to lock and release, in a controlled manner, each first snap means 61 associated with single modules "M".

[0059] During the push or pull operating step, second snap means 62, as it rotates about fulcrum "T" and push-button 2 goes past said limit angle, starts acting upon first snap means 61. At the same time, the release element disengages first snap means 61, so that the force applied to push-button 2 can be transferred, through rod 4, towards the actuating mechanism, thereby causing the switching of the two contacts 5a, 5b of associated module "M".

[0060] At the end of its travel, first snap means 61 is locked by an interlock means, which locks said snap means 61 to prevent it from executing any unintentional switching.

[0061] Preferably, each switch comprises, for each module "M", at least two interlock means, i.e. one for each end-of-travel point of each first snap means 61.

[0062] In the embodiment shown in Figs. 1A and 1B there are two interlock means arranged under fulcrum "T" with respect to axis "Z", each comprising at least one shaped foil 7 adapted to engage with at least one cavity 612 comprised in the lower portion of first snap means 61, as shown in Fig. 4.

[0063] Foils 7 are preferably parallel to the plane of printed circuit 33, equidistant from first fulcrum "S", so as to lock first snap means 61 at both end-of-travel points of snap means 61.

[0064] A first end of each foil 7 is secured to support portion 31, thus creating a cantilever, whereas the second end, which is free, can oscillate.

[0065] The second end, which is free, of each foil 7 is so shaped as to engage with cavity 612 comprised in the lower portion of first snap means 61.

[0066] Each foil is preferably made of metallic material, e.g. aluminium, or, as an alternative, of plastic material.

[0067] In the preferred embodiment, each second snap means 62 comprises the release element, e.g. in the lower portion of snap means 62 itself.

[0068] Said release element comprises at least one, but preferably two, protrusions 71 arranged at the sides of the lower portion of snap means 62, which are adapted to act upon associated shaped foils 7 in order to disengage first snap means 61.

[0069] The arrangement of said protrusions 71 is such that they exert a force onto foils 7 along an axis preferably parallel to axis "Z" when second snap means 62 is rotating about fulcrum "T", after push-button 2 has exceeded a predetermined limit angle.

[0070] Each one of said protrusions 71 of the release element is preferably made of plastic material, just like second snap means 62.

[0071] Under the action of protrusions 71 of the release element, the foil flexes and disengages from cavity 612, thus releasing first snap means 61 when the angle of inclination of push-button 2 has exceeded the limit angle, thereby bringing second snap means 62 in abutment with first snap means 61.

[0072] The oscillation of first snap means 61 up to the end of its travel allows contact portions 611 to act upon contact 5a, 5b, thereby closing it; at the same time, shaped foil 7, positioned at the opposite end-of-travel point of first snap means 61, will lock again the first snap means.

[0073] For a new switching to be possible, push-button 2 must reach an angle of inclination "α" greater than the limit angle.

[0074] In the embodiment shown in the drawings, as soon as the operator stops exerting a force onto push-button 2 towards a particular operating configuration, the energy accumulated by elastic means 41 associated with rod 4, acting upon the actuating mechanism next to the one where switching took place, which keeps its own contacts unchanged, allows push-button 2 to re-position itself into the idle operating configuration. In this way, first snap means 61 is disengaged through the action of protrusions 71 upon foil 7 associated with the actuating mechanism that performed the switching of the contacts when push-button 2 was tilted.

[0075] The stiffness of shaped foils 7 prevents disengagement by associated protrusions 71 until a minimum force is reached which allows protrusion 71 to bend foil 7 and disengage first snap means 61, thus preventing any unintentional switching caused by a light pressure being applied to push-button 2.

[0076] In the absence of the interlock means and of the release element, in both embodiments shown in Figs. 1A and 5A the time when switching between contacts 5a, 5b occurs will be different, because the elastic constant of the embodiment with foils 53 (Fig. 5A) will open the contact earlier than the embodiment of Figs. 1A and 1B, due to the fact that the elastic constant of foil 53 is higher than that of domes 52, thus needing a greater force to hold the contact closed.

[0077] The present solution allows to obtain snap-fast switches capable of switching within times shorter than 20ms, with considerably reduced start time uncertainty.

[0078] The switch according to the present invention allows to reduce uncertainty as to the instant at which the switching between one contact and the other begins.

[0079] Furthermore, the switch with interlock means and release elements allows to eliminate any uncertainty caused by the elastic constant of the contact, since the start of the switching action is totally bound to the angle of inclination "α" of push-button 2.

[0080] Finally, the switch according to the present invention is insensitive to friction and force variations.

Claims

1. Multi-contact mechanical snap-fast switch, comprising a push-button (2) and a housing structure (3), to which the push-button (2) is secured in order to be able to rotate about a fulcrum (○), at least one rod (4), constrained at one end by the push-button (2) and moving integrally therewith, countered by at least one elastic means (41), said housing structure (3) comprises a support portion (31) whereto a printed circuit (33) is secured, which is acted upon by at least one module (M) comprising at least a first contact (5A) and a second contact (5B);
said module is acted upon by an actuating mechanism, which comprises a first oscillating snap means (61) alternatively acting upon one of said contacts (5A, 5B) of each module, and a second oscillating snap means (62) comprising an actuating portion

(621) acted upon by said rod (4),
during its oscillation, said second snap means (62) acts upon the first snap means (61) and causes the switching thereof, so that said first means (61) acts upon the opposite contact (5A or 5B), thereby allowing commutation of the switch,
the switch being **characterized in that** it comprises at least one interlock means adapted to lock the first snap means (61) at the end-of-travel points, thereby preventing any unintentional movement thereof, and a release element for disengaging the first snap means (61) when the push-button (2) reaches a predetermined angle of inclination (α), thereby allowing commutation of the switch in a controlled and quick manner.

2. Switch according to claim 1, wherein the interlock means comprises at least one shaped foil (7) adapted to engage with at least one cavity (612) comprised in the first snap means (61), and the release element is comprised in the second snap means (62).

3. Switch according to claim 2, wherein the release element comprises at least one protrusion (71), arranged at the sides of the lower portion of the snap means (62), in order to exert a force onto the foils (7) along an axis parallel to an axis (Z) when the second snap means (62) is rotating about the fulcrum (T), thereby releasing the first snap means (61) from the action of the interlock means.

4. Switch according to claim 1 or 3, wherein, when the push-button (2) reaches an angle of inclination (α) equal to a limit angle, the release element disengages the first snap means (61), so that the force applied onto the push-button (2) can be transferred, through the rod (4), towards the actuating mechanism, thereby causing the switching of the contacts (5A, 5B) comprised in at least one module (M) of the switch.

5. Switch according to claim 4, wherein the limit angle of inclination of the push-button (2) beyond which the switching of the contacts (5A,5B) occurs is less than 20°.

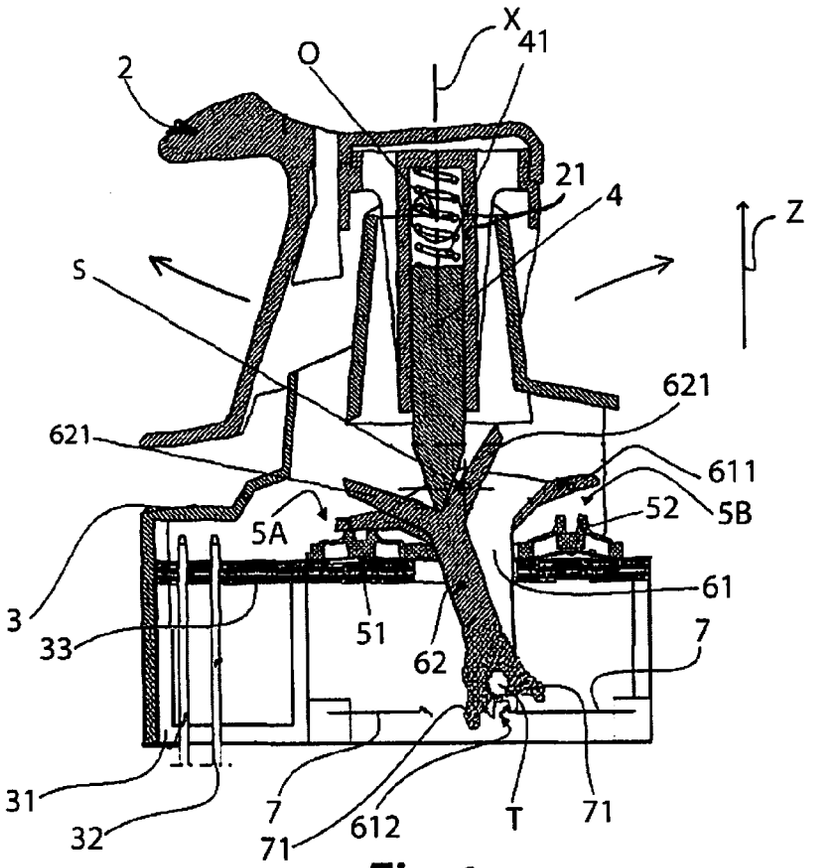
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Fig.1

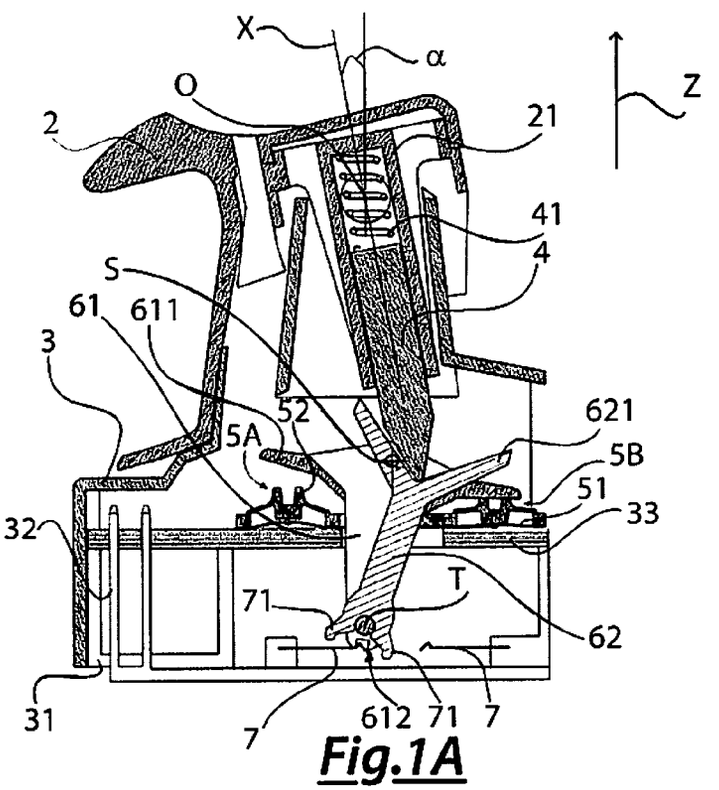
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Fig.1A

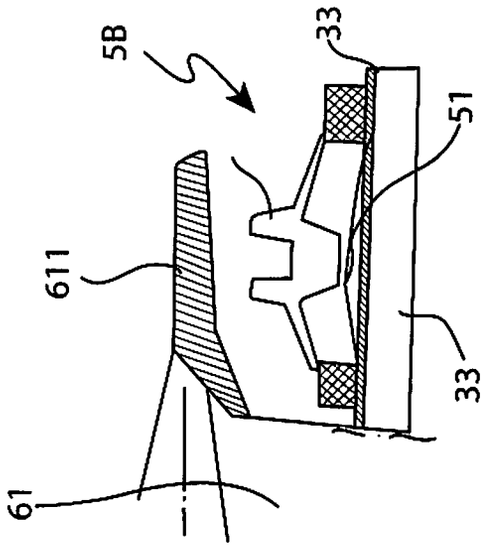

Fig.3

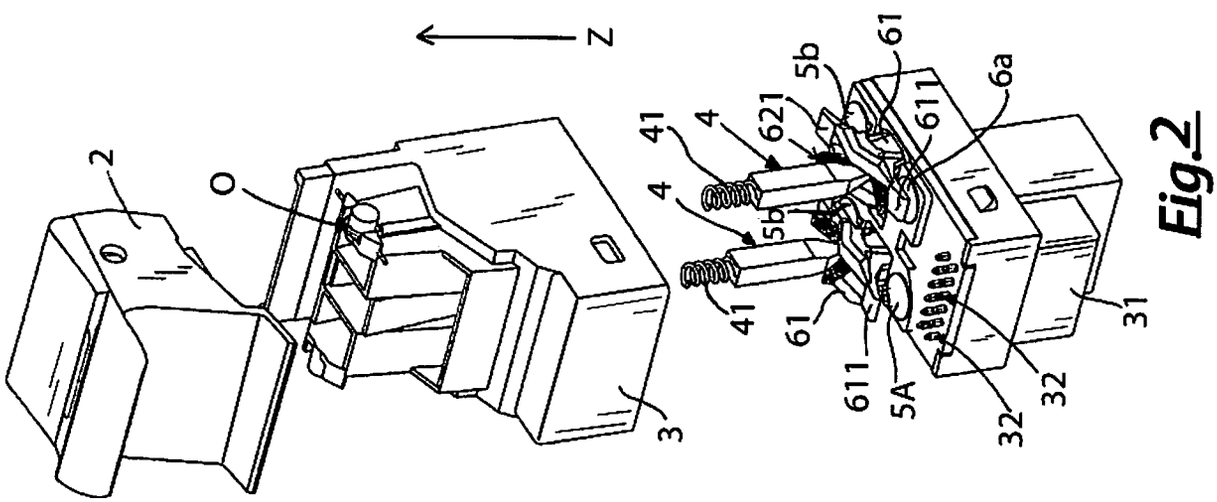

Fig.2

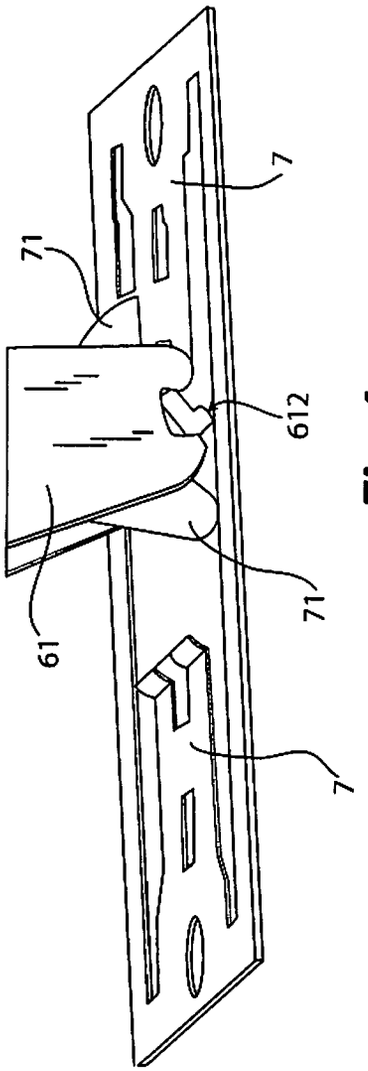

Fig.4

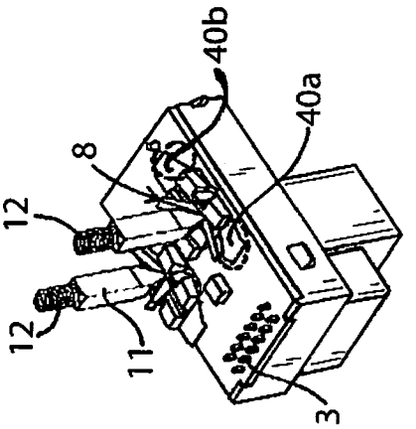

Fig.5B

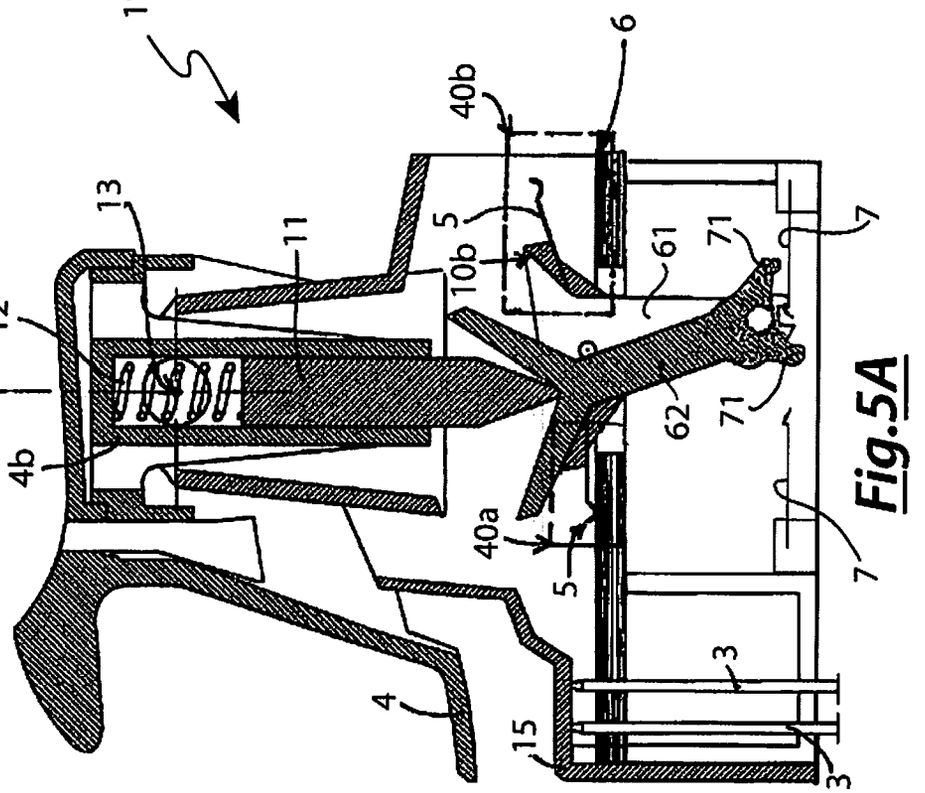

Fig.5A

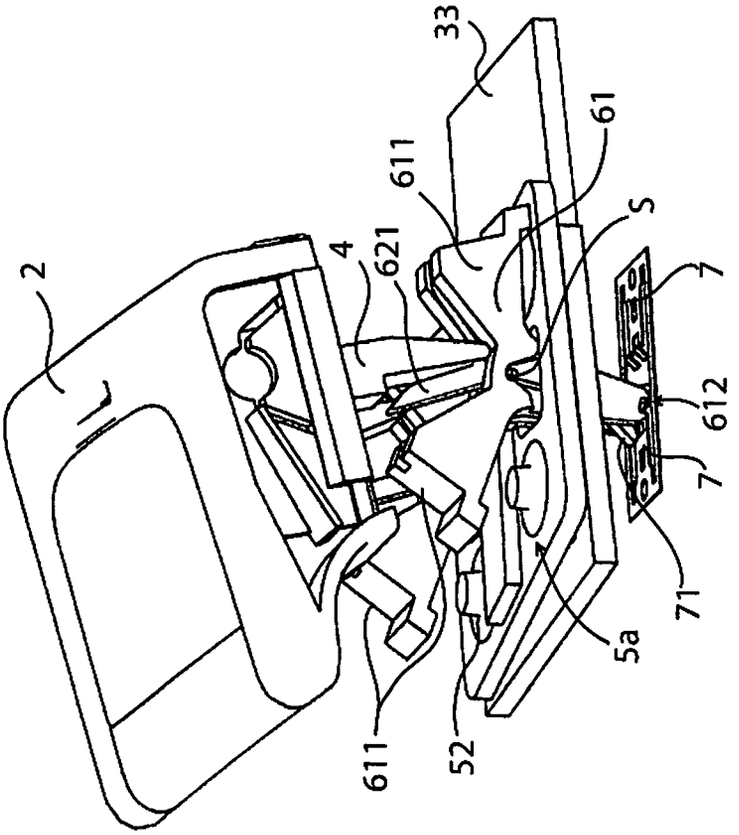
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Fig.6B

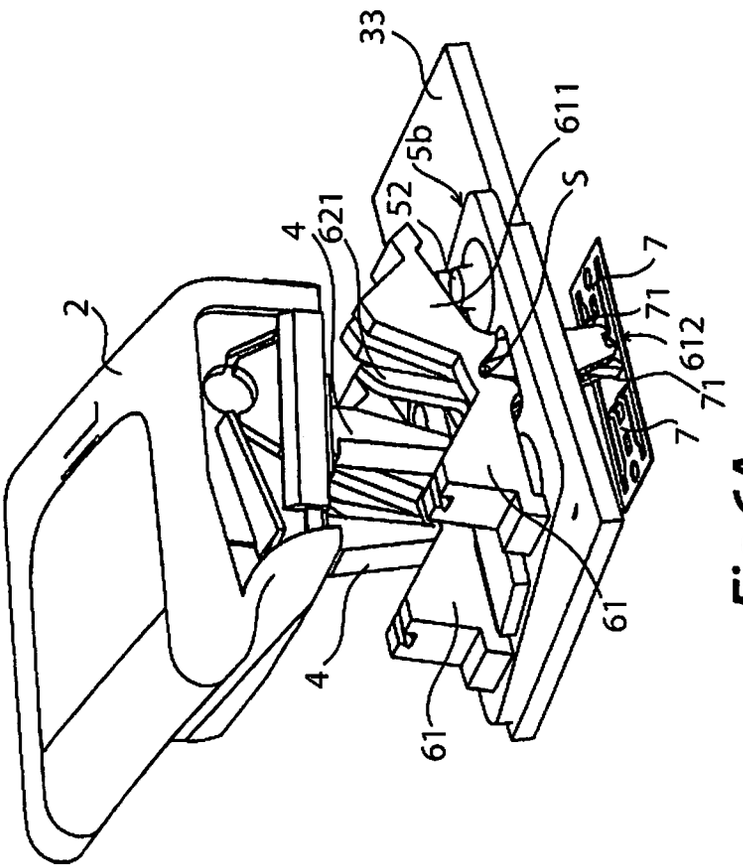
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Fig.6A

Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 12 15 7941

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 2 164 085 A1 (BITRON SPA [IT]) 17 March 2010 (2010-03-17) * column 2, line 19 - column 5, line 35; figures 1,4,5 * -----	1,4,5	INV. H01H23/20
Y	US 3 944 768 A (ARYAMANE AVINASH ET AL) 16 March 1976 (1976-03-16) * column 3, line 35 - column 6, line 52; figures 2,5-10 * -----	1,4,5	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 June 2012	Pavlov, Valeri

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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