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(54) Key-controlled electromechanical safety switch with electromagnetic controlled blocking device

(57) A key-controlled electromechanical safety switch, in particular for machines or plants, which comprises a case (2) containing pairs of electric contacts (3,3'; 4,4') operatively coupled to a shank (10) slidable along a longitudinal axis (A), cam actuation means (6) located in an end portion or head (2") of the case (2), interacting with the shank (10), at least one slot (8,8') on the head (2") of said case (2) for insertion of a control key (7) adapted to interact with the actuation means (6) to control opening and closing of the contacts (3,3';4,4'), at least one blocking electromagnet (11) acting on the shank (5) to allow safe operation of the machine or installation. The electromagnet (11) comprises a core or full armature (13), distinct and separate from the shank (10), and the cam actuation means (6) include a cam (9) with at least one seat (23) adapted to interact with the key (7) to prevent its extraction when the electromagnet (11) is not excited.

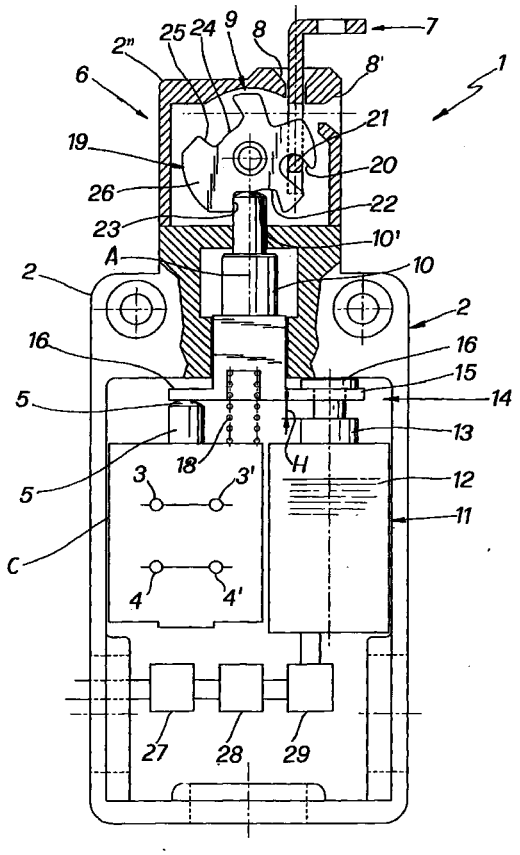

FIG. 1

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Description

Technical field

[0001] The present invention relates to a key-controlled electromechanical safety switch with an electromagnetic controlled blocking device, comprising all the features of the preamble of the main claim.

[0002] The electromagnetic safety switches of the above mentioned type are usually used on doors of cabinets or on protective barriers of machines and plants with dangerous moving parts, like saws or blades, where access time to the area interested by these parts is shorter than the stopping time of the machine or plant. Such state-of-the-art switches have inside, additionally to common commutation devices, at least one electromagnet for preventing extraction of the key for a predefined time.

[0003] When an operator must open the door or the protective barrier provided with a key inserted in the switch, he pushes a button or command for interrupting the machine power supply, thus causing the progressive deceleration of the moving parts. Appropriate sensors detect the ultimate stopping of the dangerous parts and send an electric signal exciting the electromagnet and promoting the release of the key.

[0004] Examples of key-controlled safety switches with electromagnetic blocking are illustrated in the patent documents EP-A-818490, EP-A-553885, EP-A-817227, WO-A-95/06323, WO-A-95/18457, WO-A-96/33504, DE-U-8716018, DE-A-3309372, DE-A-3710079, US-A-4904829, US-A-558829.

Background art

[0005] The safety switches of the first generation, for example represented by the utility model application DE-U-8716018 (Schmersal), are provided with cases of large dimensions, containing inside a key-controlled safety switch for checking the closing of the door by means of first electric contacts. Next to the switch, there is placed a blocking electromagnet that holds the key with protrusions of various shapes. Moreover, there are provided second electric contacts, located generally under the electromagnet, to verify if the magnet retains the key and which are connected in series with the first contacts to allow starting of the machine only if the door is closed or blocked by the electromagnet.

[0006] Such solution entails high production costs and lower flexibility, caused by the presence of four entry slots. Besides, since the electromagnet acts directly on the key, it must be powerful to prevent the extraction of the key or to free it. These performances entail rather large dimensions of the electromagnet that make a switch for some applications too cumbersome.

[0007] To overcome such drawbacks, a second generation of switches is disclosed in international patent application WO-A-95/06323, usually recognisable by means of a relatively elongated shape enclosing a series of aligned components. Between such components there is provided a device for mechanical key recognition which, under specific conditions, allows blocking of the key by means of the electromagnet armature which in turn commutes a series of electric contacts by means of a shank.

[0008] A disadvantage of this type of switch is that it doesn't provide auxiliary contacts for monitoring the insertion / extraction status of the key, and thus the open/close status of the machine door.

[0009] To overcome such drawback there has been proposed a "third generation" of switches completely similar to the former ones but with the addition of a pair of auxiliary contacts connected to the key recognition mechanism for monitoring its insertion status.

[0010] Yet, both the known switches of the second and third generations have the disadvantage of an elongated form which make [difficult] their use on doors of small dimensions rather difficult. The switches of the third generation are characterised by a hollow armature and therefore have a lower efficiency due to the lower magnetic susceptance.

[0011] In an other known type of switch, to reduce the overall dimensions of the electromagnet and maintain its actuating force, the intensity of the exciting current has been increased, however this solution can cause overheating and/or burning of the electromagnet.

[0012] To limit this disadvantage, some well-known switches of the latest generation, for example disclosed by the patent application DE-A-3710079 (Schunk), are provided with an electronic board which reduces current supply to the electromagnet, by applying a strong starting intensity for a time interval necessary for the change of status of the switch (about 1 second) and successively maintaining a reduced and/or pulsating current intensity sufficient for maintaining the electromagnet in its end position.

[0013] A drawback of this latest generation of switches is their low flexibility of use, due to the fact that they cannot be fed with both direct or alternating current and they have a reduced tolerance of the feeding tension, which involves the construction of different models for different feeding tensions.

Presentation of the invention

[0014] A primary object of the present invention is to eliminate the above disadvantages by providing a compact key-controlled safety electromechanical switch of small longitudinal dimensions with characteristics of high reliability and operative life, and with a high flexibility of use in a broad application field.

[0015] A particular object of the invention is to provide an electromechanical switch with an electromagnet able to work indifferently with a broad range of feeding tensions which are both direct and alternating.

[0016] In accordance with one preferred aspect of the

present invention, there is provided a key-controlled safety electromechanical switch, particularly for machines or plants, comprising a case containing pairs of electric contacts operatively coupled to a shank slidable along a longitudinal axis, cam actuation means located in an extremity portion or head of said cover, interacting with said shank, at least one slot on said head of said case for inserting a control key adapted to interact with said actuation means to control opening and closing of said contact, at least one block electromagnet acting on said shank to allow its actuation under safety conditions of the machine or of the installation, characterised in that said at least one electromagnet has a full core or armature, distinct and separate from said shank, and in that said cam actuation means include a cam with at least one seat adapted to interact with said key to prevent its extraction when the electromagnet is not excited.

[0017] Thanks to this particular configuration, the electromagnet has reduced dimensions compared to known similar switches though maintaining the same power, consequently the switch according to the invention has a more compact shape and reduced overall dimensions.

Brief description of the drawings

[0018] Further characteristics and advantages of the invention will become more apparent from the detailed description of some preferred but not exclusive embodiments of the electromechanical switch according to the invention, illustrated by way of non limitative example in the accompanying drawings in which:

FIG. 1 is a lateral section view of an embodiment of the switch according the invention rest position;
FIG. 2 is a view of the switch of Fig. 1 in reduced scale;
FIG. 3 is a view of the switch of Fig. 2 in a first operative phase;
FIG. 4 is a view of the switch of Fig. 1 in a second operative phase;
Figures 5 to 9 show some alternative embodiments of the switch of Fig. 1.

Detailed description of some preferred embodiments

[0019] With reference to the cited figures, there is shown a safety electromechanical switch according to the invention, generally designated by the reference numeral 1, which includes a case 2 of substantially elongated shape with a longitudinal axis A, made of a main portion 2' to which a secondary portion or head 2'' is coupled, possibly removable and orientable in angularly staggered positions of about 90° to adapt it to the different conditions of use and mounting.

[0020] In the main part of the case 2' a first pair of electric contacts 3, 3' is located in a protection box C and a second pair of contacts 4, 4' that can be selectively connected by lamellae or a similar element to commute the status of the switch.

[0021] There is provided a mobile element or slider 5 placed within the box C and sliding in a parallel direction to the longitudinal axis to connect and disconnect the contacts 3, 3', 4, 4'.

[0022] The slider 5 is connected to actuation means, globally indicated by the reference numeral 6 which will be described in greater detail hereafter. An outside key 7 acting on the slider 5 is anchored to the door of the machine or plant and is insertable in the head 2 '' through one or more reciprocally perpendicular slots 8, 8'. Possibly, the head 2 '' can be selectively pivoted around the longitudinal axis A in angularly staggered positions to arrange the slots 8, 8' in the desired positions and according to installation needs.

[0023] The actuation means 6 essentially comprise a cam 9 pivotally mounted about a substantially transversal axis T and interacting with a shank 10, mobile in a direction parallel to the longitudinal axis A. The cam 9 is in front of the slot 8, 8' and is rotatively moved by means of key 7 during its insertion in one of the above-mentioned slots. The rotative motion of cam 9 is transformed in a longitudinal motion of the shank 10 which, in turn, acts on the slider 5 to promote the opening/closing of the electric contacts.

[0024] The switch 1 is provided with at least a blocking electromagnet 11 with a winding 12 and a core or armature 13, in which the winding 12 is connected to sensor and/or external timer means not shown in the figures. Such sensor and/or timer means detect the stopping of moving parts of the machine or plants, potentially dangerous for operators, and to send to the winding of the electromagnet an exciting electric signal.

[0025] In the embodiments shown in figures 1-5, 6, 8 the switch is provided with a unique electromagnet 11 supported and interacting with the shank 5 imparting to the latter sliding movements parallel to the longitudinal axis A, so as to selectively couple the electric contacts 3, 3', 4, 4' exclusively in safety conditions of the machine.

[0026] Engaging means, globally designated with the reference numeral 14, are provided which are adapted to couple the core 13 with the shank 10 to impart to the latter a first translation S1 in a longitudinal direction for the opening/closing of the first pair of electric contacts 3, 3'.

[0027] Such engaging means 14 can be made of a first extension 15 extending from a lower extremity of the shank 10, laterally to the longitudinal axis A. Extension 15 is shaped like a fork or similar and is adapted to hook a tang or hooking extremity 16, having an expanded head, of core 13 with a clearance H in a parallel direction to the axis A so as to impart a first translation S1 to the shank in a parallel direction to the longitudinal axis A for the opening /closing of the first pair of contacts 3, 3'.

[0028] On the other side, with respect to axis A, of extension 15 there is provided a second extension 17 in contact with the free extremity 5' of slider 5. Between the body 14 and the group of contacts there is interposed a compression spring 18 which maintains the shank 10 normally in its raised position.

[0029] According to the invention, the core or armature 13 of electromagnet 11 is full, distinct and separate from shank 10. Moreover, the actuation cam 9 has at least one blocking shoulder adapted to prevent extraction of the key.

[0030] Thanks to this configuration, it is possible to reduce the dimension of the electromagnet by maintaining equal power, compared to those with hollow core of the prior art, and additionally it is possible to monitor the commutation status of the switch.

[0031] More particularly, the cam 9 has a peripheral profile 19 with a first peripheral cavity 20 for the insertion extremity 21 of key 7 and an second cavity 22 with a stop shoulder 23 for the free extremity 10' of the shank 10, to prevent extraction of the key 7 when the free extremity 10' of the shank 10 is located in the second cavity 22.

[0032] The cam profile 19 has moreover a third similar cavity 24, staggered of about 90° with respect to the second one 22 and with a stop shoulder 25 interacting with the key 7 when it is inserted through the other slot 8'. So, it will be possible to install the switch in different positions, indifferently on machines with right or left doors, thus remarkably broadening the application field of the switch.

[0033] Finally, the profile 19 has a radial protrusion 26 interacting with the shank extremity 10' for imparting a second translation S2 of predefined amplitude to the latter and then to the slider 5 to produce opening /closing of the second pair of contacts 4, 4'.

[0034] During use, when the key is inserted in the slot 8 of the head 2", the magnet 11 is not excited and the stop shoulder 23 interferes with the extremity of the shank 10, preventing rotation of the cam 9 and consequently extraction of the key 7, as shown in figures 1 and 2.

[0035] In the first operative phase, shown in Fig. 3, the magnet 11 is excited and moves the shank 10 toward the lower side with a first travel amplitude S1 and pushing in turn slider 5 toward the lower side, so as to open the first pair of contacts 3, 3'. At this stage, the shank extremity 10' doesn't interfere anymore with the cam stop shoulder 23 and the cam can freely turn under the effect of the extraction of key 7.

[0036] In the second operative phase, shown in Fig. 4, the key has been completely extracted, thus promoting a complete rotation of cam 9 which imparts to shank 10 a second travel of amplitude S 2 with its radial protrusion 26. So as to promote the aperture of the second pair of contacts 4, 4'. It is remarked that the travel S2 must not be greater than the coupling clearance H between the extremity of the core 13 and the extension 15 of the shank.

[0037] In a further aspect of the invention, the electromagnet is fed by electronic regulation means adapted to regulate the electric supply to optimise working conditions avoiding overheating and/or burning.

[0038] More precisely, such electronic regulation means can include a first rectifier stage 27 allowing supply of the switch indifferently with alternating or direct current.

[0039] Such means include additionally a second voltage regulator stage 28 that levels the tension on substantially constant predefined values.

[0040] Finally there can be provided a third current shutter stage 29, adapted to supply the electromagnet with a starting current sufficient to impart the first displacement S1 to the shank 10 and, subsequently, a substantially constant maintaining current, of lower intensity than the former one, but sufficient to keep the shank 10 in the reached position for the requested time without any risk of overheating or burning.

[0041] Thus, the electromagnet can have much lower dimensions, compared to those of similar known switches. Consequently the switch according the invention is more compact and has rather low production costs.

[0042] Figures 5 to 9 show schematically some alternative embodiments of the switch according to the invention different from those shown in figures 1 to 4 substantially for the number of electromagnets and/or for their arrangement in relation to the shank.

[0043] From what has been said above, it is clear that the switch according the invention reaches fully the aims set and it is particularly underlined its compact shape, flexibility of use and broad application field.

[0044] The instant application is based upon and claims priority of Italian patent application No. VI98A000141, filed on 27.07.1998, the disclosure of which is hereby expressly incorporated herein by reference thereto.

Claims

1. Key-controlled safety electromechanical switch, particularly for machines or plants, comprising a case (2) containing pairs of electric contacts (3,3'; 4,4') operatively coupled to a shank (10) slidable along a longitudinal axis (A), cam actuation means (6) located in an extremity portion or head (2") of said case (2), interacting with said shank (10), at least one slot (8,8') on said head (2") of said case (2) for inserting a control key (7) adapted to interact with said actuation means (6) to control opening and closing of said contacts (3,3';4,4'), at least one blocking electromagnet (11) acting on said shank (10) to allow its actuation in safety conditions of the machine or of the installation, characterised in that said at least one electromagnet (11) has a full core or armature (13), distinct and separate from said

shank (10), and in that said cam actuation means (6) include a cam (9) with at least one seat (23,25) adapted to interact with said key (7) to prevent its extraction when the electromagnet (11) is not excited.

2. Electromechanical switch according to claim 1, characterised in that the core (13) of said electromagnet (11) has engagement means (14) interactive with said shank (10) to impart to the same a first translation (S1) in longitudinal direction for opening/closing a first pair of contacts (3, 3'), and a radial protrusion (26) of said cam (9) interacting with an extremity (10') of said shank (10) to impart to the latter a second translation (S2) in the same direction for opening/closing a second pair of contacts (4,4').

3. Electromechanical switch according to claim 2, characterised in that said engagement means (14) include a lateral extension (15) made at an extremity of said shank (10) and coupled to a free extremity of said core (13).

4. Electromechanical switch according to claim 3, characterised in that the coupling between said extension (15) and the extremity of said core (13) has a longitudinal clearance (H) of predefined amplitude at least equal to said second longitudinal translation (S2).

5. Electromechanical switch according to claim 2, characterised in that the peripheral profile (19) of said cam (9) has at least a first peripheral cavity (20) for the insertion extremity (21) of said key (7) and at least a second cavity (22,24) defining said stop shoulder (23,25) for the contact extremity (10') of said shank (10) adapted to prevent the extraction of the key (7) when said contact extremity (10') is placed in said second cavity (22).

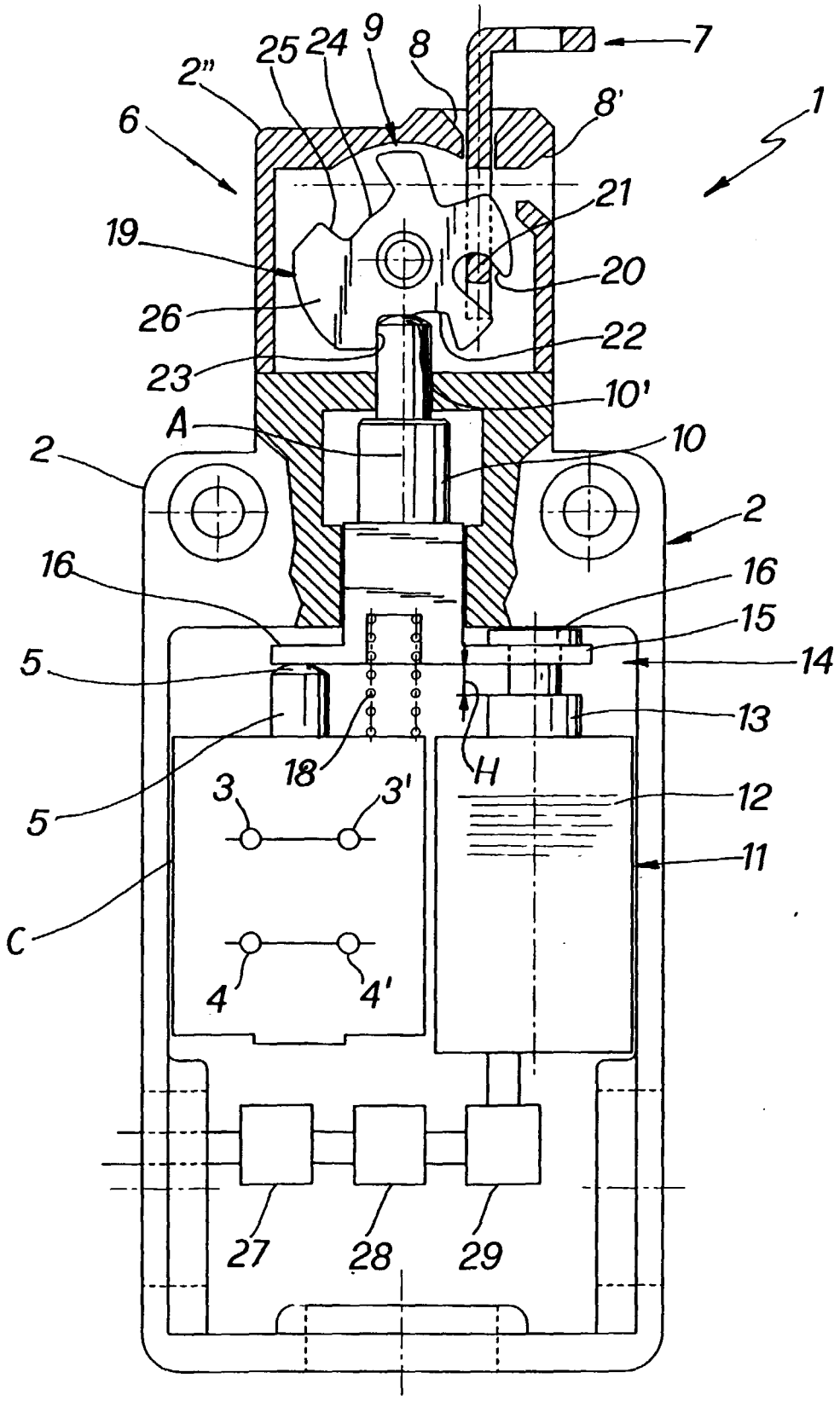
6. Electromechanical switch according to claim 3, characterised by the fact of providing a slider (5) operatively connected to said shank (10) and interacting with a first (3,3') and a second pair (4,4') of contacts to promote their selective coupling in correspondence with said first (S1) and said second (S2) translation.

7. Electromechanical switch according to claim 6, characterised in that said shank (10) has a second lateral extension (17) opposite to the first one (15) facing and interactive with a free extremity (5') of said slider (5) to promote its translation parallel to said longitudinal axis (A).

8. Electromechanical switch according to any one or more of the previous claims, characterised by the fact of providing sensitive electronics regulation means connected to said electromagnet (10) adapted to adapt automatically the feeding tension and/or current of the electromagnet (11).

9. Electromechanical switch according to claim 8, characterised in that said sensitive electronic regulation means include a first current rectifier stage (27) and a third current shutter stage (29).

10. Electromechanical switch according to claim 9, characterised in that said sensitive electronic regulation means include a second current regulating stage (28) to keep [substantially unchanged] the tension and/or the feeding current of the electromagnet (11) substantially unchanged independently from the applied entry tension of the switch.


2"
25
24
9
8
7
8'
1
6
21
19
20
26
22
23
10'
A
10
2
2
16
16
15
14
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13
18
H
3
3'
12
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C
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29

FIG. 1

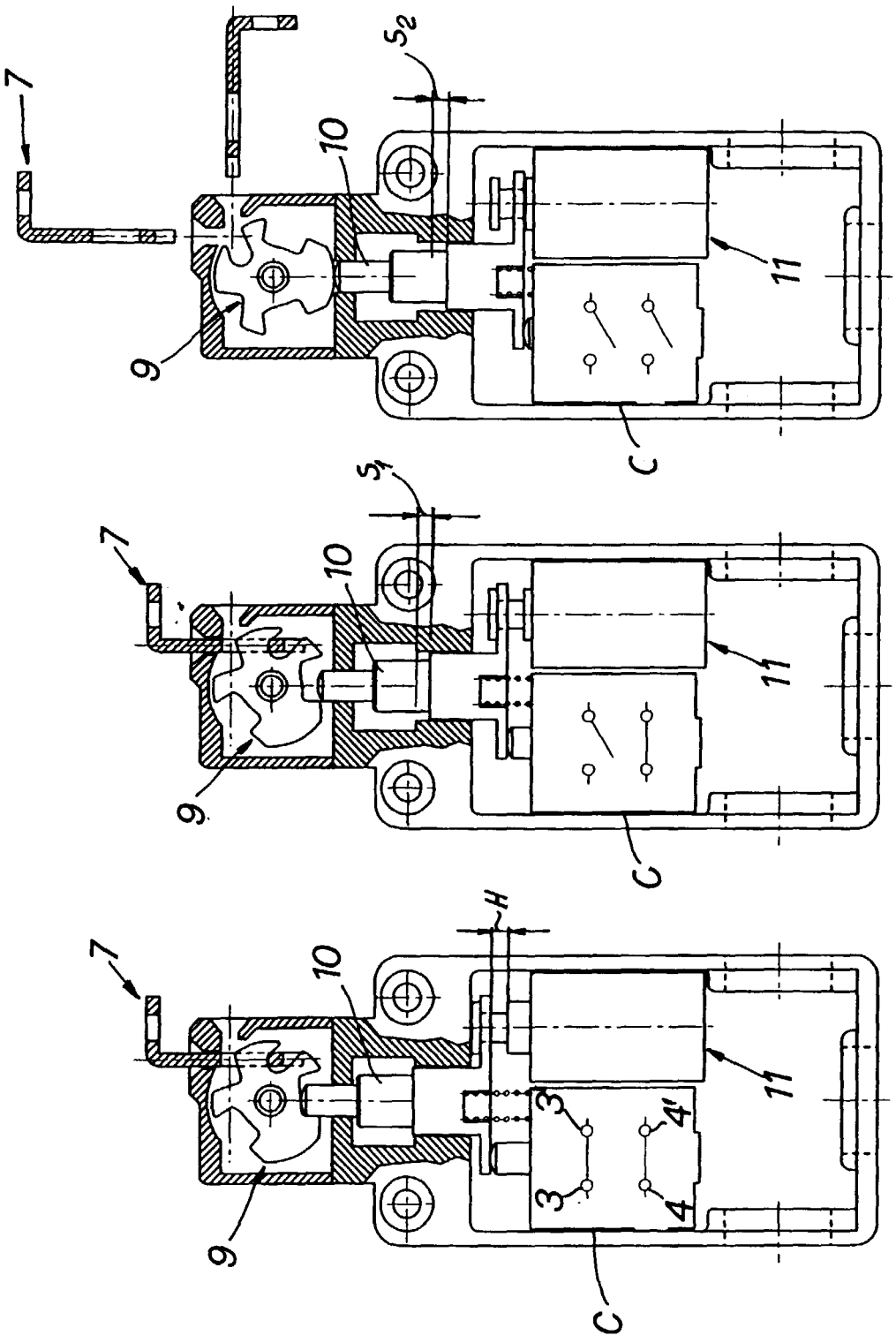

FIG. 4

FIG. 3

FIG. 2

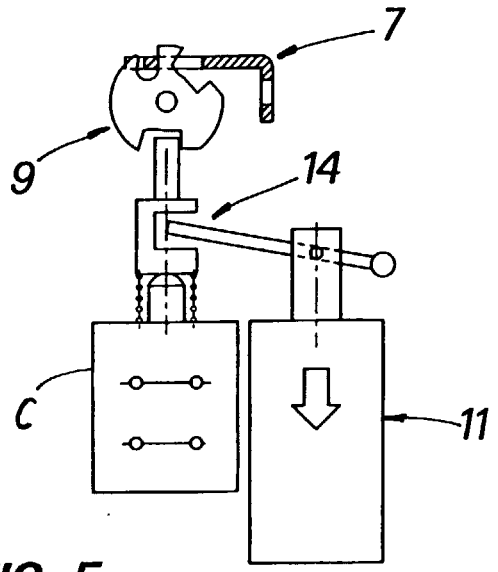

FIG. 5

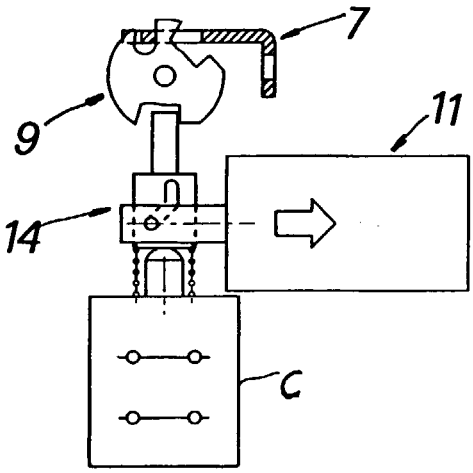

FIG. 6

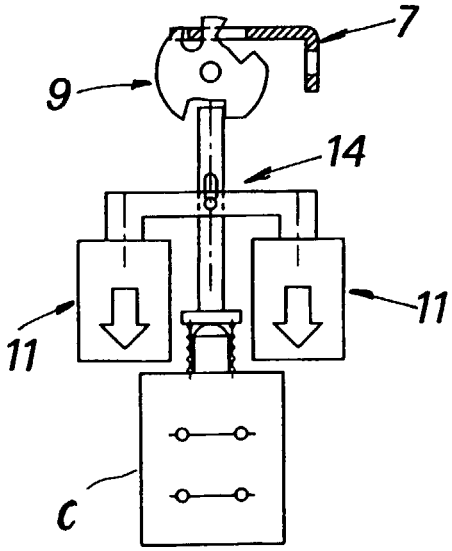

FIG. 7

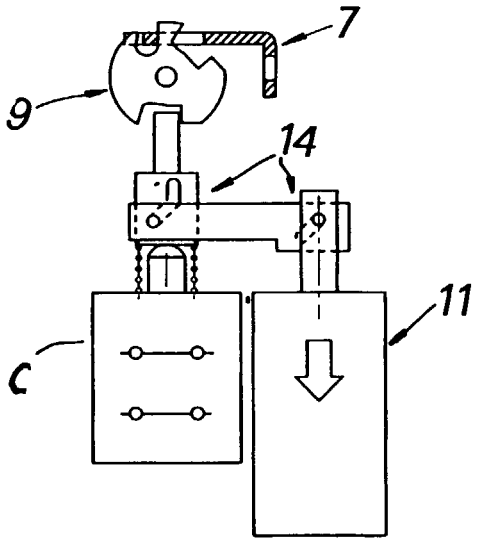

FIG. 8

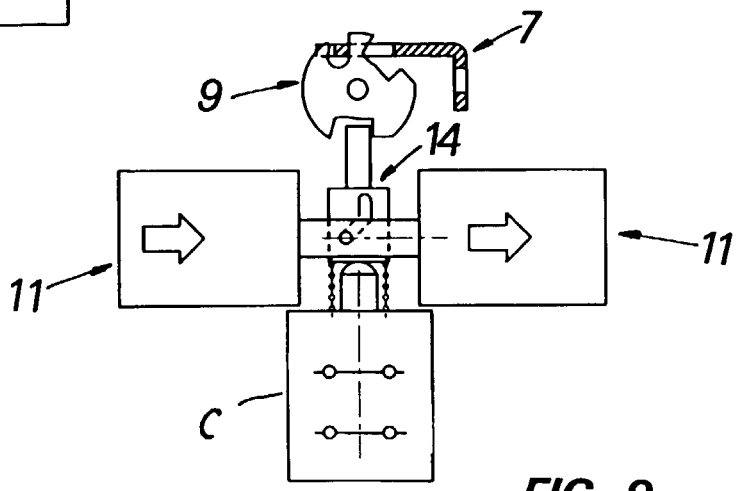

FIG. 9