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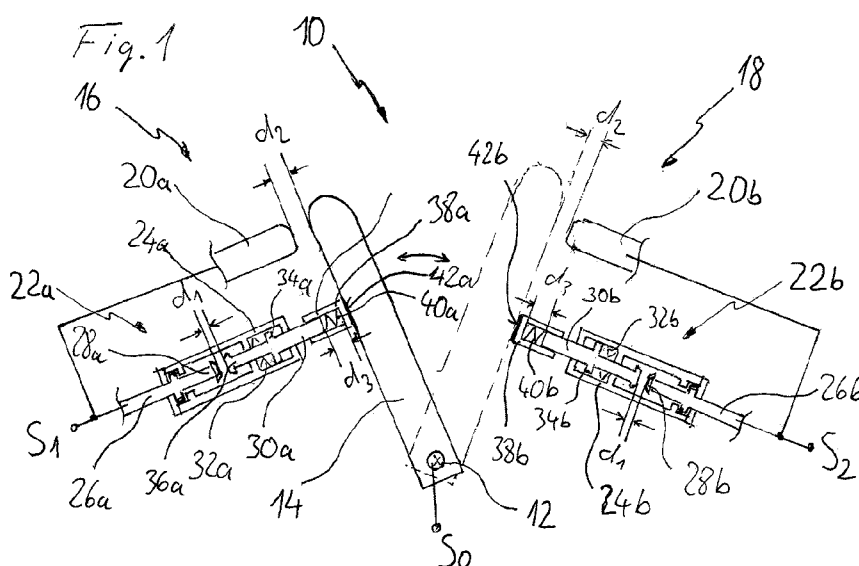
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(54) Title: SWITCH



(57) Abstract: The invention relates to a switch (10) with two stationary switch contacts (16, 18) and a switching component (14) for switching between the two stationary switch contacts, in which switch at least one stationary switch contact is formed by a fixed contact (20a, b) and a vacuum switch (22a, b) with an actuating contact (42a, b). For this purpose, the actuating contact is arranged relative to the fixed contact and to the switching component such that the switching component first contacts the actuating contact and only after that the fixed contact and such that the switching component only contacts the fixed contact after it has pushed the vacuum switch into its contact position by means of the actuating contact. In this way, gas-free switching of high currents is possible.

SWITCH

5 The invention relates to a switch with at least two stationary switch contacts and a switching component switching between the two stationary switch contacts. The switching component performs either a translatory motion or a rotary motion for the purpose of contacting. When such switches are used in high voltage applications, in particular in the area of energy supply, for instance in connection with power transformers, capacitive coupling can lead to discharges in the surrounding oil when switching under load. For this reason,
10 switches are used that have a vacuum switch as switching component. Such a switch is disclosed in DE 10 2009 025 358, for instance. Although the switch arrangement shown there functions reliably, it has the disadvantage that the construction of the switch component with a vacuum switch is relatively complex and elaborate.

15 The object of the invention is therefore to create a switch that switches in a gas-free manner, in particular in high voltage applications.

The object is fulfilled by a switch having the features of claim 1.

In the switch according to the invention, at least one stationary switch contact is formed by a fixed contact and a vacuum switch, which are electrically connected with each other. The vacuum switch has an actuating contact, which is actuated by the switching component,
20 and, on being actuated, the vacuum switch is switched from an open position into a contact position. The actuating contact is upstream of the fixed contact in the direction of motion of the switching component so that the switching component contacts the actuating contact first and only afterwards contacts the fixed contact. The actuating contact is arranged at such a distance before the fixed contact that the switching component does
25 not contact the fixed contact until the switching component has pushed the vacuum switch into its contact position by means of the actuating contact. In this manner it is achieved, on the one hand, that the switching component touches the actuating contact first in the beginning of the contacting process, then closes the switch in the vacuum switch by the actuating contact, which closing is performed in a gas-free manner due to the vacuum
30 prevailing in the vacuum switch so that gases are effectively prevented from developing in the transformer oil. Only after closing the vacuum switch does the switching component contact the fixed contact so that the running current flow primarily runs via the fixed contact (possibly with lower resistance) and to a lesser extent via the vacuum switch. In this

way it is possible to scale the vacuum switch to smaller dimensions. The arrangement of all components of the switch enables the vacuum switch itself to be stationarily disposed, and it does not have to be moved together with the switching component.

The procedure described above in the context of producing a contact also works vice versa for disconnecting the contact. For this purpose, the switching component moves away from the fixed contact with the vacuum switch remaining closed for a transitional period, and only after the switching component has disconnected from the fixed contact does the vacuum switch open, again without high-current discharge and thus without gas being released into the surrounding atmosphere or into the surrounding oil bath in the instance of the switch being arranged in oil. Both closing the contact and disconnecting the contact is thus performed in a gas-free manner by means of the switch according to the invention.

Preferably, a spring component is arranged between the actuating contact of the vacuum switch and a support for the vacuum switch. After closing the vacuum switch, the switching component can in this way continue to move in the direction toward the fixed contact with the spring component being correspondingly deflected. Thus, the spring component allows the intended switching sequence to be performed in a simple manner, according to which sequence the contact of the vacuum switch is closed first and only then the fixed contact is contacted when closing a contact, and when disconnecting a contact, the fixed contact is disconnected first and only then the contact in the vacuum switch is opened.

It can principally be sufficient for an intended switching purpose that only one of the two stationary switch contacts is formed in the above-described manner with a fixed contact and a vacuum switch. Preferably, however, both stationary fixed contacts are constructed in this way, in which instance it is possible to use the switch as a preselector in a tap changer of a regulating transformer, for example. Both stationary switch contacts are then preferably identically formed.

Furthermore, it is possible that multiple stationary switch contacts, for instance two to ten switch contacts, are arranged on a circular path and that the switching component is rotatably hinged in the center of the circular path. In this instance, the switch can also be used for a load selector.

The vacuum switch is preferably preloaded into an open position by means of a preferably integrated preloading device. The vacuum switch is thus pushed from its open position into its contact position in an advantageous way only after pressure impingement on the actuating contact by means of the switching component. In this manner, the above-

described switching sequence can be easily performed. In the instance of a spring component being arranged between the actuating contact and a support for the vacuum switch, the spring constant of the spring component is preferably greater than the spring constant of the preloading device. When the actuating contact is impinged with pressure by the switching component, the vacuum switch is thus first switched from its open position into its contact position and only then is the spring component deflected until the switching component touches the fixed contact. After closing the vacuum switch, it is finally necessary that the switching component can continue to deflect in the direction toward the fixed contact. This is realized by the spring component. To this effect, the spring component can also be formed by a coil spring, by an elastic material, or by arrangements as they are in principle known, for instance telescopic arrangements.

The switching direction of the vacuum switch preferably runs in the direction of motion of the switch contact with reference to the point of time when the switching component touches the actuating contact of the vacuum switch. In this way, it is achieved that the switching component pushes from above in an axial direction onto the vacuum switch, thus enabling easy switching from the open position into the contact position of the vacuum switch.

The switching component preferably is an electric conductor, for instance a copper switch lever. Such a switching component has a low resistance and is capable of conducting high currents.

The switching component is movable between the two stationary switch contacts, for instance in a translatory manner. Preferably, the switching component can be pivoted back and forth about a swivel axis or an axis of rotation between two switching positions, in which the switching component contacts respectively one of the two stationary switch contacts. The switching movement can be reliably and simply realized in this way.

The fixed contact and the vacuum switch of each stationary switch contact are preferably arranged in parallel to each other and thus jointly connected with an electric switching point.

In the following passages, the invention will be exemplarily described by way of the schematic drawing. This shows a lateral view of a switch with a pivotable switching component and two stationary switch contacts, which are each formed by a fixed contact and a vacuum switch.

The switch 10 comprises a switching component 14, which is pivotable about a swivel axis 12, and which is, in particular, a copper switch lever. Although not illustrated here, the switching component 14 itself is contacted with an electrical tap in the area of the swivel axis 12. By a mechanism, which is not illustrated, the switching component is movable or actuatable between the presented first switching position and a second switching position shown in a dotted outline.

The switch 10 has two preferably identically constructed stationary switch contacts 16, 18, which are each formed by a fixed contact 20a,b and a vacuum switch 22a,b. All components of the first stationary switch contact 16 on the left side are designated by the notation a, whereas all components of the second stationary switch contact 18 arranged on the right side are designated by the notation b.

The fixed contact 20a and the vacuum switch 22a of the first stationary contact 16 are electrically connected with a first switching point S_1 , while the fixed contact 20b and the vacuum switch 22b of the second stationary contact 18 are electrically connected with a second switching point S_2 . The switching component 14 is electrically connected with a tap S_0 . The motion of the switching component 14 about the swivel axis 12 thus causes either the first switching point S_1 or the second switching point S_2 to become electrically connected with the tap S_0 of the switching component 14.

The vacuum switch 22a,b of each stationary switch contact 16, 18 is structured as follows. The vacuum switch 22a,b is formed as a vacuum tube with a cylindrical housing 24a,b, which is held in a support 26a,b formed as a first power feed. The support 26a is insulated against the housing 24a and leads to a first contact 28a of the vacuum switch. Formed as a cylindrical push rod, a second power feed 30a,b is held in the housing 24a so as to be axially shiftable against the force of a preloading device 32a in the form of a coil spring. The coil spring 32a acts against a ring flange 34a of the second power feed 30a. Both power feeds 26a,b, 30a,b are formed from a conductive material. At the end of the push rod 30a,b the second contact 36a,b of the vacuum switch 22a,b is formed within the housing 24a,b. Arranged on the end of the push rod 30a,b facing toward the free switching component is a cylinder 38a,b, which is preloaded against the free end of the push rod 30a in a telescopic manner via a spring component 40a,b. The face side of the cylinder 38a forms the actuating contact 42a,b of the vacuum switch 22a,b. The spring constant of the spring component 40a,b is greater than that of the coil spring 32a,b so that the coil spring 32a is compressed first in the process of the switching component 14 being pushed onto the actuating contact 42a,b.

At the point of time when the switching component contacts the actuating contact 42a,b, said actuating contact 42a,b is arranged upstream at a distance d_2 from the fixed contact 20a,b in the direction of motion of the switching component 14. This distance, in turn, is greater than the switch travel d_1 of the vacuum switch. After contacting the actuating contact 42a,b, the switching component 14 thus first compresses the contacts 28a,b, 36a,b of the vacuum switch 22a,b, and in the process, the switching component continues to move toward the fixed contact 20a,b by the switch travel d_1 of the vacuum switch. When the switching component 14 has pushed the vacuum switch 22a,b into contact position and continues the motion toward the fixed contact 20a,b, the switching component 14 thus compresses the spring component 40a by an actuating travel $d_2 - d_1$, until the switching component 14 touches the fixed contact 20a,b. The permissible spring travel d_3 of the spring component 40a,b thus has to be greater than the actuating travel $d_2 - d_1$. By the switch according to the invention it is achieved that, in the process of closing the contact, the vacuum switch will be closed first, in a gas-free manner, and only after the vacuum switch has been closed is the fixed contact contacted, also in a gas-free manner, because the vacuum tube connected in parallel is already connected with the switch component.

During opening, the above-described process is carried out in the opposite sequence, with the switching component first lifting off from the fixed contact 20a,b until the spring component 40a,b is completely relaxed or the cylinder 38a,b has reached a stop (after the actuating travel $d_2 - d_1$). Only then will the coil spring 32a in the vacuum switch 22a,b become relaxed, thus disconnecting the two contacts 26a,b, 36a,b of the vacuum switch 22a,b from each other into the open position of the vacuum switch 22a,b. Both closing the contact and disconnecting the contact is always realized via the vacuum switch first, and therefore in either case in a gas-free manner.

The switch 10 is preferably used as preselector. In this instance, the preselector can take the form of a change-over selector or a coarse tap selector. The change-over selector then connects the main winding with one of the two ends of the regulating winding of a regulating transformer. The coarse tap selector connects the regulating winding, or rather one of the both ends of the regulating winding, with one end of the main winding or with a tap of the main winding. The coarse tap selector allows connecting a relatively large section of the main winding.

The invention is not limited to the above-described exemplary embodiments, but can rather be varied within the scope of the following claims.

CLAIMS

1. A switch (10) with at least two stationary switch contacts (16, 18) and a switching component (14), which is movable between the two stationary switch contacts,
5 – in which switch at least one stationary switch contact is formed by a fixed contact (20a,b) and, connected in parallel therewith, a vacuum switch (22a,b) with an actuating contact (42a,b),
wherein
– the actuating contact is arranged at such a distance (d_2) upstream of the fixed contact in the direction of motion of the switching component that the switching component only contacts the fixed contact after it has switched the vacuum switch into its contact position by means of the actuating contact.
10
2. Switch (10) according to claim 1, wherein a spring component (40a,b) is arranged between the actuating contact (42a,b) of the vacuum switch (22a,b) and a support (26a,b)
15 for the vacuum switch.
3. Switch (10) according to claim 2, wherein the spring component (40a,b) is arranged between the actuating contact (42a,b) and the vacuum switch (22a,b).
4. Switch (10) according to one of the previous claims, wherein each of the two stationary switch contacts (16, 18) is formed by a fixed contact (20a,b) and a vacuum switch
20 (22a,b).
5. Switch (10) according to one of the previous claims, wherein the vacuum switch (22a,b) is preloaded into its open position by a preloading device (32a,b, 34a,b).
6. Switch (10) according to claim 2 or 3 and 5, characterized in that the spring constant of the spring component (40a,b) is greater than the spring constant of the preloading device (32a,b, 34a,b).
25
7. Switch (10) according to one of the previous claims, wherein the switching direction of the vacuum switch (22a,b) runs in parallel to the direction of motion of the switching component (14) when it touches the actuating contact.
8. Switch (10) according to one of the previous claims, wherein the switching component (14) is pivotable between the two stationary switch contacts (16, 18) about a swivel axis (12).
30

9. Switch (10) according to one of the previous claims, constructed as a preselector in a regulating transformer, in particular as a change-over selector or a coarse step selector.

10. Regulating transformer with a tap changer, consisting of

(a) a preselector and

5 (b) a fine selector and load diverter switch or a load selector,

wherein

– the preselector is a switch (10) according to one of the previous claims,

– the switching component (14) of the switch (10) is connected with a main winding of the regulating transformer, and

10 – the two stationary switch contacts (16, 18) of the switch (10) are connected with the two ends of a regulating winding of the regulating transformer.

11. Regulating transformer with a tap changer, consisting of

(a) a preselector and

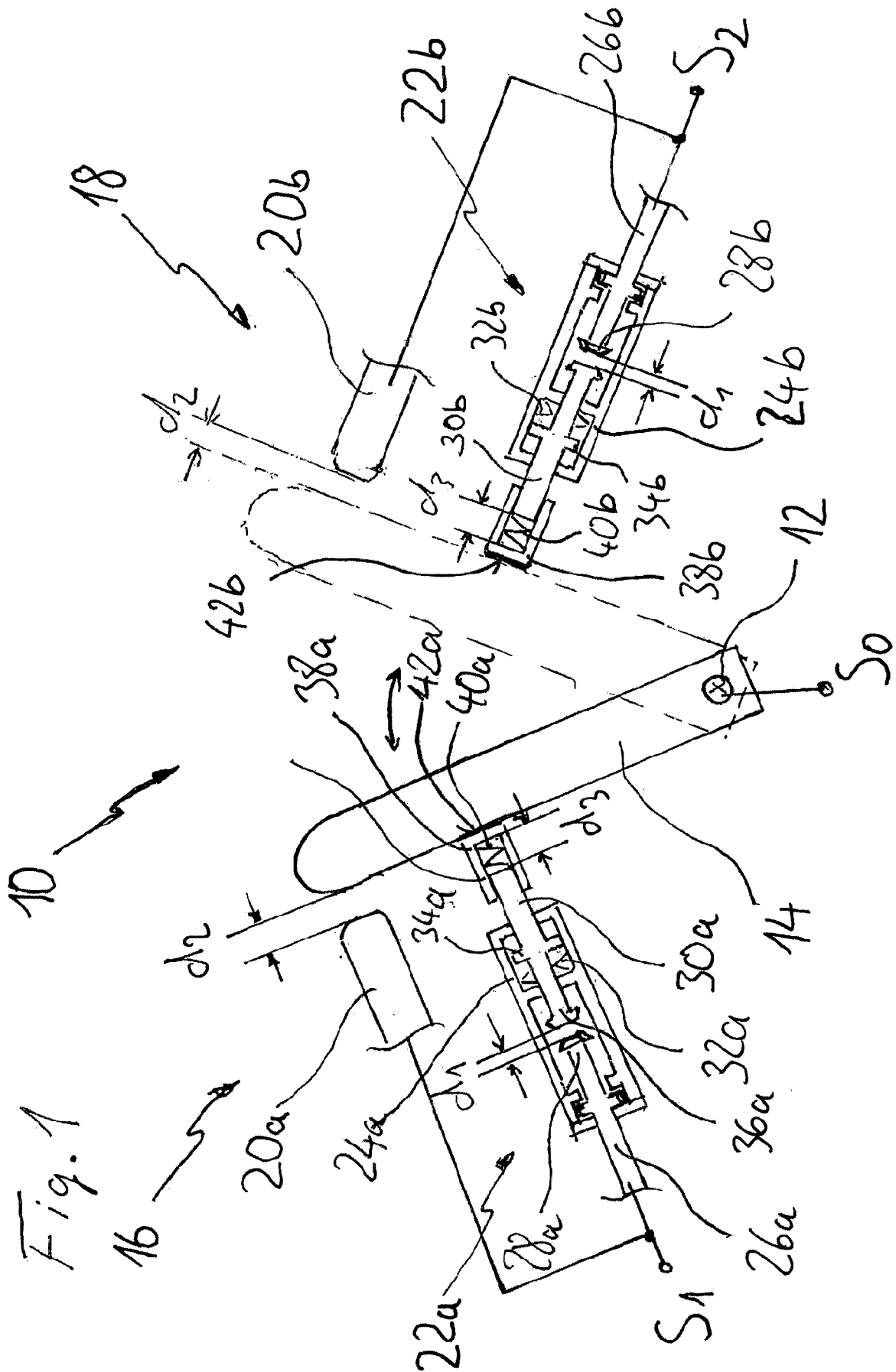
(b) a fine selector and load diverter switch or a load selector,

15 wherein

– the preselector is a switch (10) according to one of the previous claims,

– the switching component (14) of the switch (10) is connected with one of the two ends of a regulating winding of the regulating transformer, and

20 – the two stationary switch contacts (16, 18) of the switch (10) are connected with one end of the main winding or with a tap at the main winding of the regulating transformer.



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2014/070638

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01H9/00 H01H33/666
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 102 709 106 A (SHANGHAI HUAMING ELECTRICAL EQUIPMENT GROUP CO LTD; HUAMING POWER EQUI) 3 October 2012 (2012-10-03) the whole document	1-11
A	WO 2013/053510 A1 (REINHAUSEN MASCHF SCHEUBECK [DE]; BISGES MICHAEL [DE]) 18 April 2013 (2013-04-18) page 2, line 43 - page 4, line 13; figures 1-4	1



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 102709106 A	03-10-2012	CN 102709106 A	03-10-2012
		DE 112012003991 T5	28-08-2014
		US 2013306601 A1	21-11-2013
		WO 2013170405 A1	21-11-2013

WO 2013053510 A1	18-04-2013	DE 102011116158 A1	18-04-2013
		WO 2013053510 A1	18-04-2013
