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(54) **SWITCH**

(57) A switch is provided with a snap-action mechanism (10) which brings a movable contact (7) into contact with fixed contacts (5) and (6) and separates the contact (7) from the contacts (5) and (6) through snapping actions. Each contact is formed of a contact material containing 2.0-5.0 wt.% of tin, 5.0-8.0 wt.% of indium, and less than 0.5 wt.% of an iron family metal, and the balance silver.

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Description

Technical Field

5 The present invention relates to a switch such as a micro switch or a limit switch.

Background Art

10 Conventionally, AgCdO based alloy has been widely used as a material for an electrical contact for power application used in this type of switch, in view of superior welding resistance and ablation resistance and inexpensiveness of the alloy.

However, AgCdO based alloy contains cadmium (Cd) which is a hazardous component. Accordingly, Ag-SnO based alloy not containing the hazardous component, such as Ag-Sn-In disclosed in United States Patent No. 4,243,413, for example, has been attracting attention as the material of the electrical contact.

15 Recently, use of AgCdO based alloy containing cadmium (Cd) which is hazardous to human tends to be restricted, while Ag-SnO based alloy is preferred as it does not contain any component hazardous to human body.

Ag-Sn-O based alloy is disadvantageous, however, since thin oxide (SnO₂) which is electrically insulative goes free and is deposited on a surface of the contact when an arc is generated as the contact is opened/closed, resulting in increased contact resistance value and hence abnormal heat built up. As a result, the contact is welded or ablated, and therefore it is inferior to AgCdO based alloy in welding resistance, ablation resistance and in cost.

20 The present invention was made in view of the above described problem and its object is to provide a switch having superior welding resistance and ablation resistance as well as high contact reliability.

Disclosure of the Invention

25 The switch in accordance with the present invention for making contact and separation between a movable contact and a fixed contact in a snap action. Each contact is formed of a material prepared by inner oxidation of an alloy having the composition of 2.0 to 5.0 wt% of tin, 5.0 to 8.0 wt% of indium, at most 0.5 wt% of iron family metal and remaining part of silver. According to the present invention, 2.0 to 5.0 wt% of tin, which improves welding resistance and 5.0 to 8.0 wt% of indium, which improves ablation resistance, are mixed, whereby welding resistance and ablation resistance of the contact material itself can further be improved.

When this material for the contact is used, the aforementioned thin oxide (SnO₂) which is an insulating oxide goes free and is deposited on the surface of the contact as an arc is generated upon opening/closing of the contact, increasing contact resistance value. However, the oxide which is deposited on the contact surfaces of the movable and fixed contacts is removed from the contact surfaces by rolling or wiping operation of the movable contact associated with the snap action. Further, the movable contact is brought into contact with the fixed contact at a high speed almost independent from the speed of operation of the switch by the snap action, and therefore the above described deposited oxide can be scattered and removed from the surfaces of the contact by the shock wave at the time of contact.

35 Accordingly, the contact surfaces of the movable and fixed contacts are always kept clean, so that the contact resistance value of the contacts is kept stable at a low value, whereby abnormal heat build up is prevented, and welding resistance and ablation resistance can be improved.

Further, the movable contact is opened and separated at high speed from the fixed contact. Therefore, it is possible to further improve ablation resistance by quickly cutting arc generated at the time of separation, whereby a switch having high contact reliability is provided.

45 Preferably, the switch is a micro switch.

More preferably, the switch is a limit switch.

By applying the switch to a micro switch or a limit switch, a micro switch or a limit switch having superior welding resistance and ablation resistance as well as high contact resistance can be provided.

Preferably, the weight ratio of tin and indium is 1 tin to about 2 indium.

50 More preferably, the weight ratio of tin and indium is about 3.2 tin to about 6.3 indium.

Since tin having superior welding resistance and indium having superior ablation resistance are mixed to an optimal ratio, a switch having superior performance and high reliability is provided.

Brief Description of the Drawings

55 Fig. 1 is a cross section showing an example of the switch in accordance with the present invention applied to a micro switch.

Fig. 2 shows temperature increase characteristics of the switch shown in Fig. 1.

Best Mode for Carrying out the Invention

The present invention will be described in greater detail with reference to appended figures.

Referring to Fig. 1, in a switch case 1 constituting micro switch M, a common fixed terminal piece 2, a normally-open fixed terminal piece 3 and a normally-closed fixed terminal piece 4 are fixed, and a normally-open fixed contact 5 and a normally-closed fixed contact 6 are fixed opposing to each other at inner end portions of fixed terminal pieces 3 and 4.

A movable contact 7 which is brought into contact and separated from the normally-open and normally-closed fixed contacts 5 and 6 is fixed on a tip end portion 8a of movable contact piece 8, and a pressing body 9 is arranged at a base end portion 8b of movable contact piece 8.

Movable contact piece 8 includes a contact mechanism 10 for providing the snap action. The contact mechanism 10 includes, for example, a compression spring 11 arranged between a bent portion at an inner end 2a of common fixed terminal piece 2 and the tip end portion 8a of movable contact piece 8, and a receiving member 12 having its tip end portion 12a rotatably engaged with an inner end portion 2b of common fixed terminal piece 2. A base end portion 12b of the receiving member 12 held by engaging portion 13 is provided opposing to base end portion 8b of movable contact piece 8.

In the above described structure, when pressing body 9 is pressed and movable contact piece 8 is pressed down against compression spring 11, movable contact piece 8 rotates about engaging portion 13 through receiving member 12. When this rotation exceeds a limit value, the movable contact piece 8 is rotated in reverse direction by the reaction force of compression spring 11. As a result, state of contact of movable contact 7 is switched by the snap action, from the normally-closed fixed contact 6 to normally-open fixed contact 5.

When pressing force on the pressing body 9 is released, the state of contact of movable contact 7 is switched by the snap action from the normally-open fixed contact 5 to normally-closed fixed contact 6, and returns to the state shown in the figure.

As materials of contacts 5, 6 and 7, three different samples A, B and C having different compositions and different composition content ratios are adopted as samples for examination. In Table 1, composition content ratio represents percentage by weight.

Table 1

Sample	Ag	Sn	In	Ni
A	Remaining Part	5.1	3.1	0.2
B	Remaining Part	3.2	6.3	0.2
C	Remaining Part	0.5	9.5	-

Referring to Table 1, the samples are as follows. Sample A has, as alloy composition before internal oxidation, Sn: 5.1 wt%, In: 3.1 wt%, Ni: 0.2 wt% and remaining part of Ag.

Sample B contains Sn: 3.2 wt%, In: 6.3 wt%, Ni: 0.2 wt% and remaining part of Ag.

Further, sample C contains Sn: 0.5 wt%, In: 9.5 wt% and remaining part of Ag.

Results of temperature measurement when temperature increase test and ramp load test were performed on the micro switch shown in Fig. 1 in which respective contacts 5, 6 and 7 having the above described compositions were switched by the snap action.

(1) Temperature increase test

Test condition:

opening/closing operation is repeated 50 times with power conduction of AC250V-20A (power factor $\cos\Phi=0.75$). Thereafter, opening/closing operation is repeated 6,000 times with power conduction of AC250V-16A ($\cos\Phi=0.75$).

① After repeating opening/closing operation under the above described test condition, temperatures of terminals 2, 3 and 4 are measured with power conduction of 16A.

② After repeating opening/closing operation under the above described test condition, withstanding voltage of the switch (1000V, 1 min) is inspected.

(2) Ramp load test

Test condition:

opening/closing operation is repeated 50 times with power conduction to ramp load of AC125V-7.5A. Thereafter, opening/closing operation is repeated 25,000 times with power conduction to ramp load of AC125V-5.0A.

① After repeating opening/closing operation under the above described test condition, temperatures of terminals 2, 3 and 4 are measured with power conduction of 5A.

② After repeating opening/closing operation under the above described test condition, withstanding voltage of the switch (1000V, 1 min) is inspected.

Test result:

The results of temperature increase test on the micro switch shown in Fig. 1 are as shown in Table 2.

Table 2

Sample A					
Sample No.	COM Terminal (°C)	NO Terminal (°C)	NC Terminal (°C)	Contact Resistance Value (mΩ)	Withstanding Voltage
No. 1	29	-	43	28	OK
No. 2	17	19	-	18	OK
No. 3	30	45	-	220	OK
Sample B					
Sample No.	COM Terminal (°C)	NO Terminal (°C)	NC Terminal (°C)	Contact Resistance Value (mΩ)	Withstanding Voltage
No. 1	18	-	18	18	OK
No. 2	23	21	-	17	OK
No. 3	20	19	-	20	OK
Sample C					
Sample No.	COM Terminal (°C)	NO Terminal (°C)	NC Terminal (°C)	Contact Resistance Value (mΩ)	Withstanding Voltage
No. 1	23	-	25	25	NG
No. 2	23	29	-	30	NG
No. 3	22	27	-	20	NG

Samples A, B and C of Fig. 2 are switches in which normally-open fixed contact 5, normally-closed fixed contact 6 and movable contact 7 have the compositions and composition content ratios of samples A, B and C.

More specifically, Table 2 shows measured temperatures (°C) of common fixed terminal piece (COM terminal) 2, normally-open fixed terminal piece (NO terminal) 3 and normally-closed fixed terminal piece (NC terminal) 4, respective contact resistance values (mΩ) of normally-open fixed contact 5, normally-closed fixed contact 6 and movable contact 7, as well as test results of withstanding voltage, of three switches (Nos. 1 to 3) of respective samples A, B and C.

As is apparent from Table 2, sample B has higher content of In as compared with sample A, and is superior in ablation resistance. Therefore, contact resistance values of respective contacts 5, 6 and 7 after test were low, and temperature increase of terminal pieces 2, 3 and 4 was small.

Sample C has still higher content of In as compared with sample B, and therefore the contacts are much ablated, contact resistance values of respective contacts 5, 6 and 7 after test were high and temperature increase of respective terminal pieces 2, 3 and 4 was large.

For reference, Table 3 shows results of similar temperature increase test performed on samples in which contact mechanism (Fig. 1) requiring the snap action is not provided at movable contact piece 8. The test was performed on

known micro switches in which movable contact 7 is switched between fixed contacts 5 and 6 in a slow action.

Table 3

Sample A					
Sample No.	COM Terminal (°C)	NO Terminal (°C)	NC Terminal (°C)	Contact Resistance Value (mΩ)	Withstanding Voltage
No. 1	32	-	45	33	OK
No. 2	30	47	-	250	OK
No. 3	18	20	-	26	OK
Sample B					
Sample No.	COM Terminal (°C)	NO Terminal (°C)	NC Terminal (°C)	Contact Resistance Value (mΩ)	Withstanding Voltage
No. 1	20	-	22	22	OK
No. 2	24	24	-	20	OK
No. 3	19	23	-	18	OK
Sample C					
Sample No.	COM Terminal (°C)	NO Terminal (°C)	NC Terminal (°C)	Contact Resistance Value (mΩ)	Withstanding Voltage
No. 1	25	-	26	28	NG
No. 2	24	30	-	30	NG
No. 3	24	32	-	113	NG

As is apparent from A, in samples A, B and C having the snap action, contact resistance values of respective contacts 5, 6 and 7 and temperature increase in respective terminal pieces 2, 3 and 4 after test are low as compared with samples A, B and C having the slow action, and hence the samples having the snap action have superior ablation resistance.

For better understanding, Fig. 2 shows temperature increase characteristic (dotted line) in slow action and temperature increase characteristic (solid line) in snap action of samples A, B and C, respectively. It is apparent from this figure also that in sample B, terminal pieces 2, 3 and 4 after test experience lower temperature increase as compared with samples A and C, and hence sample B has superior ablation resistance.

Results of ramp load test of samples B and C of the micro switch shown in Fig. 1 are shown in Table 4.

Table 4

Sample B				
Sample No.	COM Terminal (°C)	NO Terminal (°C)	NC Terminal (°C)	Withstanding Voltage
No. 1	7	-	10	OK
No. 2	5	6	-	OK
No. 3	6	7	-	OK
Sample C				
Sample No.	COM Terminal (°C)	NO Terminal (°C)	NC Terminal (°C)	Withstanding Voltage
No. 1	5	-	7	NG
No. 2	3	3	-	NG
No. 3	3	3	-	NG

As is apparent from Table 4, sample B containing much Sn has superior welding resistance, and hence ensures withstanding voltage (OK), while sample C containing less Sn has inferior welding resistance, and it cannot stand the applied voltage (NG).

As is apparent from the test result described above, it is confirmed that a switch including as contact material of contacts 5, 6 and 7, tin improving welding resistance and indium improving ablation resistance, with alloy composition before internal oxidation having the mixture of 2.0 to 5.0 wt% of tin and 5.0 to 8.0 wt% of indium, provides superior welding resistance and ablation resistance.

When the contact material described above is used, tin oxide (SnO_2) which is an electrically insulative oxide goes free and is deposited on the surfaces of respective contacts 5, 6 and 7 as an arc is generated associated with opening/closing of contacts 5, 6 and 7, causing increased electrical resistance. However, movable contact 7 removes the oxide deposited on the surfaces of the contact by rolling or wiping operation associated with the stop action. Further, the deposited oxide can be scattered and removed from the surfaces of the contacts by the shock wave caused at the time of contact by the snap action of movable contact 7 brought into contact with and separated from fixed contacts 5 and 6 at high speed almost independent from the speed of operation of the micro switch.

Accordingly, the contact surface of movable contact 7 opposing to fixed contacts 5 and 6 is always kept clean. As a result, a micro switch having superior welding resistance and ablation resistance as well as high contact resistance, in which contact resistance value is kept low and abnormal heat built up is prevented, is provided.

Further, movable contact 7 is opened and separated at high speed from fixed contacts 5 and 6, and hence the arc generated at the time of contact and separation can be cut rapidly, further improving ablation resistance.

Though a micro switch in which movable contact 7 is brought into contact with normally-open fixed contact 5 and normally-closed fixed contact 6 has been described in the foregoing, one of the normally-open fixed contact 5 and normally-closed fixed contact 6 may be omitted. Further, a switch other than the micro switch, for example a limit switch, may be used.

Industrial Applicability

As described above, the switch in accordance with the present invention ensures improved welding resistance and ablation resistance as well as high reliability. Therefore, it exhibits superior effects when applied to a micro switch or a limit switch.

Claims

1. A switch provided with a contact mechanism for bringing into contact a movable contact to a fixed contact in snap action, characterized in that each of said contacts is formed of a material prepared by internal oxidation of an alloy having the composition of 2.0 to 5.0 wt% of tin, 5.0 to 8.0 wt% of indium, at most 0.5 wt% of an iron family metal and remaining part of silver.
2. A micro switch employing the switch in accordance with claim 1.
3. A limit switch employing the switch in accordance with claim 3.
4. The switch according to claim 1 wherein weight ratio between tin and indium is about 3.2 tin to about 6.3 indium.
5. The switch according to claim 1, wherein weight ratio between tin and indium is 1 tin to about 2 indium.

FIG. 1

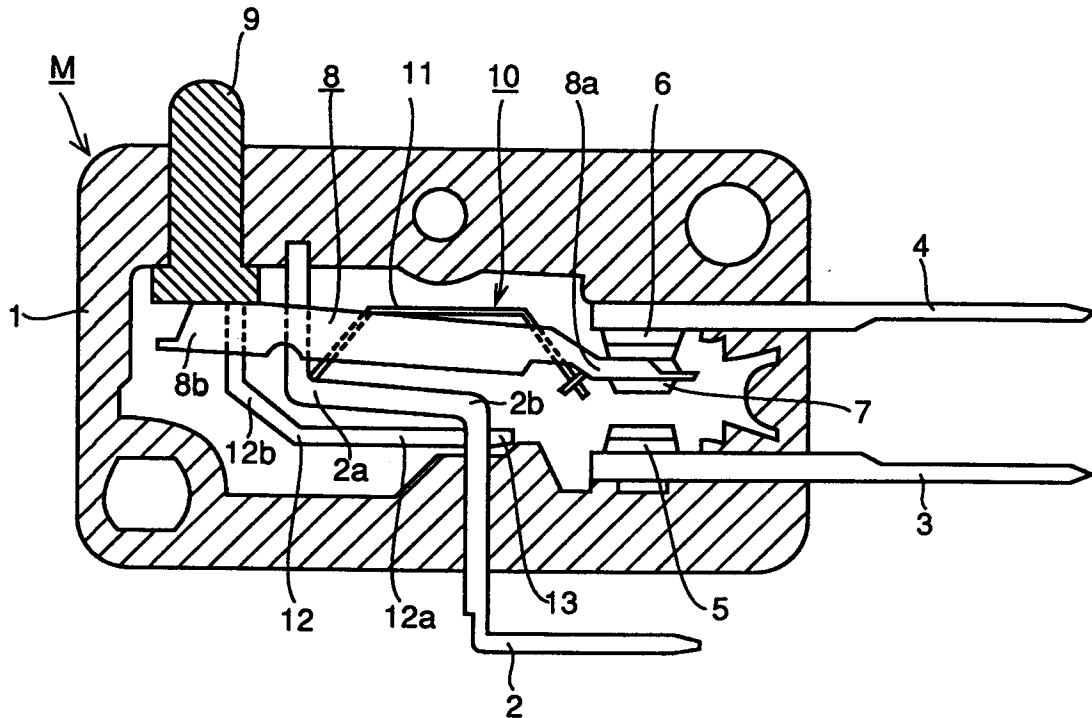
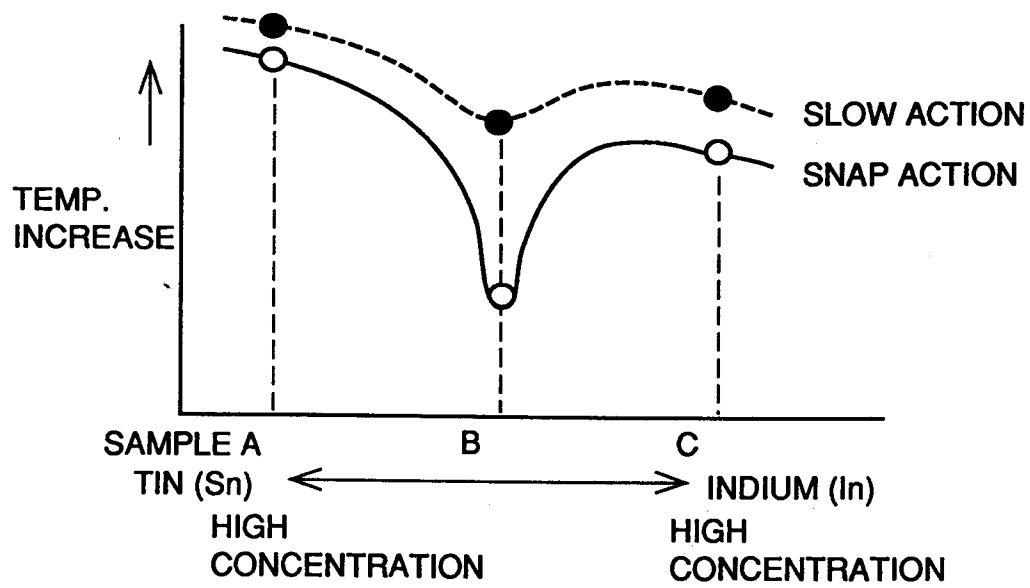


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP96/02972

A. CLASSIFICATION OF SUBJECT MATTER Int. Cl ⁶ H01H1/02 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) Int. Cl ⁶ H01H1/00-1/06 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926 - 1996 Kokai Jitsuyo Shinan Koho 1971 - 1996 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP, 51-41893, A (Sumitomo Electric Industries, Ltd.), April 8, 1976 (08. 04. 76) (Family: none)	1, 2, 3, 4, 5
P	JP, 07-305128, A (Tanaka Kikinzoku Int'l K.K.), November 21, 1995 (21. 11. 95)	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 document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "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		
Date of the actual completion of the international search December 18, 1996 (18. 12. 96)		Date of mailing of the international search report January 8, 1997 (08. 01. 97)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.		Authorized officer Telephone No.

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