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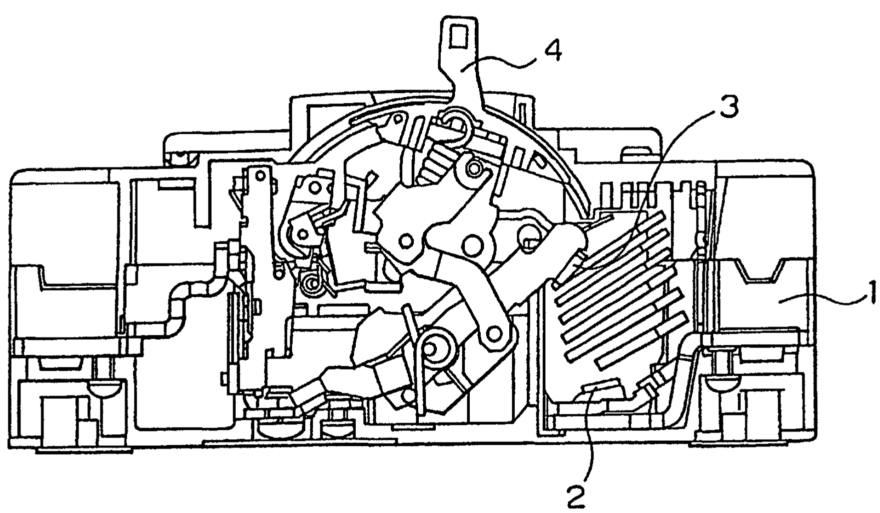
(54) **SWITCH**

(57) There is disclosed a switch including a molded article composed of a flame retardant material, which flame retardant material includes from 35 to 50% by weight of a resin, from 20 to 60% by weight of a reinforcement, from 5 to 40% by weight of an inorganic compound and from 0.3 to 1.8% by weight of red phosphorus flame retarder, and which inorganic compound undergoes dehydration reaction at temperatures equal to or higher than a predetermined temperature. The switch according to the invention is satisfactory in flame retardancy and resistance to metal contamination or metal corrosion.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a switch using a molded article composed of a flame retardant material having flame retardancy.

Background Art

[0002] As a conventional flame retardant material for a switch, Japanese Patent Laid-Open No. 8-171847, for example, describes a material containing a polyamide, a glass fiber and magnesium hydroxide.

[0003] Japanese Utility Model Laid-Open No. 2-125943 describes a flame retardant material for an illuminator receptacle containing a polyester, a glass fiber, calcium carbonate, aluminum hydroxide, a halogen-based flame retarder and antimony oxide.

[0004] EP-A1-278555 describes a polyamide composition containing, for example, at least 40% by weight of a polyamide, from 5 to 50% by weight of a glass fiber, less than or equal to 50% by weight of magnesium hydroxide and from 4 to 15% by weight of red phosphorus.

[0005] The flame retardant material for a switch described in Japanese Patent Laid-Open No. 8-171847 contains magnesium hydroxide as a flame retarder that imparts high flame retardancy to the flame retardant material. This flame retardant material, however, cannot significantly have still higher flame retardancy. To satisfy still higher flame retardancy such as in the materials containing a halogen-based flame retarder or red phosphorus, the flame retardant material must contain a larger amount of magnesium hydroxide. However, a flame retardant material containing a still larger amount of magnesium hydroxide invites defective appearance such as white appearance of the resulting molded article or invites decreased compressive strength and is not suitable as a flame retardant material for a switch.

[0006] The technologies described in Japanese Utility Model Laid-Open No. 2-125943 and EP-A1-278555 are not intended to be used in a switch and are different in technical field from the present invention. Additionally, these technologies cannot solve problems such as contamination or corrosion of metallic contact parts as described later and cannot be used in a switch.

[0007] The flame retardant material for a illuminator receptacle described in Japanese Utility Model Laid-Open No. 2-125943 has high flame retardancy but is not suitable for use in a switch. This is because the material contains a halogen-based flame retarder and some types of the halogen-based flame retarder used may contaminate or corrode metallic parts such as contacts or electronic parts when they are used as materials for a switch part. The metallic part is supposed to be contaminated or corroded by a halogen gas generated from the halogen-based flame retarder over time. In this means, the halogen gas is considered as a contaminative gas or corrosive gas. Additionally, such halogen-based flame retarders may possibly yield dioxins, thus inviting environmental problems. Antimony used in the material as a flame retardant aid is a heavy metal and can cause environmental pollution.

[0008] The flame retardant material disclosed in EP-A1-278555 contains at least 40% by weight of a polyamide, from 5 to 50% by weight of a glass fiber, less than or equal to 50 of magnesium hydroxide and from 4 to 15% by weight of red phosphorus, has high flame retardancy but is not suitable for use in a switch. This is because this flame retardant material contains magnesium hydroxide and red phosphorus as flame retarders, and the present inventors found that this material is satisfactorily flame retardant but contaminates or corrodes metallic parts. The metallic parts are supposed to be contaminated or corroded by a contaminative gas or corrosive gas generated from red phosphorus over time.

[0009] The term "contamination or corrosion" as used herein means at least one of the formation of an insulator on a surface of a metallic part, an increased contact resistance of the metallic part and the detection of a highly reactive element (halogen element or phosphorus) on a surface of the metal.

[0010] The term "contaminative gas or corrosive gas" means a gas which is supposed to cause contamination or corrosion.

[0011] Decreased insulating resistance due to the contamination or corrosion of metallic parts becomes a great barrier to miniaturization and higher breaking capacity of a switch. Separately, satisfactory flame retardancy in a thin-wall part is required to reduce a switch in weight.

[0012] Accordingly, an object of the present invention is to solve the above problems to thereby provide a switch including a highly flame retardant molded article.

Disclosure of Invention

[0013] Specifically, the present invention provides a switch including a molded article composed of a flame retardant material, which flame retardant material includes from 35 to 50% by weight of a resin, from 20 to 60% by weight of a reinforcement, from 5 to 40% by weight of an inorganic compound and from 0.3 to 1.8% by weight of red phosphorus flame retarder, and which inorganic compound undergoes dehydration reaction at temperatures equal to or higher than a predetermined temperature.

[0014] The present invention provides the switch in which the content of the red phosphorus flame retarder is from 0.5 to 1.8% by weight.

[0015] The present invention provides the switch in which the contents of the inorganic compound and the red phosphorus flame retarder are from 30 to 40% by weight and from 0.5 to 1.0% by weight, respectively.

[0016] Further, the present invention provides the switch in which the resin is a thermoplastic resin.

[0017] The present invention provides the switch in which the thermoplastic resin is a polyamide.

[0018] The present invention provides the switch which comprises the molded article at least as part of a base of a housing.

[0019] In addition, the present invention provides the switch which includes the molded article in the vicinity of an arc generated between contacts and comprises a structural material in the other portions, which structural material has mechanical strength higher than that of the molded article.

[0020] The term "% by weight" as used in the present description does not mean a so-called weight percentage but means the ratio of a component in question to the total weight of the composition. In other words, a total of the contents of the aforementioned components in % by weight does not always amount to 100% by weight.

Detailed Description of the Invention

[0021] The present invention will be illustrated in further detail below.

[0022] The molded article for use in the present invention comprises a flame retardant material including from 35 to 50% by weight of at least one thermoplastic resin, from 20 to 60% by weight of a reinforcement, from 5 to 40% by weight of at least one inorganic compound and from 0.3 to 1.8% by weight of a red phosphorus flame retarder, which inorganic compound is capable of undergoing dehydration reaction at temperatures equal to or higher than the molding temperature of the thermoplastic resin (a predetermined temperature). Preferably, the content of the red phosphorus flame retarder is from 0.5 to 1.8% by weight. Alternatively, the content of the inorganic compound is from 30 to 40% by weight and the content of the red phosphorus flame retarder is from 0.5 to 1.0% by weight.

[Thermoplastic Resins]

[0023] The thermoplastic resin includes, for example, poly(butylene terephthalate), poly(ethylene terephthalate), polyamides, aliphatic polyketones, poly(phenylene sulfide) and alloys of these thermoplastic resins. Among them, polyamides are typically preferred for their satisfactory heat resistance, compressive strength and insulation performance of the resulting switch after arc generation.

[Reinforcements]

[0024] The reinforcement is used for improving compressive strength and is at least one selected from the group consisting of glass fibers, inorganic minerals and ceramic fibers. As the reinforcement, the flame retardant material preferably comprises equal to or more than 20% by weight of a glass fiber.

[Inorganic Compounds]

[0025] The molded article contains the flame retardant material including the inorganic compound. This inorganic compound is capable of undergoing dehydration reaction and is supposed to serve for improvement of flame retardancy of the molded article.

[0026] This is probably because, when the molded article is exposed to elevated temperatures (e.g., temperatures equal to or higher than 340°C), the inorganic compound in the molded article is thermally decomposed, the resulting water vapor retards heat generation, and an endothermic reaction upon the formation of the water vapor absorbs the generated heat.

[0027] The inorganic compound which is capable of undergoing dehydration reaction and is contained in the flame retardant material in the molded article does not cause contamination or corrosion of metals in contrast to halogen-based flame retarders or red phosphorus flame retarders. In addition, the experiments made by the present inventors suggest that the inorganic compound operates to prevent contamination or corrosion of metals caused by red phosphorus flame retarders. Specifically, the present inventors have found a specific compositional ratio of the inorganic compound to the red phosphorus flame retarder, which inorganic compound is capable of undergoing dehydration reaction at temperatures equal to or higher than a predetermined temperature. The resulting molded article containing the material having the specific composition is satisfactory both in flame retardancy and in resistance to contamination or corrosion of metals.

[0028] In addition, the inorganic compound which is capable of undergoing dehydration reaction and is contained in the flame retardant material in the molded article is supposed to be conducive to the prevention of decreased insulation after arc generation between contacts of electrodes when the switch makes or breaks a circuit between the electrodes.

[0029] This is supposed as follows: When the switch makes or breaks a circuit between the electrodes, an arc is generated between the contacts of the electrodes, and the temperature generally rises to a range from about 4000°C to about 6000°C. Consequently, the inner constitutional metallic parts of the electrodes, contacts and of the switch are heated, a metal vapor or molten metal droplet is formed from the metal and is released therefrom. Concurrently, not only the arc but also the metal vapor or molten metal droplet decomposes the housing of the switch and inner constitutional organic parts of the switch, thus liberating free carbon. An insulating-property-imparting gas is then generated from the inorganic compound contained in the molded article, and this insulating-property-imparting gas converts the free carbon or sublimated metal or molten metal droplet into an insulator and is conducive to the prevention of decreased insulation after arc generation. For example, when the inorganic compound undergoing dehydration reaction is magnesium hydroxide, the generated insulating-property-imparting gas is supposed to be H_2O. In this connection, when a circuit breaker makes or breaks a circuit between the electrodes, the free carbon is generated from, for example, the housing or inner mechanical parts which are molded articles composed of the flame retardant material, and the contacts or inner constitutional metallic parts yield the sublimated metal and release the molten metal droplet.

[0030] When the free carbon, metal vapor and molten metal droplet are converted into insulators, a high pressure vapor is formed and expanded by action of the arc in the vicinity of the contacts, and the generated insulating-property-imparting gas cannot approach the vicinity of the contacts. Accordingly, an insulator layer derived from the free carbon, metal vapor and molten metal droplet is not formed in regions around the contacts, thus not inhibiting energizing of the circuit.

[0031] The dehydration reaction of the inorganic compound capable of undergoing dehydration reaction is preferably initiated at a temperature of equal to or higher than 250°C in order to avoid dehydration reaction of the inorganic compound during kneading when it is kneaded with the thermoplastic resin and other components.

[0032] Such inorganic compounds capable of undergoing dehydration reaction at temperatures equal to or higher than 250°C include, for example, calcium aluminate ($Ca_3Al_2(OH)_{12}$), zinc borate ($2ZnO$, $3BO_2O_3$, $3.5H_2O$), calcium hydroxide ($Ca(OH)_2$) and magnesium hydroxide ($Mg(OH)_2$).

[0033] When the thermoplastic resin is a polyamide, the temperature of a mixture of the thermoplastic resin, reinforcement, inorganic compound and red phosphorus flame retarder rises near to 340°C during kneading or molding, in view of a set temperature of kneading operation and heat generation due to shear. In this case, to avoid dehydration reaction during kneading or molding of the inorganic acid capable of undergoing dehydration reaction, the initiation temperature of the dehydration reaction of the inorganic compound capable of undergoing dehydration reaction is preferably equal to or higher than 340°C. On the other hand, the decomposition of a polymer is generally initiated at temperatures from 400°C to 550°C which are just below the combustion temperature. Accordingly, if the initiation temperature of the dehydration reaction is excessively high, in other words, if the initiation temperature of the dehydration of the inorganic compound capable of undergoing dehydration reaction is higher than the initiation temperature of the decomposition of the polymer, sufficient flame retardant effect cannot be exhibited and it is not desirable.

[0034] Inorganic compounds capable of undergoing dehydration reaction and satisfying these requirements include, for example, calcium hydroxide and magnesium hydroxide.

[0035] Among them, magnesium hydroxide is typically preferred, since flame retardant efficiency increases with an increasing heat absorption per unit mass.

[0036] Of the inorganic compounds capable of undergoing dehydration reaction, calcium hydroxide, calcium aluminate and magnesium hydroxide are nontoxic and are preferable.

[0037] If the content of the inorganic compound capable of undergoing dehydration reaction at temperatures equal to or higher than the molding temperature of the thermoplastic resin is equal to or higher than 40% by weight, the resulting molded article tends to exhibit decreased tensile strength and to show whitened appearance in its surface to thereby invite defective appearance of the switch.

[Red Phosphorus Flame Retarder]

[0038] As the red phosphorus flame retarder, red phosphorus particles having mean particle size of from 25 to 35 µm and being coated with phenol are used.
A content of the red phosphorus flame retarder exceeding 1.0% by weight tends to deteriorate current-carrying property. This tendency is noticeable when the content exceeds 1.8% by weight. The tendency is supposed to be caused by increased ratio of the red phosphorus flame retarder. This is probably because the red phosphorus flame retarder yields phosphine (PH_3) and phosphoric acid (H_2PO_3) which are phosphorus compounds capable of contaminating or

corroding metals, and these substances form insulating compounds at the contacts of the switch, thus contaminating or corroding the metal of the contacts.

[0039] In contrast, if the content of the red phosphorus flame retarder is less than 0.5% by weight and specifically less than 0.3% by weight, the flame retardant effect tends to become insufficient.

[0040] The content in % by weight of the red phosphorus flame retarder is indicated in terms of red phosphorus.

[0041] To avoid deterioration in current-carrying property, i.e., to avoid metal contamination or corrosion, the red phosphorus flame retarder preferably comprises at least one of surface coating of red phosphorus and an adsorbent for phosphorus compounds.

[0042] Additionally, a contamination or corrosion inhibitor is preferably used in combination with the red phosphorus flame retarder. The contamination or corrosion inhibitor is a substance that inhibits contamination or corrosion of metals by action of red phosphorus. For example, an alkaline substance is preferred when the resin is a polyamide.

[0043] If a molded article does not comprise the inorganic compound capable of undergoing dehydration reaction at temperatures equal to or higher than a predetermined temperature but comprises the red phosphorus flame retarder, reinforcement and thermoplastic resin, it tends to exhibit decreased electric resistance after the formation of an arc, i.e., after exposure to the arc. This is probably because a carbonized layer is bonded to an inner surface of the housing of the switch or to a surface of the inner constitutional parts of the switch.

[0044] The red phosphorus flame retarder is not a halogen-based flame retarder and does not yield dioxins.

[0045] As is described above, a molded article for a switch that is satisfactory both in flame retardancy and resistance to metal contamination or metal corrosion can be obtained by the combination use of the red phosphorus flame retarder and the inorganic compound in addition to the resin and reinforcement and by specifically selecting the compositional ratio of the red phosphorus flame retarder and the inorganic compound, which inorganic compound is capable of undergoing dehydration reaction at temperatures equal to or higher than a specific temperature.

[0046] Specifically, within the above-specified compositional ratio, it is supposed that the amount of the red phosphorus flame retarder is minute to thereby decrease the formation of a carbonized layer, and the insulating-property-imparting gas generated from the inorganic compound capable of undergoing dehydration reaction converts the carbonized layer into an insulator. Decrease in electric resistance is therefore prevented to thereby inhibit decrease in insulation after arc generation. Additionally, both the red phosphorus flame retarder and the inorganic compound capable of undergoing dehydration reaction can increase flame retardancy.

[0047] The flame retardant material comprises a very trace amount (from 0.3 to 1.8% by weight) of the red phosphorus flame retarder and a small amount (from 5% by weight to 40% by weight) of the inorganic compound capable of undergoing dehydration reaction and can achieve a very high level of flame retardancy, which only large amounts of the inorganic compound alone can achieve. In this case, a relatively small amount (equal to or more than 5% by weight) of the inorganic compound is enough from the viewpoints of flame retardancy and resistance to metal contamination or metal corrosion, the resulting molded article does not exhibit decreased compressive strength and can be formed into a thin wall. The flame retardancy tends to increase with an increasing amount of the inorganic compound from 5% by weight.

[0048] Additionally, the combination use of the red phosphorus flame retarder and the inorganic compound capable of undergoing dehydration reaction at temperatures equal to or higher than a predetermined temperature can reduce the amount of red phosphorus which is required to maintain the same flame retardancy and can improve resistance to metal contamination or corrosion as compared with the use of the red phosphorus flame retarder alone as a flame retarder.

[0049] When the red phosphorus flame retarder is used in combination with the inorganic compound capable of undergoing dehydration reaction at temperatures equal to or higher than a predetermined temperature and the inorganic compound capable of undergoing dehydration reaction is an alkaline substance such as a hydroxide, the inorganic compound is supposed to play a role as a contamination or corrosion inhibitor with respect to the red phosphorus flame retarder to thereby effectively inhibit metal contamination or corrosion.

Brief Description of the Drawings

[0050]

Fig. 1 is a sectional view of a switch according to Example 1 of the present invention taken along its side.

Fig. 2 is a sectional view of the switch of Fig. 1 taken along its plane.

Fig. 3 is a partially sectional perspective view of a base of a housing of a switch according to Example 2 of the present invention.

Examples

[0051] The present invention will be illustrated in further detail with reference to several examples below.

EXAMPLE 1

[0052] Test pieces were molded from flame retardant materials as shown in Table 1 below and were subjected to the following combustion tests.

[0053] Fig. 1 is a sectional view of a switch according to Example 1 of the present invention taken along its side, and Fig. 2 is a sectional view of the switch of Fig. 1 taken along its plane.

[Combustion Test 1 (960°C GWFI)]

[0054] This combustion test is described in Japanese Industrial Standards (JIS) C0074, in which a glow wire heated at 960°C was pressed to a test piece for 30 seconds, and the condition of the test piece after removal of the wire was evaluated.

[0055] Each of the test pieces was 75 mm square having an optionally fixed thickness.

[0056] In this test, criteria is that a flame or glow disappeared within 30 seconds and a wrapping tissue placed under the test piece did not ignite. When the test piece satisfied this criteria sequentially three times or more, it was passed in the constant thickness. In this evaluation, test pieces were ranked by the thickness in which the test piece was passed.

[Combustion Test 2 (HWI)]

[0057] This combustion test is described in IEC 974-1, in which a prescribed nichrome wire was wound around a test piece, followed by supply of a prescribed power to thereby heat the test piece until it ignited. Upon ignition of the test piece, power was shut down, and the time that elapsed before ignition was recorded. Five test pieces of each of the tested materials are tested. In this evaluation, the test piece was passed when the time that elapsed before ignition was equal to or more than 30 seconds.

[0058] Test pieces are 150 mm long and 13 mm wide having an optionally fixed thickness. The nichrome wire was wound five times at intervals of 6 mm.

[Metal Contamination (Corrosion) Resistance Test]

[0059] A molded article obtained according to Example 1 was subjected to the following metal contamination or corrosion resistance test.

[0060] The molded article was base 1 of a housing shown in Figs. 1 and 2.

[0061] As an article to be contaminated or to be corroded (hereinafter referred to as "article to be contaminated"), two articles, i.e., a copper plate (C11001/4H) and a silver-plated copper plate obtained from this copper plate each 28 mm x 14 mm x 1 mm were used.

[0062] The article to be contaminated (including one ply of the copper plate and two plies of the silver-plated plate) was subjected to ultrasonic cleaning in acetone and was placed on base bottom 5 shown in Fig. 2.

[0063] Next, base 1 was packaged in order to enclose a metal-contaminative gas or metal-corrosive gas generated from the base and to prevent a gas in a thermostat (environmental chamber) as described later to enter the package.

[0064] Then, packaged test sample base 1 was allowed to stand in a thermostat (120°C) for 3000 hours.

[0065] After leaving standing in the thermostat, a noncontact surface between the article to be corroded and the molded article (base 1) was analyzed by SEM (scanning electron microscope) and XMA (energy dispersive X ray analyzer) to thereby evaluate resistance to metal contamination or metal corrosion.

[0066] In this procedure, possible regions to be measured of the article to be contaminated are both a contact surface and a noncontact surface of the article to be contaminated with the molded article (base 1), but the noncontact surface was measured and evaluated in this test as a result of the following preliminary investigation.

[0067] After leaving standing in the thermostat, a contact surface and a noncontact surface between the article to be contaminated and the molded article (base 1) were analyzed by SEM (scanning electron microscope) and XMA (energy dispersive X ray analyzer). As a result, a larger amount of red phosphorus was detected in the noncontact surface between the article to be contaminated and the molded article (base 1). This contamination or corrosion was supposed not to be corrosion occurring in a contact interface with the molded article but to be contamination or corrosion caused by a gas that issued in a jet from the molded article. Accordingly, the resistance to metal corrosion was evaluated on a noncontact surface of the article to be contaminated with the molded article (base 1), as described above.

[Measurement of Contact Resistance]

[0068] The contact resistance was measured in the following manner: After standing in the thermostat, two plies of the silver-plated plate were taken from the packaged sample (base 1) and were partially overlapped with each other, a constant electric current (1 A) was supplied between the two plates while a fixed contact pressure was applied on the overlapped region, and the contact resistance was determined from a voltage drop in the overlapped region of the test samples.

[0069] A margin to be overlapped of the silver-plated copper plate test samples in measurement of the contact resistance was 14 x 15 mm, and the contact pressure was about 98 KPa (about 1.0 kg/cm^2).

[0070] The surface of the article to be contaminated was analyzed using SEM and XMA (applied voltage of an electron gun: 15 KV). The region analyzed by XMA was about 10 x 7 mm square.

[0071] The surface of the article to be contaminated was analyzed based on an SEM image and detection peaks of XMA (especially, a mass ratio calculated from detection peaks of P and Ag).

Table 1

Sample type	Housing composition (wt %)				Flame resistance test		Metal contamination (corrosion) resistance test		
	Resin ratio	Reinforcement ratio	Flame retarder ratio				Silver-plated plate		Copper plate
							120°C x 3000 Hrs		120°C x 3000 Hrs
			Red phosphorus	Inorganic compound undergoing dehydration reaction	960°C GWFI	HWI	Contact resistance (μΩ)	SEM-XMA (15 kV)	SEM-XMA (15 kV)
Sample 1	50 nylon 6	45 glass fiber	5.4	5 $Mg(OH)_2$	1.5 mm passed	-	30000-128000 x <120°C x 1000 Hrs>	phosphorus detected <120°C x 1000 Hrs>	-
Sample 2	40 nylon 6	60 glass fiber + wollastonite	1.8	5 Mg(OH)2	2.0 mm passed	-	O 35-43	no phosphorus detected	phosphorus detected P/Cu = 0.03
Sample 3	40 nylon 6	60 glass fiber + wollastonite	1.2	5 Mg(OH)2	2.0 mm passed	-	O 82-176	no phosphorus detected	phosphorus detected P/Cu = 0.01
Sample 4	40 nylon 6	20 glass fiber	1	40 Mg(OH)2	1.5 mm passed	1.5 mm passed	(O)	(O)	-
Sample 5	50 nylon 6	20 glass fiber	0.5	30 Mg(OH)2	1.5 mm passed	1.5 mm passed	(O)	(O)	-
Sample 6	50 nylon 6	20 glass fiber	0.3	30 Mg(OH)2	1.5 mm failed	1.5 mm failed	O 85-100	no phosphorus detected	no phosphorus detected
Sample 7	50 nylon 6	20 glass fiber	0	30 Mg(OH)2	2 mm passed	2.5 mm passed	O 57-74	(O)	(no phosphorus detected)

The results in the parenthesis are estimated results.
-: no data

[Test Results]

[0072] The test results will be described below. Table 1 is a table showing the test results of Samples 1 to 7.

[0073] Samples 1 to 3 each comprised from 40 to 50% by weight of nylon 6, from 45 to 60% by weight of a glass fiber or a mixture of a glass fiber and wollastonite as a reinforcement, from 5% by weight of magnesium hydroxide and from 1.2 to 5.4% by weight of red phosphorus as flame retarders.

[0074] Samples 4 to 6 each comprised from 40 to 50% by weight of nylon 6, 20% by weight of a glass fiber as a reinforcement and, as flame retarders, from 30 to 40% by weight of magnesium hydroxide and a very small amount, from 0.3 to 1% by weight, of red phosphorus as flame retarders.

[0075] Sample 7 comprised 50% by weight of nylon 6, 20% by weight of a glass fiber as a reinforcement and 30% by weight of magnesium hydroxide alone as a flame retarder.

[0076] Sample 1 (containing 5.4% by weight of red phosphorus and 5% by weight of magnesium hydroxide) exhibited satisfactory flame retardancy of 1.5 mm in 960°C GWFI but was insufficient in resistance to metal contamination or metal corrosion.

[0077] After leaving standing at 120°C for about 1000 hours, a phosphorus compound was found in places on a surface of this sample, and phosphorus was detected on a surface of the silver-plated copper plate as analyzed by SEM and XMA. Additionally, the contact resistance in a region where two plies of the silver-plated plates were overlapped remarkably increased, showing that phosphorus was detected. If a molded article composed of this flame retardant material is used as a housing of a switch, the phosphorus compound may be deposited on surfaces of stationary contact 2 and movable contact 3 to thereby cause faulty electrical continuity.

[0078] As phosphorus was detected in the silver-plated plate, the copper plate was not subjected to analysis by SEM and XMA, in which phosphorus was detected in a higher amount.

[0079] Sample 2 (containing 1.8% by weight of red phosphorus and 5% by weight of magnesium hydroxide) and Sample 3 (containing 1.2% by weight of red phosphorus and 5% by weight of magnesium hydroxide) exhibited satisfactory flame retardancy of 2.0 mm in 960°C GWFI test and were also satisfactory in the contamination or corrosion test on the silver-plated plate.

[0080] In these samples, a slight amount of phosphorus was detected (P/Cu = 0.03) in the contamination or corrosion test on the copper plate but the amount was minute and was trivial level for use in a switch.

[0081] Sample 4 (containing 1.0% by weight of red phosphorus and 40% by weight of magnesium hydroxide) and Sample 5 (containing 0.5% by weight of red phosphorus and 30% by weight of magnesium hydroxide) exhibited satisfactory flame retardancy of 1.5 mm in the 960°C GWFI test and of 1.5 mm in the HWI test. No phosphorus was detected in the contamination or corrosion test on the silver-plated plate of Samples 2 and 3 and these samples each had a higher content of red phosphorus and a lower content of magnesium hydroxide than Samples 4 and 5, which magnesium hydroxide served as a contamination inhibitor or corrosion inhibitor. Accordingly, no phosphorus was supposed to be detected in the contamination or corrosion test on the silver-plated plate of Samples 4 and 5 that had less factors to yield phosphorus.

[0082] Sample 5 was obtained by adding a slight amount (0.5% by weight) of red phosphorus to Sample 7, was satisfactory in resistance to metal contamination or metal corrosion and exhibited markedly improved flame retardancy as compared with Sample 7. To achieve equivalent flame retardancy with the use of magnesium hydroxide alone as a flame retarder, the material must comprise a still larger amount of magnesium hydroxide (e.g., more than 50% by weight of magnesium hydroxide). A magnesium hydroxide content exceeding 40% by weight may invite whitening of surfaces and other defective appearance of the molded article and may deteriorate compressive strength.

[0083] Sample 6 (containing 0.3% by weight of red phosphorus and 30% by weight of magnesium hydroxide) exhibited satisfactory flame retardancy as failed in 1.5 mm and passed in 2.0 mm in the 960°C GWFI test and failed in 1.5 mm and passed in 2.0 mm in the HWI test. This sample was also satisfactory in resistance to metal contamination or metal corrosion, and no phosphorus was detected both in the silver-plated plate and in the copper plate.

[0084] Sample 7 was a comparative example containing no red phosphorus, was satisfactory in resistance to metal contamination or metal corrosion but was inferior in flame retardancy to Samples 1 to 6.

[0085] These results show that molded articles obtained from the flame retardant materials of Samples 2 to 6 are satisfactory both in flame retardancy and in resistance to metal contamination or metal corrosion and that molded articles obtained from the flame retardant materials of Samples 4 and 5 are still more satisfactory both in flame retardancy and in resistance to metal contamination or metal corrosion.

[0086] When the content of red phosphorus is less than or equal to 1.8% by weight, resistance to contamination or corrosion of the resulting flame retardant material is good as far as it contains equal to or more than 5% of magnesium hydroxide, indicating that magnesium hydroxide in this amount satisfactorily serves as a contamination inhibitor or corrosion inhibitor. Samples 4 to 7 comprises a large amount of, from 30 to 40% by weight of, magnesium hydroxide in order to improve flame retardancy.

EXAMPLE 2

[0087] Fig. 3 is a partially sectional perspective view of a base of a housing of a switch according to Example 2 of the present invention. In Fig. 3, a housing of a circuit breaker comprises base 11, and base bottom 13 constitutes an outer surface of base 11 and is arranged in a position distant from an arc generated between contacts not shown. The base bottom 13 is composed of a structural material having satisfactory mechanical strength such as a thermosetting resin or thermoplastic resin alone or a composite including these resins and a reinforcement as described in the example. Arced base portion 15 is arranged at a position of base 11 to be exposed to the arc generated between the contacts not shown and is composed of the composite described in Embodiment 1. Arced base portion 15 is hatched for the purpose of explanation.

[0088] Base 11 can be obtained by placing a composite material for base bottom 13 and a composite material for arced base portion 15 respectively in predetermined positions in a die not shown and heating and pressing the two composite materials.

[0089] As thus described, arched base portion 15 of base 11 comprises a molded article being satisfactory in flame retardancy and resistance to metal contamination or corrosion, and base bottom 13 distant from the source of an arc is composed of a structural material having satisfactory mechanical strength. By this configuration, the insulation resistance of a surface of base 11 after arc generation can be prevented from decreasing without deterioration in creep resistance.

[0090] In Example 2, an embodiment is explained in which the composition of Example 1 was only arranged in the vicinity of contacts of arced base portion 15 alone which constitutes only part of an inner surface of base 11, as this region is exposed to arc and is markedly decreased in insulation resistance. It is also effective to arrange the composition of Example 1 in the entire inner surface of base 11.

Industrial Applicability

[0091] The switch according to the present invention is composed of a flame retardant material comprising from 35 to 50% by weight of a resin, from 20 to 60% by weight of a reinforcement, from 5 to 40% by weight of an inorganic compound and from 0.3 to 1.8% by weight of red phosphorus flame retarder, and the inorganic compound is capable of undergoing dehydration reaction at temperatures equal to or higher than a predetermined temperature. This switch is satisfactory in flame retardancy and resistance to metal contamination or metal corrosion.

[0092] When the content of the red phosphorus flame retarder is from 0.5 to 1.8% by weight, the resulting switch is still more satisfactory in flame retardancy.

[0093] When the content of the inorganic compound is from 30 to 40% by weight and that of the red phosphorus flame retarder is from 0.5 to 1.0% by weight, the resulting switch is still more satisfactory in resistance to metal contamination or metal corrosion.

[0094] If the resin is a thermoplastic resin, the material can be easily molded into a thin-wall article.

[0095] When the thermoplastic resin is a polyamide, the resulting switch is satisfactory in insulation property after arc generation.

[0096] When the switch comprises the molded article as a base of its housing, the switch is satisfactory, for example, in flame retardancy, insulation property after arc generation and mechanical strength and can be miniaturized.

[0097] When the switch comprises the molded article in the vicinity of an arc generated between contacts and includes a structural material in the other portions, and the structural material has mechanical strength higher than that of the molded article, the resulting switch has satisfactory creep resistance.

Claims

1. A switch including a molded article composed of a flame retardant material, said flame retardant material comprising from 35 to 50% by weight of a resin, from 20 to 60% by weight of a reinforcement, from 5 to 40% by weight of an inorganic compound and from 0.3 to 1.8% by weight of a red phosphorus flame retarder, and said inorganic compound capable of undergoing dehydration reaction at temperatures equal to or higher than a predetermined temperature.

2. A switch according to claim 1, wherein the content of said red phosphorus flame retarder is from 0.5 to 1.8% by weight.

3. A switch according to claim 1, wherein the contents of said inorganic compound and said red phosphorus flame retarder are from 30 to 40% by weight and from 0.5 to 1.0% by weight, respectively.

4. A switch according to claim 1, wherein said resin is a thermoplastic resin.

5. A switch according to claim 4, wherein said thermoplastic resin is a polyamide.

6. A switch according to claim 1, wherein said switch comprises said molded article at least as part of a base of a housing.

7. A switch according to claim 6, wherein said switch comprises said molded article in the vicinity of an arc generated between contacts and comprises a structural material in the other portions, said structural material having mechanical strength higher than that of said molded article.

FIG. 1

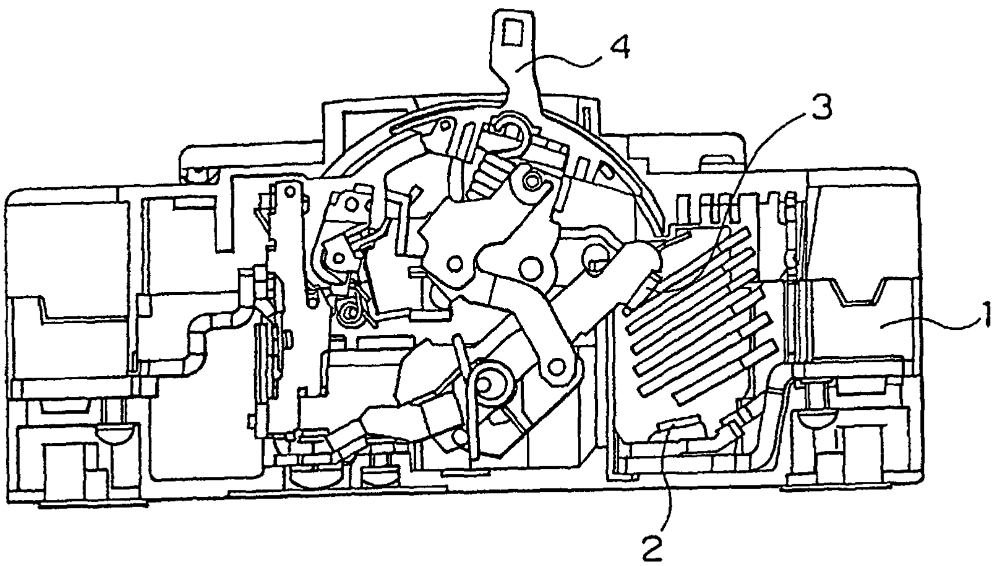


FIG. 2

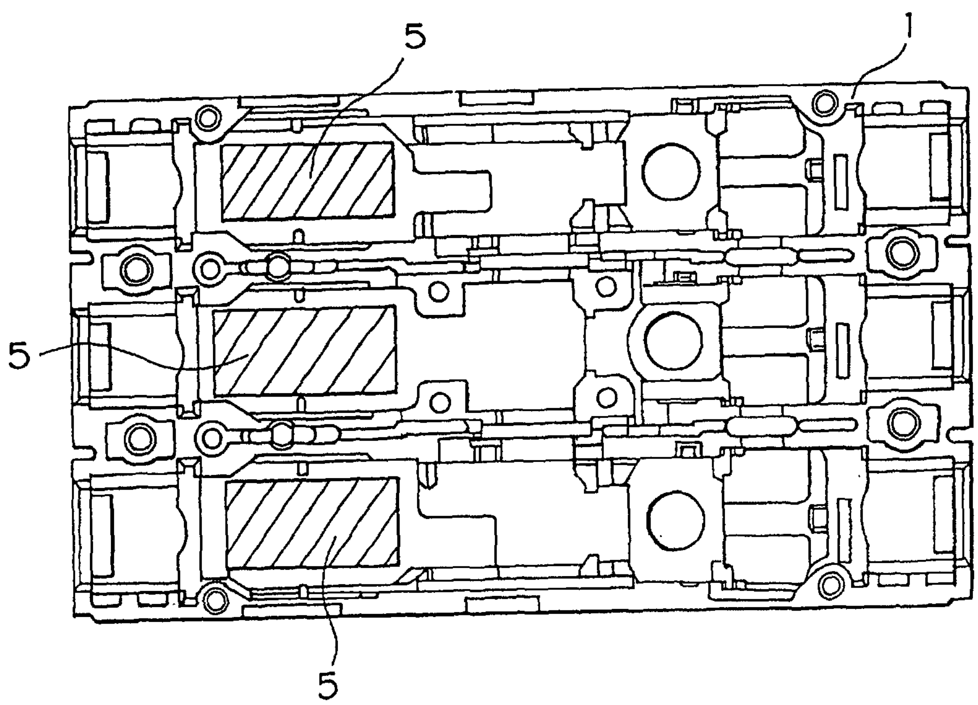
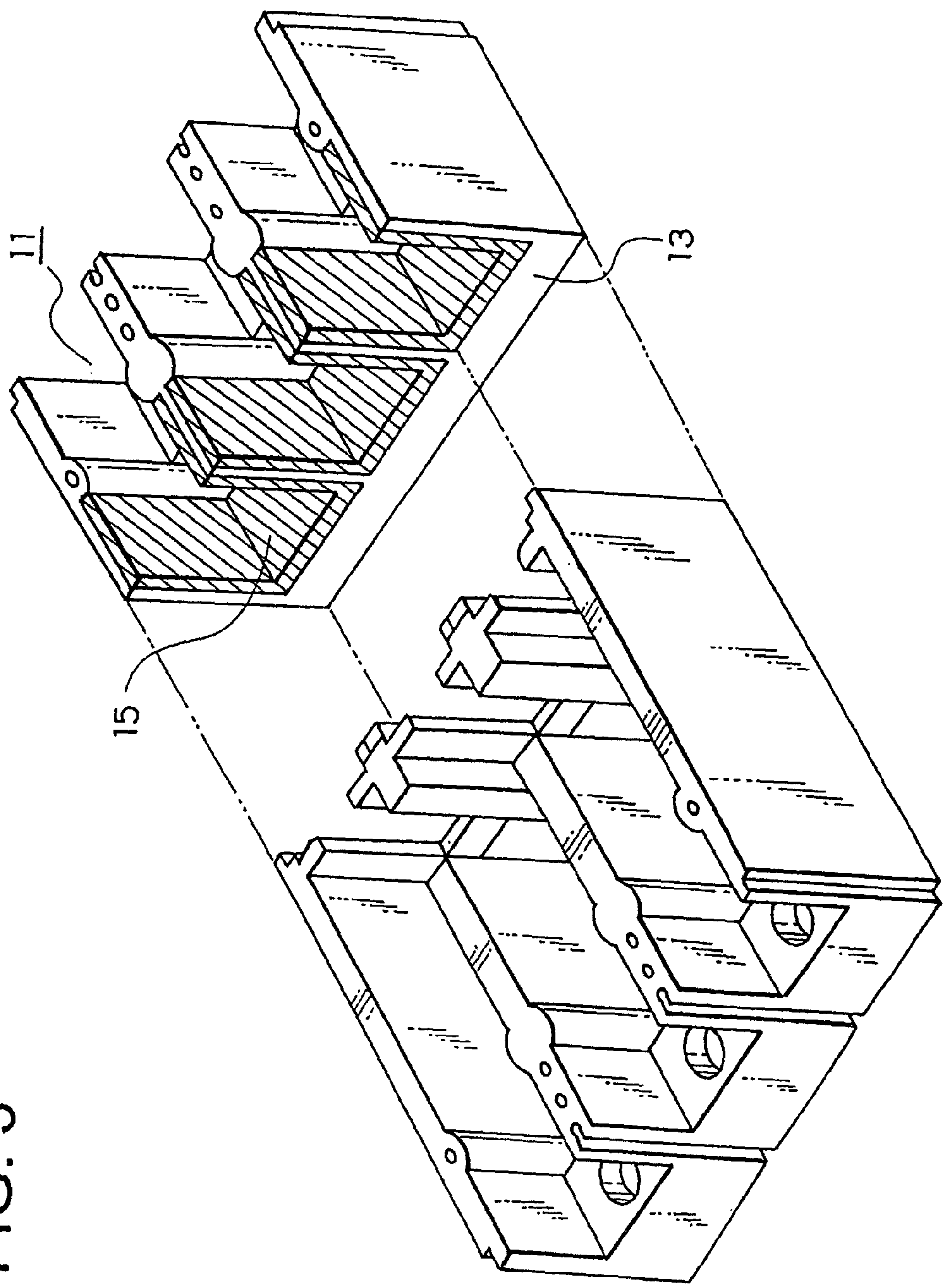


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/03318

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] H01H9/04, H01H73/06, H01H73/18

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[7] H01H9/04, H01H73/06, H01H73/18, C08K3/00

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

Jitsuyo Shinan Koho	1926-1996	Toroku Jitsuyo Shinan Koho	1994-2000
Kokai Jitsuyo Shinan Koho	1971-2000	Jitsuyo Shinan Toroku Koho	1996-2000

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, 2000-109686, A (Toray Industries, Inc.), 18 April, 2000 (18.04.00) (Family: none)	1-5 6-7
Y	JP, 8-171847, A (Mitsubishi Electric Corporation), 02 July, 1996 (02.07.96), & EP, 718356, A2 & CN, 1125236, A & TW, 324733, A	6-7
A	US, 4985485, A (Rhone-Poulenc Chimie), 15 January, 1991 (15.01.91) & EP, 364377, B1 & PT, 91948, A & FR, 2637905, A & BR, 8905185, A & NO, 8904059, A & FI, 8904845, A & DK, 8905066, A & ZA, 8907715, A & JP, 2169666, A & DE, 68908831, E & CA, 1322800, C	1-7

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search 03 August, 2000 (03.08.00)	Date of mailing of the international search report 29 August, 2000 (29.08.00)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
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