

[54] **ARC INTERRUPTING COMPOSITION AND APPARATUS**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 59,554, July 30, 1970, abandoned.
[52] U.S. Cl. **200/144 C, 200/149 A**
[51] Int. Cl. **H01h 33/04**
[58] Field of Search **200/144 C, 149 A, 200/149 R, 144 R**

References Cited

UNITED STATES PATENTS

2,526,448 10/1950 Amundson et al. 200/149 A
2,768,264 10/1956 Jones et al. 200/144 C
3,242,257 3/1966 Jones et al. 200/144 C

3,582,586 6/1971 Jones 200/144 C

FOREIGN PATENTS OR APPLICATIONS

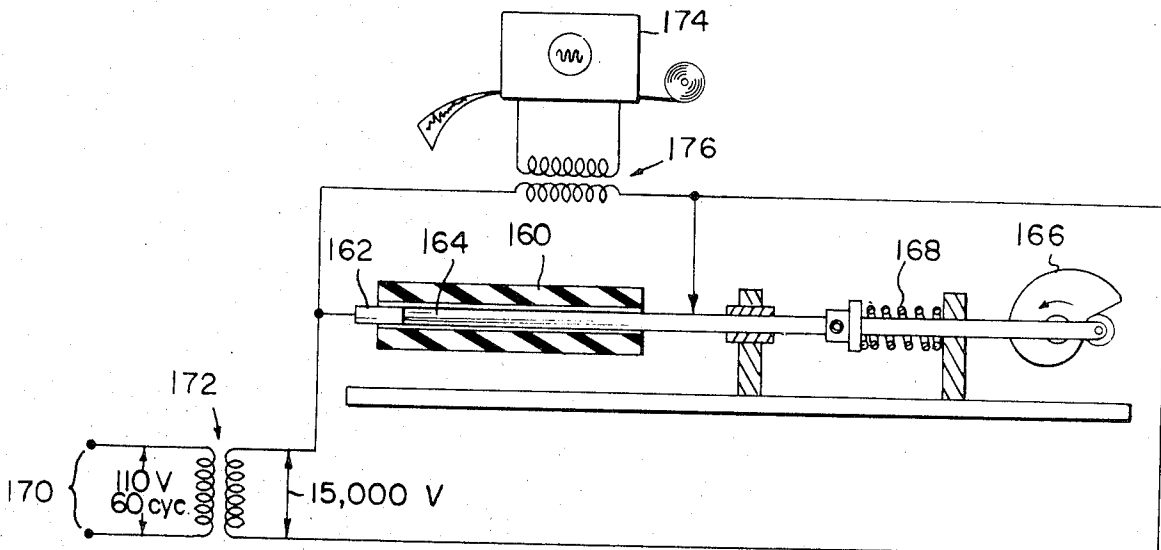
1,065,914 11/1958 Germany 200/144 C

Primary Examiner—Robert S. Macon
Attorney—Thomas P. Jenkins et al.

[57] **ABSTRACT**

An arc interrupting composition for the arc-exposure walls or surfaces of electric circuit interrupting devices. The composition comprises a combination of hydrated alumina and melamine in a binder which may be a thermosetting resin but is preferably a thermoplastic resin which is more reactive to arcing than the melamine. Under arcing conditions, it is believed the binder vaporizes or decomposes violently and the hydrated alumina gives off water of hydration, and that these effects interact to render the melamine more effective and to create improved arc interruption conditions and service life.

6 Claims, 7 Drawing Figures



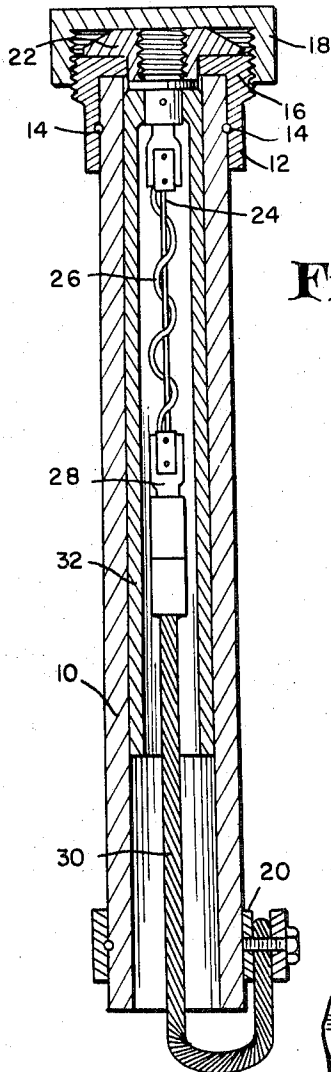


Fig. 1

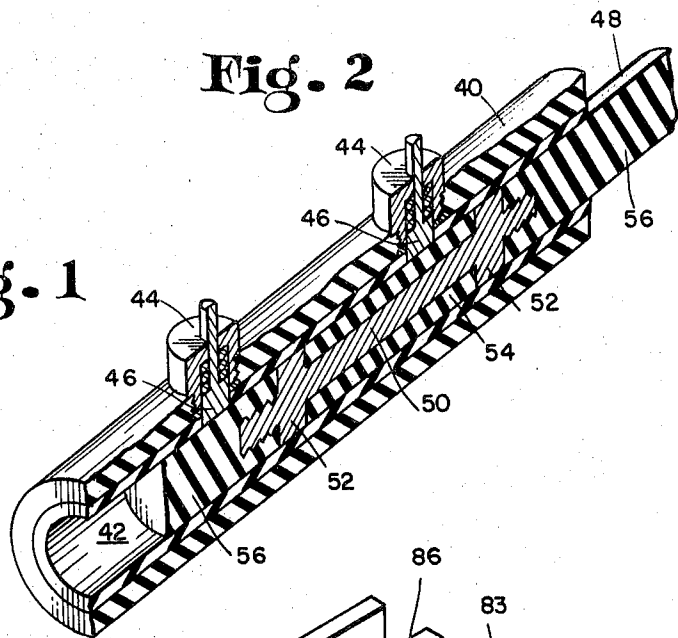


Fig. 2

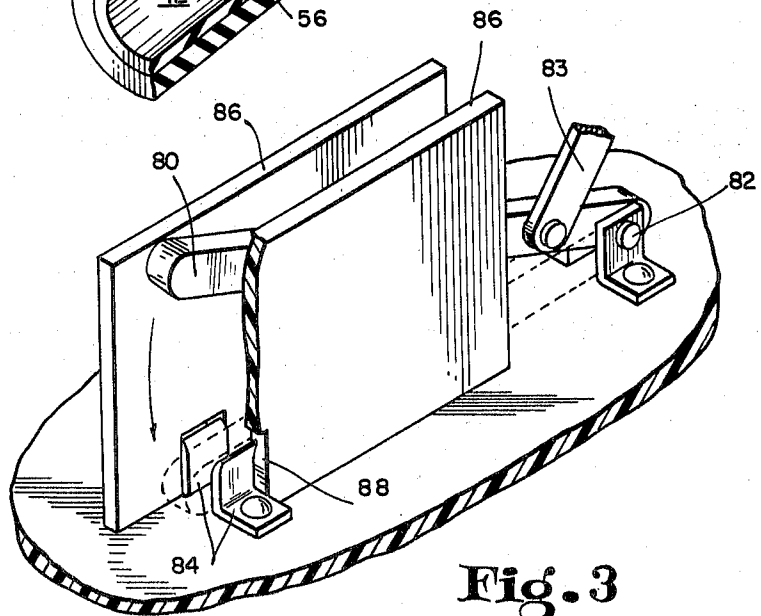


Fig. 3

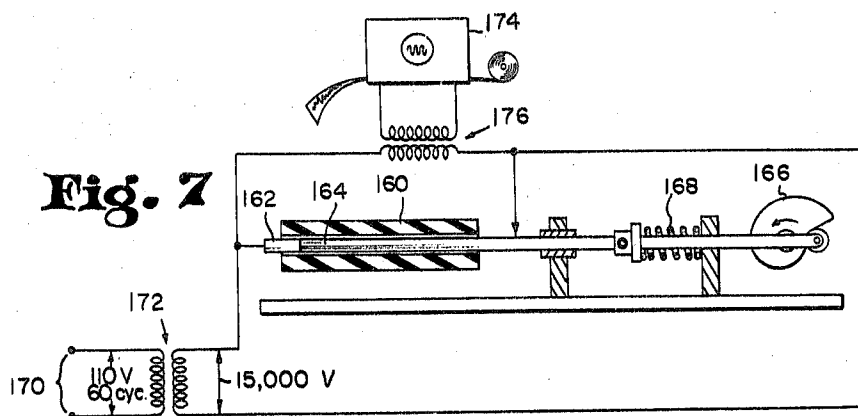
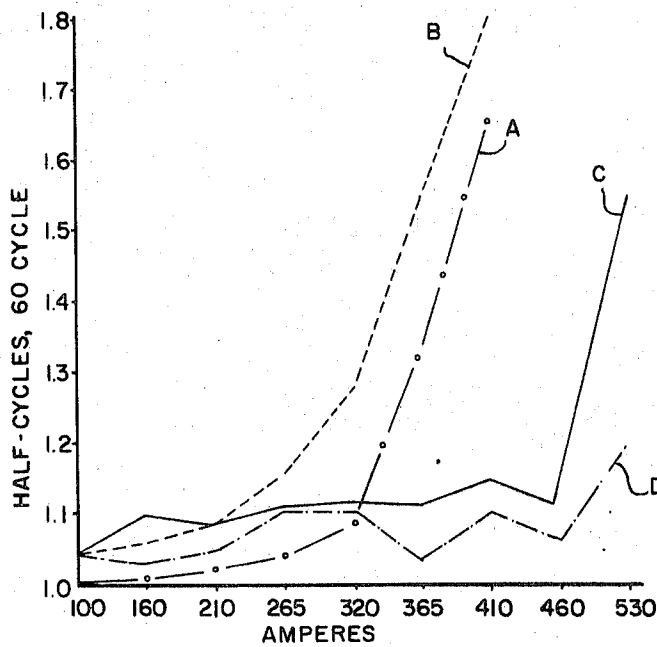
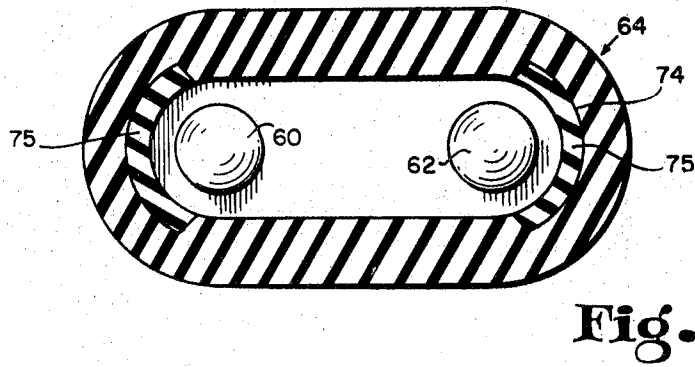
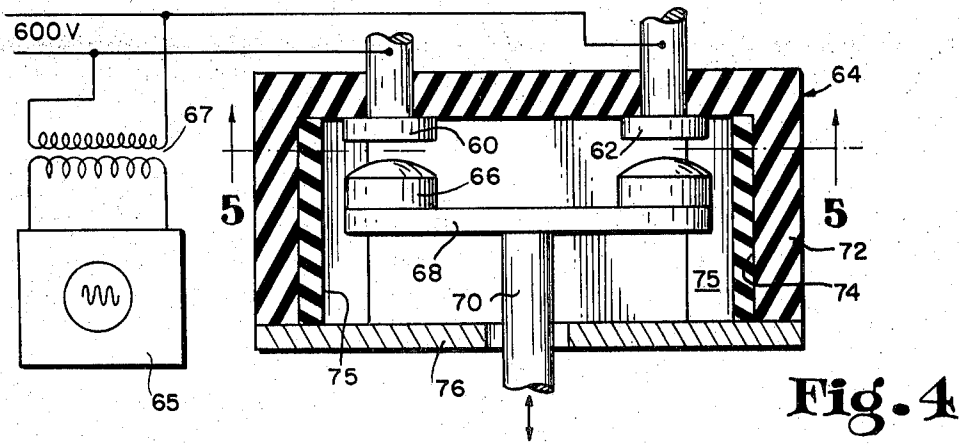


Fig. 7



ARC INTERRUPTING COMPOSITION AND APPARATUS

This application is a continuation-in-part of my prior copending application Ser. No. 59,554, filed July 30, 1970, now abandoned which discloses certain subject matter which was previously disclosed in my prior copending application Ser. No. 536,119, filed Mar. 21, 1966, for Arc-Interrupting Materials and Apparatus, now U.S. Pat. No. 3,582,586.

BACKGROUND OF THE INVENTION

This invention relates to arc-interrupting compositions especially adapted for use at the arc-exposure walls and surfaces, i.e., those exposed to arcing, in electric circuit-interrupting apparatus, to improve the circuit interrupting characteristics of such apparatus.

U.S. Pat. No. 2,768,264 to myself and Robert E. Wilkinson discloses the use of hydrated alumina in molded electrical insulating elements to provide both good physical strength and good electrical properties, especially to provide advantageous arc suppressing and arc quenching characteristics and to reduce the tendency of organic substances to carbonize on the surface of the material and form a conductive path, that is, to prevent so-called "carbon tracking". U.S. Pat. No. 3,242,257 to the same patentees discloses the use of certain addition compounds providing electronegative elements in the composition to improve the ionization conditions produced by such hydrated alumina compositions. The use of hydrated alumina in electrical apparatus as disclosed in these prior patents has become wide spread and has been responsible for great improvements in electrical apparatus, for example, in reducing the size and increasing the capacity of switching apparatus and various other circuit interrupting devices. The role and action of hydrated alumina to give its improved results has been investigated by several investigators and has been attributed both to its release of water of hydration for effective arc quenching and to its catalyzing the oxidation of carbonaceous material and thereby preventing carbon deposits on arc-exposure surfaces.

The arc-quenching abilities of hydrated alumina compositions and other materials has not, however, satisfied the demand for even better arc controlling means, arising both from the use of electrical circuits at higher voltage and amperages, and from economic requirements for greater performance and safety at less cost. This is an empirical art, dealing with the violent and variable conditions of electrical arcing. Hydrated alumina compositions seemed to have reached the limit of their performance capabilities.

My prior co-pending application, now U.S. Pat. No. 3,582,586, proposed arc interrupting compositions of a different character, and sought to provide effective arc interruption under performance conditions, such as at high voltage and amperage, where hydrated alumina compositions were not adequately effective. Such application proposed compositions consisting of (1) the chemical compound melamine, which is effective as an arc interrupting material for very high power arcs but is not highly effective at lower power conditions, and particularly not at low currents, and (2) a thermoplastic binder which is substantially more volatile and more unstable than the melamine and which in the presence of an arc would rapidly volatilize or decompose to form a large volume of gas and to propel the melamine with

explosive force into the core of the arc to render the melamine more effective under a wide range of conditions.

The present application is based on the discovery that whereas the hydrated alumina-based compositions and the melamine-based compositions were each limited in their arc-interrupting characteristics, particularly in some ranges of voltage and amperage conditions, the combination of both melamine and hydrated alumina as essential components with a binder in a single composition gives remarkably improved results over those obtainable with compositions based on either hydrated alumina or melamine alone.

The reason and explanation for this improvement is not clear, and runs counter to what might be expected. Thus the hydrated alumina has been considered to be effective because of the cooling effect of its release of water of hydration, whereas the melamine composition of my prior co-pending application could be considered effective because of the effect of the binder in producing more effective heating of the melamine. It is thought that the improvement involves a change in the ionization conditions in the arc as a result of interaction of the melamine and the hydrated alumina.

In addition to the melamine, hydrated alumina, and binder, the composition may contain other conventional fillers and the like, and may contain reinforcing fibers such as glass fiber, asbestos, and the like. The composition may also contain addition agents in accordance with the teachings of U.S. Pat. No. 3,242,257 issued to me jointly with Robert E. Wilkinson and copending with my said application Ser. No. 536,119.

One of the essential components of the composition is melamine, which is a chemical compound having the empirical formula $C_3N_6H_6$ and which occurs as a white crystalline powder having a melting point of approximately $350^\circ C.$, but which sublimates at melting temperature and below. Its molecule is relatively large and stable, and I believe these properties contribute to its arc-interrupting characteristics. It has been proposed in the prior art as an arc-interrupting compound, as in Amundson et al. U.S. Pat. No. 2,526,448. Melamine itself, however, has a number of deficiencies, notably its lack of effect at lower power conditions and its extreme structural weakness which prevents it from being molded or pressed in a satisfactory structural shape.

The second essential component of the composition is hydrated alumina, which is considered to have the formula $Al_2O_3 \cdot 3H_2O$. This is also obtainable as a finely divided dry material which can be mixed in dry state with the melamine.

The binder used in the composition is preferably a thermoplastic resin. Polyethylene resin is especially satisfactory and desirable, since it is obtainable in a finely divided dry state which can be thoroughly and uniformly mixed with the other dry components to form a dry mixture which can be charged directly as such to molding apparatus. Other thermoplastic resins which may be used as binders include the polypropylene, polytetrafluoroethylene, acrylic and acetyl resins mentioned in my copending application. Other thermoplastic binders which I consider suitable include vinyl polymers, styrene polymers, cellulose polymers, polyamides, and polyimides.

Thermoplastic binders are desirable in that they volatilize or decompose violently in the presence of an electric arc over a wide range of arcing conditions, espe-

cially under low power conditions below those at which melamine itself is effective. The effect of the combination of such binders in a composition with melamine may be visualized as one in which the more responsive binder drives the melamine violently into the very core of the arc where melamine becomes effective, and one in which the combination of components produces large volumes of gas both for its expulsion effects and for its arc extinguishing effects under all of a wide range of conditions.

In addition, thermoplastic binders are advantageous in the composition with melamine and hydrated alumina to provide convenient molding properties, and to give with such other components a structure of adequate physical strength, physical and chemical stability, electrical insulating properties, etc. The choice and proportion of such binders may be varied to suit the application for which the composition is intended. Preferably, the binder may be selected for its own arc-interrupting properties. However, both the melamine and the hydrated alumina in the composition provide effective arc quenching properties, and the hydrated alumina provides non-carbonizing properties, so that the binder itself need not necessarily have good arc-quenching properties or non-carbonizing characteristics.

Whereas the thermoplastic binders are preferable for the reasons indicated, especially for their interaction with the melamine to enhance the arc quenching effects of the melamine, the hydrated alumina in the presence of the arc also appears to interact with the melamine to make it more effective, so that for at least some applications, various other organic binders may be used and may be found desirable. Such other organic binders which may be used comprise various known thermosetting resins, including amino resins such as melamine-formaldehyde resin and urea-formaldehyde resin, epoxy resins, polyester resins, and phenolic resins. They may also include rubber-like compounds, such as butyl and other synthetic elastomer.

The proportions of the essential compounds of the composition may vary, depending on the application and the arcing conditions to be controlled. The binder is preferably present in an amount from 10 to 50 percent of the total composition. All proportions are by weight.

On the basis of present information, I prefer to use melamine and hydrated alumina in a combined amount at least equal to the amount of binder, and not more than 90 percent and desirably not more than 80 percent of the combined total of said components and the binder, and at least about 25 percent of the total composition. I have found that in combination with melamine and binder, even very small amounts, for example, 1 or 2 percent of hydrated alumina is effective to produce improved arc interrupting results. In each 100 parts by weight of the essential components melamine, hydrated alumina and binder, the binder should constitute from 10 parts to 50 parts, melamine desirably constitutes from 10 parts up to about 80 parts, and hydrated alumina is effective and desirably present in a range of from about one (1) part up to about 70 parts.

When fillers and like other components are used in the composition, they may be used in amounts up to say 50 percent of the total composition.

To improve operation at extremely high voltages and amperages, the composition may desirably contain a proportion of finely divided inorganic fillers such as silica, SiO_2 , or aluminum fluoride, Al_2F_6 . It is thought that these act to physically absorb heat when projected into the arc, and also, by their vaporization, to remove considerable energy from the arc. Under repeated operation, however, these tend to build up fused or sintered residues, and hence should be avoided in devices where the parts are required to slide on one another or on other parts.

The compositions are used at surfaces which are exposed to arcing in circuit interrupting apparatus. They may be used to mold electrical insulating elements which forms parts of the apparatus, and the moldings may carry inserts forming contacts or mechanical parts of the apparatus. Also, the composition may be formed as inserts in structural parts made of other material, so that they serve only for arc interrupting purposes and hence are placed as arc chutes or wall liners where they confine and are directly exposed to the arcs which occur. Such inserts may be molded or fabricated as separate parts, or may be formed of composition molded in place on or in a previously formed part. Also, the compositions may be applied as surface coatings, as by formulating the composition with a binder in liquid state and applying such composition as a paint-like coating.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate the invention. In such drawings:

FIG. 1 is a longitudinal sectional view of an expulsion type fuse containing a liner made of a composition in accordance with my invention;

FIG. 2 is an isometric view of a bayonet-type circuit interrupter having a liner made of a composition embodying my invention;

FIG. 3 is a diagrammatic view of a testing device for evaluating arc interrupting compositions of the type here involved;

FIG. 4 is a diagrammatic vertical section of a circuit interrupting switch which may be considered to represent either one "pole" of a switch such as that shown in FIG. 1 of prior U.S. Pat. No. 2,768,264 or to represent a testing device for evaluating compositions in accordance with the invention;

FIG. 5 is a section on the line 5—5 of FIG. 4;

FIG. 6 is a graph of the results of tests conducted on a device as shown in FIGS. 4 and 5; and

FIG. 7 is a diagrammatic view of test apparatus used in Example III.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The expulsion-type fuse shown in FIG. 1 is adapted for use in a conventional manner in a conventional fuse carrier. It comprises an outer rigid tube 10 which may be of conventional vulcanized horn fiber, or a glass-reinforced molded tube, or other known type of expulsion-type fuse tube. At its upper end it carries a terminal collar 12 secured to the tube 10 by a pair of pins 14 and having an externally threaded upper end 16 for the reception of a cap 18. Adjacent its lower end it carries a terminal clamp 20. The fuse comprises an upper headed fuse terminal 22 adapted to be removably clamped between the collar terminal 14 and the cap 18, and connected to the upper end of a strain wire 24 and

a fuse wire 26. The lower ends of the strain wire and fuse wire are connected to a lower terminal 28 which is connected by a flexible conductor 30 to the clamp terminal 20 at the lower end of the tube. The fuse is surrounded by a liner 32 which at its upper end is secured and sealed to the body of the upper fuse terminal 22 and which extends as a liner inside the fuse tube 10 for the entire length of the fuse wire 26 and for a distance beyond the lower fuse terminal 28. The liner is composed of an arc-interrupting composition in accordance with the present invention.

In operation, when the fuse blows, an arc is formed between the upper fuse terminal 22 and the lower fuse terminal 28, and such arc is closely confined and surrounded by the walls of the arc extinguishing liner 32. The arc vaporizes the metal of the fuse wire 26 and strain wire 24 and causes the surface of the liner 32 to vaporize or break down with a rapid evolution of gases which expel the terminal 28 and the now free end of the flexible conductor 30 out of the fuse tube. This lengthens the arc path, and the gases act to extinguish the lengthened arc. To renew the fuse, the cap 18 is removed, the fuse terminal 22 and liner 32 are withdrawn from the supporting outer tube 10, and a new fuse assembly and liner 32 are inserted and locked in place by the cap. The conductor 30 of the spent fuse is discarded and that of the new fuse assembly is connected to the clamp 20. Since the liner 32 is physically supported by the rigid tube 10 it need not be of high strength material and its composition can contain relatively large amounts of melamine and hydrated alumina.

The circuit interrupter illustrated in FIG. 2 is for interrupting heavy power circuits. It comprises an outer cylindrical shell 40 of a molded composition selected for its physical strength, lined with a molded tubular liner 42 of a composition selected for its arc-interrupting characteristics. At spaced points along its length, the tubular assembly carries a pair of contact units each consisting of a fixed hollow stud 44 in which a contact 46 is spring pressed inward. For closing a circuit between the contacts, the shell assembly 40-52 contains a slidable rod 48 which has a relatively close fitting relation in the liner 42. The rod comprises a shorting spool 50 having lands 52 spaced to engage with the spring-pressed contacts 46 and having its center portion surrounded by an insulating sleeve 54 and its ends fixed in end pieces 56. The sleeve and end pieces, like the liner 42 are of a composition having arc-interrupting characteristics in accordance with the present invention.

When the rod assembly 48 is moved to bring the lands 52 into registry with the contact members 46, a large-capacity electrical circuit is closed between the two contacts 46. To open that circuit, the rod assembly is drawn axially to carry the lands 52 out of registry with the contacts 46. When this is done, the arcs which form between the separating lands and contacts are drawn between the close fitting surfaces of the liner 42 and the insulating parts 54 and 56 of the rod, so that the physical confinement of the arcs, and the arc-interrupting characteristics of the material in those surfaces cooperate to interrupt the arc.

In the test apparatus shown in FIG. 7, the test specimen is molded as a tube 160. This is mounted to enclose a fixed electrode 162, and a movable electrode 164 is cyclically moved into arc-striking proximity with

the fixed electrode 162 and withdrawn therefrom to lengthen the arc between the electrodes. The movable electrode is actuated by a motor-driven constant-rise cam 166 which withdraws the movable electrode 164 at a constant rate through a stroke of fixed length and then releases the electrode for return by a spring 168. The arc circuit is supplied with power from a 110 volt, 60 cycle A.C. circuit 170 and the voltage is raised by a transformer 172 to 15,000 volts. The electrode circuit is coupled through a transformer 176 to an oscillograph 174 of a type which draws a trace of the alternating instantaneous current waveform on a paper tape which is advanced as the electrodes are drawn apart. In the recorded waveform, the amplitude of the oscillations represents the current flowing in the arc, and the duration of the oscillations represents the duration of the arc, and shows when the current is interrupted and the arc is extinguished.

EXAMPLE I

The test apparatus shown in FIGS. 4 and 5 was used to run tests giving the results shown in FIG. 6. The test apparatus comprises a pair of contacts 60 and 62 mounted in a box like housing 64 and arranged to be closed by a pair of bridging contacts 66 mounted on a cross bar 68 operatively connected to a plunger 70 by which the contacts 66 can be raised and lowered into and out of engagement with the contacts 60 and 62, to close a circuit between them. In a test setup, the contacts 60 and 62 are connected across a 600 volt circuit, and an oscillograph 65 is connected across the contacts 60-62 through a transformer 67. The oscillograph shows essentially no voltage when the contacts are closed, then as the contacts open the voltage drop across the arc increases until the arc extinguishes and the full voltage is registered across the contacts. The time the arc continues constitutes a measure of the efficiency of the arc extinguishing characteristics of the apparatus, and the duration of the arc is counted in half-cycles of 60-cycle current.

The housing 64 is a molded body of a conventional high-strength molding composition, of polyethylene resin, glass fiber, and hydrated alumina. Its end wall portions 72 are formed with cavities 74 which are filled with inserts 75 of different test materials. The bottom of the housing is closed by a bottom wall 76. In the operation of such a switch, magnetic field effects cause the arc formed between the contacts to be deflected outward from between the contacts and hence against the inserts 75 of test material.

In test operation, the contacts 66 are closed against the contacts 60 and 62 and then opened, once every 10 seconds, and the time required to interrupt the circuit on opening of such contacts is counted in half cycles of 60-cycle current. Such test sequence is repeated 50 times for each test, and the count of half-cycles for the 55 sequences is averaged to give a single test result value. For each composition tested, a 50 sequence test was made at different current values, in progressively increasing steps, so that each composition was subjected to a series of such 50 test-cycle tests at progressively increasing current values.

The test results for four compositions are shown in FIG. 6. The four compositions, identified as compositions A, B, C, and D, contained the components and the proportions shown in the following table.

TABLE I

Composition	A	B	C	D
Melamine.....		3	3	1
Binder:				
Polyethylene.....		3	3	1
Melamine resin.....	15			
Hydrated: Alumina.....	85		3	4
Silica Filler.....		3		

In each case, the components of the composition were mixed thoroughly together and then hot molded in the cavities 74 of previously prepared housings 64.

Composition A, of hydrated alumina and melamine-formaldehyde resin, is representative of the hydrated alumina compositions of U.S. Pat. No. 2,768,264. (The melamine-formaldehyde resin used as the binder in this composition is not the same as melamine, the compound in compositions B-D, but is a thermosetting resin binder which has a strong tendency to carbonize and does not have the arc interrupting characteristics of melamine per se.) Composition A was tested in a series of 50 test-cycle tests at progressively increasing current values from 100 amperes to 410 amperes. The switch 60-62-66 was opened 50 times at 10-second intervals, the time required for arc interruption on each switch opening was counted in half-cycles, and the 50 counts were averaged. The resulting average interruption times for the successive tests are shown by Curve A on the graph of FIG. 6. The average interruption time was less than 1.1 half-cycles on each of the tests at 100, 160, 210, 265, and 320 amperes, but on subsequent tests at 365 amperes and 410 amperes the arc interruption time increased abruptly and Curve A therefore rises steeply after the 320 ampere position. The location of this abrupt increase is significant for comparison with test of other materials.

Composition B comprised three parts each of melamine, polyethylene resin binder, and silica filler. This composition was disclosed as one of the examples in our prior co-pending application, and is representative of a number of test compositions consisting essentially of melamine and a thermoplastic binder. Again, with composition B, a series of tests were made on apparatus as shown in FIGS. 4 and 5, at progressively increasing amperages from 100 amperes to 410 amperes. At each ampere value, the switch contacts were opened once every 10 seconds for 50 times, and the time required for circuit interruption on each such opening observed and counted in half-cycles. The average interruption time at each amperage is plotted on the graph and shown by Curve B of FIG. 6. With composition B, the interruption time progressively increased at a moderate rate on the successive tests at from 100 amperes to 265 amperes and then increased rapidly at the subsequent tests at 320, 365, and 410 amperes, so that the Curve B rose sharply for these ampere values.

Compositions C and D embody the present invention. Composition C contained three parts each of melamine, polyethylene resin binder, and hydrated alumina, and composition D contained one part melamine, one part polyethylene resin binder, and four parts hydrated alumina. These were tested in the same manner as Compositions A and B. With both of these compositions, the average arc interruption time on 50 switch openings on each test was only about 1.1 half cycle or

less throughout the eight successive tests from 100 amperes up to an amperage level of 460 amperes, and the arc-interruption time did not sharply increase until after the 460 ampere test.

Thus on these four tests, compositions A and B showed a sharp rise in the arc-interruption time in successive tests after 320 amperes, whereas compositions C and D in accordance with the present invention gave arc-interruption times averaging only about 1.1 half cycles or less over a much larger number of successive tests and at much higher amperage levels.

EXAMPLE II

Tests of different compositions were made using apparatus as shown in FIG. 3. Such apparatus consists of a switch blade 80 mounted to be swung about a fixed pivot 82 into and out of engagement with a pair of contact jaws 84. The blade was operated by an arm 83 which swung the switch blade 80 with a snap action between open and closed positions. A pair of arc quenching plates 86 were mounted closely beside the path of the blade 80. Such walls 86 were provided with notches 88 at the bottom to clear the switch jaws 84, and the walls extended beyond such jaws sufficiently to confine the arc which formed between the blade and jaws as the switch was opened.

In test operations, the blade 80 was opened from the jaws 84 in a series of openings with the walls 86 composed of different test compositions, and observations were made of the efficiency of the wall compositions in extinguishing the arc formed between the blade and the jaws.

A test was made with walls of a composition E, composed of two parts melamine and one part polyethylene resin binder. Such components were mixed in dry powder state, and then hot-molded in the form of flat sheets. The walls 86 were cut from such sheets. For this test, the switch parts were connected to interrupt a circuit at 15 KV and 200 amperes. Although composition E in the walls 86 was effective at first to extinguish the arc, after three or four switch-openings, such walls 86 of composition E became so softened and deformed by the heat of the arc that they physically interfered with the opening of the switch blade 80 and prevented continuation of the test.

Another test was made with the same apparatus using walls of a composition F consisting of two parts melamine and one part polyethylene resin binder (the same as composition E) and one part hydrated alumina. Again, the components were mixed dry and hot molded to form sheets from which the walls were fabricated. With walls 86 of such composition F, the arc was extinguished effectively during continuous repetitions of switch openings for more than 300 openings with no noticeable softening or deformation of the walls. Tests were then made with the same walls at higher amperage, namely, at 300 amperes and 15 KV, and the walls of the Composition F were again effective to extinguish the arc formed between the blade 80 and the jaws 84 on a continuous succession of switch openings, without wall softening or deformation. Tests were then made at 22 KV and 200 amperes, and the walls of Composition F were again effective. Tests were then made at 15 KV and 400 amperes, and the walls of composition F were again effective to extinguish the arc in a continuous succession of switch openings. Thus, where composition E failed by softening and physical deformation

within a few test openings, composition F in accordance with the present invention gave effective arc interruption and maintained its physical integrity throughout a number of tests with continuously repeated openings, at the same and higher power conditions, and for a total of several hundred switch openings.

Instead of molding the arc-interrupting compositions in or as the arc confining walls of electrical apparatus as in FIGS. 1-5, such compositions may also be applied as coatings to selected surfaces of walls formed of other material. This is especially suitable for certain classes of overload circuit breakers, for example, in which effective arc interruption performance is required but which need to have a service life of only a few operating cycles.

A paint-like coating suitable for application to the inner walls of the housing of a circuit breaker of this class may be formulated by first mixing melamine and hydrated alumina in finely powder state, and then suspending the mixed powders in a liquid vehicle to form a paint-like coating material. The liquid vehicle may be a mixture of a binder resin and a solvent, to form a coating material from which the solvent will evaporate to leave a solid coating. Alternatively, the liquid vehicle may be a mixture of reactive components, such as are known in the formulation of epoxy paints, which will react after application to form a solid coating. By using melamine and hydrated alumina as the solids content with such liquid vehicles, a paint like material is formed which, on application to an arc exposure surface, forms a solid coating thereon having a composition in accordance with the present invention.

EXAMPLE III

The test apparatus shown in FIG. 7 was used to determine the range of proportions of the essential components of arc interrupting compositions. Specimen tubes 160 were molded of different compositions including a binder, different proportions of melamine and hydrated alumina, as shown in the following Table II. With each specimen, a series of circuit interruptions were made, and the arc length and current in each case was recorded in a trace on the tape. The resulting tape records were examined to make sure that uniform arc interrupting results were obtained on each composition, and the tape records were then evaluated to obtain comparative numerical values, as follows:

"Arc Length Index" is a measure of the length of the arc as a percentage of the total stroke length, and indicates the duration of the arc and its energy.

"Ampere Index" is a measure of the amplitude of the current waveform just before the arc is extinguished and represents the current then flowing in the arc in comparison with the full amperage (30 ma) of the circuit. A lower Ampere Index indicates attenuation of the current waveform, and shows greater deionization and reduced conductivity in the arc path, and greater quenching produced by the composition being tested. "Energy Product" is the mathematical product of the Arc Length Index and the Ampere Index, and is a comparative representation of the energy expended in the arc.

These values are not given as accurate quantitative measurements, but are considered to be representative for purposes of comparison.

In the following Table II, the first three columns represent the percentage proportions of melamine, hydrated alumina and binder in the composition tested. The same binder was used in all compositions. The compositions are arranged in the decreasing order of the proportions of melamine to hydrated alumina. The last three columns show the results obtained, in terms of the three values explained above.

For correlation with previous test results, Table II also includes compositions of Examples I and II. Thus, I-A, I-C, and I-D respectively represent compositions A, C and D of Example I above, and II-E and II-F represent compositions E and F of Example II. (Composition A of Example I used a different binder than that tested in this Example III, but had the same proportions.)

TABLE II

	Melamine	Hydrated alumina	Binder	Arc length index	Ampere index	Energy product
20	90	0	10	86.1	27	23
	80	0	20	89.2	28	25
II-E	66 $\frac{2}{3}$	0	33 $\frac{1}{3}$	86.1	30	26
	77.5	2.5	20	80	15	12
	75	5	20	76.9	15	12
	72.5	7.5	20	67.7	10	7
	70	10	20	70.7	10	7
25	61	9	30	80	15	12
	52.5	7.5	40	80	12	10
II-F	50	25	25	81.5	25	20
	50	30	20	81.5	25	20
	48.8	26.2	30	73.8	15	11
	37.5	22.5	40	73.8	15	11
	45	45	10	80	27	22
I-C	33 $\frac{1}{3}$	33 $\frac{1}{3}$	33 $\frac{1}{3}$	72.2	15	11
30	30	30	40	73.8	10	7.4
	25	25	50	80.0	25	20
	30	50	20	80.1	20	17
	26.2	43.8	30	81.5	20	16
I-D	22 $\frac{1}{2}$	37 $\frac{1}{2}$	40	81.5	27	22
	16 $\frac{2}{3}$	66 $\frac{2}{3}$	16 $\frac{2}{3}$	81.5	27	22
I-A*	10	70	20	81.5	27	22
	0	85	15	No interruption	-----	-----
35	0	66 $\frac{2}{3}$	33 $\frac{1}{3}$	No interruption	-----	-----

*Composition I-A (Rosite 2150) contained a different binder, but had the same proportions.

Table II shows that dramatic improvements are obtained by adding hydrated alumina to a melamine composition and by adding melamine to a hydrated alumina composition.

a. At the top of the table, the first three compositions contain melamine and binder but no hydrated alumina. While they were effective to extinguish the arc, they gave high Arc Length Indexes of from 86.1 to 89.2 percent of the total stroke length, and gave high Ampere Indexes. The Energy Product in each case is correspondingly high. The next four compositions represent the addition of small proportions of hydrated alumina to melamine compositions, and produce a dramatic and surprising improvement. They greatly reduce the arc length, the current, and the energy product.

b. At the bottom of the table, the bottom two compositions contain hydrated alumina and binder but no melamine. These alumina-alone compositions each failed to interrupt the arc under the test conditions. A dramatic improvement was obtained by using small percentages of melamine in combination with the hydrated alumina. The three-component compositions, instead of failing, were operative to interrupt the arc. They gave shorter arcs than the three melamine-alone compositions at the top of the table, gave substantially reduced Ampere Indexes, and gave reduced Energy Products.

c. Throughout Table II, all compositions containing both melamine and hydrated alumina showed improved results over compositions containing either melamine alone or hydrated alumina alone.

The test results show that improved results are obtained by the combination of both melamine and hydrated alumina in a binder, and that the improved results are obtained over a wide range of proportions. They show that for each 100 parts of the three essential components, the binder is effective if present in the proportion of from 10 to 50 parts. They show that melamine is effective if present in an amount of at least 10 parts and up to very high proportions limited only by the necessity for a small proportion of hydrated alumina. They show that hydrated alumina is effective if present in amounts up to 70 parts out of the 100 total, and that it is especially effective in very small amounts, down to 1 part per 100 or less. Good results were obtained with only 2.5 parts and the best test results were obtained with hydrated alumina present in amounts of 5 to 10 parts.

The test results of this Example III correlate with the test results previously reported. Thus the 85 percent hydrated alumina, 15 percent binder composition failed here, and the corresponding composition A of Example I have poor results on lower voltage tests, and the melamine composition II-E permitted long high energy arcing here and the same composition was destroyed by heat in the tests of Example II. Also, Compositions I-D and I-C of the present example are in the range where better results were obtained in this Example III, and those compositions also gave better results in the tests of Example I and FIG. 6. Also, Composition

II-F is in the range where better results were obtained than with composition II-E, just as was the case in Example II.

I claim:

1. A new arc interrupting composition consisting essentially of melamine, hydrated alumina, and a binder, each 100 parts by weight of said components containing binder in an amount from 10 parts to 50 parts, melamine in an amount of at least 10 parts, and hydrated alumina in an amount in the range of from about 1 part up to about 70 parts.

2. An arc interrupting composition as in claim 1 wherein the binder is a thermoplastic resin.

3. An arc interrupting composition as in claim 1 wherein the binder is a polyethylene resin.

4. An arc interrupting component for an electrical circuit interrupter, comprising a molded body defining an arc exposure surface and composed at such surface of an arc-interrupting composition as defined in claim 1.

5. An electrical circuit interrupting device, comprising an insulating body defining a surface across which an electric arc can occur, and composed at such surface of an arc-interrupting composition as defined in claim 1.

6. An arc interrupting device as in claim 5 in which said arc-interrupting composition is present as a surface layer on an insulating body of other composition.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,761,660 Dated September 25, 1973

Inventor(s) Paul W. Jones

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 2, line 34, change "compunned" to --compound--.

Col. 5, line 42, change "40-52" to --40-42--.

Col. 5, line 60, change "insulting" to --insulating--.

Col. 6, line 57, change "half-cyces" to --half-cycles--.

Col. 6, line 58, change "55" to --50--.

Col. 7, line 41, change "discloSed" to --disclosed--.

Col. 7, line 42, change "reresentative" to --representative--.

Col. 7, line 59, change "C and C" to --C and D--.

Col. 10, in Table II, column entitled Melamine, change the 12th number down from the top from "48.8" to --43.8--.

Col. 12, line 17, change "comrising" to --comprising--.

Signed and sealed this 19th day of March 1974.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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