May 7, 1940. J. SLEPIAN 2,200,125

ELECTRICAL CONTACT MEANS

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Fig. 1.

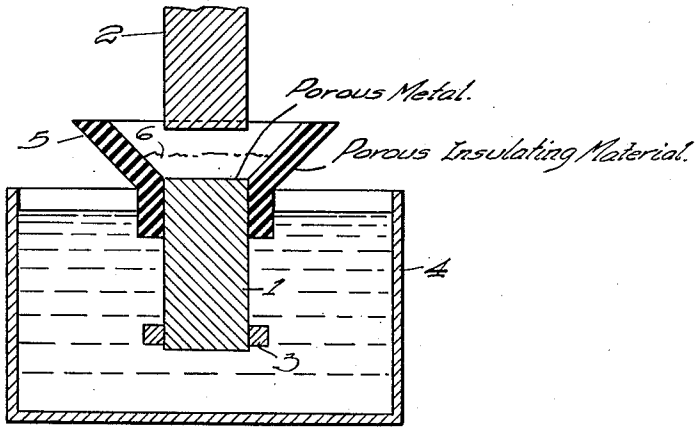


Fig. 2.

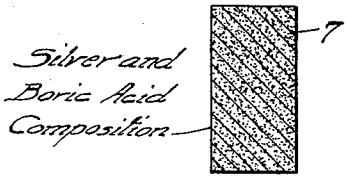
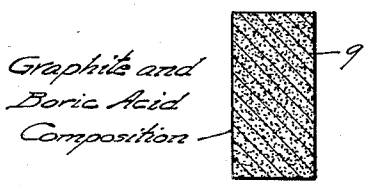


Fig. 3



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ELECTRICAL CONTACT MEANS

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22 Claims. (Cl. 200—149)

The invention relates to electrical contact means for switches and circuit breakers that are adapted to interrupt a circuit under load and overload conditions.

Prior to the present invention it has been the usual practice to provide circuit breakers with some form of arc extinguishing means or device for extinguishing the arcs formed during circuit interruption. This was found necessary in order to shorten the time required for complete circuit interruption and to protect the contacts from damage by the arcs.

An object of the invention is the provision of electrical contacts that are capable of extinguishing the arcs formed during circuit interruption.

Another object of the invention is the provision of electrical contacts containing an appreciable quantity of a substance which gives off an arc extinguishing gas or vapor when acted on by an arc for quickly extinguishing the arc.

Another object of the invention is the provision of an electrical contact as previously described in which the arc extinguishing substance is substantially uniformly distributed through the conducting material of the contacts.

The contact means of the present invention may be used without any additional or separate arc extinguishing device, or they may be used in conjunction with an arc extinguishing device to materially aid the same in more quickly extinguishing the arc.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof, will best be understood from the following detailed description of several embodiments thereof when considered in connection with the accompanying drawing, in which:

Figure 1 is a vertical sectional view of a contact means constructed in accordance with the invention,

Fig. 2 is a sectional view of a modified form of contact, and

Fig. 3 is a sectional view of another modified form of contact.

Referring to Figure 1 of the drawing, the reference numerals 1 and 2 indicate a pair of coaxially mounted separable contacts of a circuit breaker or other form of circuit interrupting device. The contact 1 is carried by a rigid support 3 to form the stationary contact, and the contact 2 is movable into and out of engagement with the stationary contact 1 by any suitable form of circuit breaker operating mechanism to establish and interrupt an electrical circuit in which the contacts are connected.

The stationary contact 1 is formed of wholly porous conducting material such as copper or a suitable alloy of copper and other conducting materials, and is immersed to the level indicated in a body of arc extinguishing liquid such as oil, water or the like held in a container 4. The contact 1 may be made porous in any suitable manner as, for example, by thoroughly mixing a quantity of finely divided particles of the conducting material with an organic binder material such as soap, compressing the mixture into a composite mass of the desired shape, and heat treating the mass to volatilize the soap and bond the conducting material. The voids produced by the removal of the soap form a sponge-like matrix which is about 60% to 70% solid and has a large number of small voids or passages which are substantially uniformly dstributed and extend continuously through the matrix of conducting material. The voids or passages in the contact are maintained filled with the arc extinguishing liquid by capillary action of the small voids, and the contact is preferably surrounded by a barrier 5 of a suitable porous insulating material which is partially submerged in the liquid so as to be soaked with the arc extinguishing liquid. The movable contact 2 may be of solid conducting material, or of the same porous metal construction as the contact 1 and its voids impregnated with an arc extinguishing liquid by vacuum impregnation.

When the contacts 1 and 2 are connected in an electrical circuit and the movable contact moved to open circuit position to interrupt the circuit under load or overload conditions, the heat of the arc drawn between the contacts liberates a considerable quantity of arc extinguishing gas or vapor from the arc extinguishing liquid contained in the stationary contact 1 and also from the surrounding walls of the barrier 5.

The arc extinguishing gas quickly extinguishes the arc in a well known manner. The evolution of the gas in the case of an alternating current continues as the current passes through its zero value introducing an unionized layer of gas as indicated by the dotted lines 6 in Fig. 1. The thickness of the layer may be expected to grow at the rate of about 10^4 centimeters per second and its dielectric strength may be about 10^4 volts per centimeter. Therefore, it should be capable of developing dielectric strength at the rate of about 10^8 volts per second. Since even the highest practical high voltage circuits can develop voltage at only a few

times this rate, several pairs of the contacts connected in series and provided with means for properly dividing the voltage therebetween should be able to successfully interrupt even very high voltage circuits.

The barrier 5 in addition to increasing the quantity of arc extinguishing gas given off also keeps the arc on the contact face of the stationary contact 1. If desired, the barrier may be formed of a material such as horn fibre which gives off an arc extinguishing gas when acted on by an arc.

A number of tests have been made using porous metal contacts which were vacuum impregnated with oil in accordance with the present invention. The oil impregnated porous copper contacts used were about ⅛" thick and ½" in diameter and each was surrounded by an annular ring or barrier of horn fibre for the purpose of keeping the arc on the faces of the contact. The pair of contacts were mounted coaxially, the arc being drawn by separating the contacts a distance of ½". All the tests were made in the air. The results of the tests were as follows:

Circuit voltage, R. M. S.	R. M. S. amperes	Arc time in cycles of 60-cycle circuit
A. C.		
472	44	½
355	42	½
355	2350	½
355	45	½
470	3980	½

The above results indicate that a single pair of oil impregnated porous metal contacts is capable of handling voltages up to about 350 to 400 volts R. M. S. over the wide range of currents tested.

A modified form of arc extinguishing contact is shown in Fig. 2. Referring to Fig. 2, the contact 7 consists of a mixture of silver and boric acid, the boric acid being in the form of powdered ortho-boric acid which is substantially uniformly distributed through the silver. The contact 7 is formed by intimately mixing finely divided silver and powdered ortho-boric acid and afterwards compressing the mixture to the desired shape in suitable molds at a high pressure of several thousand pounds per square inch. There is no difficulty in obtaining a firm hard contact member regardless of the percent of silver used.

When an arc is drawn between a pair of silver boric acid contacts constructed as described above, the heat of the arc causes the emission of a water vapor from the boric acid immediately upon separating of the contacts. The evolution of the water vapor raises the arc voltage considerably to cause a rapid extinction of the arc in the case of low voltage circuits.

The percentage by weight of the silver and boric acid of the contact may be varied over a considerable range. The silver content may range from about 50% to 90% by weight, and the boric acid content from about 10% to 50% by weight, depending upon the particular operating requirements of the contacts. The circuit interrupting ability of the contact improves as the boric acid content is increased. On the other hand, the current carrying capacity decreases when the boric acid content is increased. A practical contact would, therefore, have to weigh these two conflicting factors so as to obtain a material which not only has the requisite circuit interrupting ability but which also has a satisfactory current carrying capacity. A contact which has been found to give good all around performance is one containing about 80% by weight of silver and 20% by weight of boric acid where the object is to clear circuits having a voltage of the order of 110 volts.

A number of tests have been made using contacts composed of silver and boric acid having different percentages of the two materials. The diameter of the contacts was about ⅜ of an inch and each was surrounded by an annular barrier of horn fibre to keep the arc on the face of the contact. The contacts were separated ¼ of an inch and the full contact separation was obtained in about 1/60 of a second. The results of these tests were as follows:

D. C. test data

Tip composition (percent by weight)	Amperes	Circuit volts, D. C.	Time to clear circuit
			Seconds
80% Ag—20% boric acid	310	110	.012
Do	155	110	.017
75% Ag—25% boric acid	59	110	.011
66.7% Ag—33.3% boric acid	255	110	.013
50% Ag—50% boric acid	38	260	.01
Do	86	520	.043

A. C. test data—110 v.–60 cycles

Tip composition	R. M. S. amperes	Time to clear circuit
90% Ag—10% boric acid	2,220	½ cycle.
80% Ag—20% boric acid	Over 2,000	Probably ½ cycle.
66.7% Ag—33.3% boric acid	1,130	½ cycle.
60% Ag—40% boric acid	Over 2,000	Probably ½ cycle.

Another modified form of contact is illustrated in Fig 3, where the contact 9 consists of a mixture of graphite and powdered boric acid, the boric acid being substantially uniformly distributed through the graphite. The contact 9 is formed substantially in the same manner as the previously described silver boric acid contact. A quantity of finely divided particles of graphite are intimately mixed with powdered ortho-boric acid. The mixture is compressed to a solid composite mass of the desired shape in suitable molds at a high pressure of several thousand pounds per square inch. Where the contact contains more than about 60% of graphite by weight, the mixed powder is heat treated at a moderate temperature of from about 80° C. to 100° C. so that when the heated powder is compressed, a better bonding of the materials will take place.

When a pair of graphite boric acid contacts constructed as previously described are separated to interrupt an electrical circuit, the arc drawn between the contacts causes the emission of water vapor from the boric acid immediately upon separating of the contacts. The water vapor raises the arc voltage a considerable amount to cause a rapid extinction of the arc on low voltage circuits. The percentage by weight of the graphite and boric acid of the contact may be varied over a considerable range. The circuit interrupting ability of the contacts increases as the boric acid content is increased. On the other hand, the current carrying capacity of the contact is decreased when the boric acid content is increased. A practical content would, therefore, have to weigh these two conflicting factors so as to obtain a contact which has the requisite circuit interrupting ability but which also has a satisfactory current carrying capacity. A contact which is

capable of giving good all around results is one which contains from 50% to 60% by weight of graphite and the remainder substantially all of boric acid.

A number of tests have been made using contacts composed of graphite and boric acid having different percentages of the two materials. The diameter of the contacts was ⅝" and each was surrounded by an annular fibre barrier to keep the arc on the face of the contact. The contacts were separated ¼", and the full contact separation was obtained in 1/60 of a second.

The results of the tests were as follows:

D. C. test data

Tip composition (percent by weight)	Amperes	Circuit volts D. C.	Time to clear circuit
			Seconds
60% graphite—40% boric acid	740	520	.017
50% graphite—50% boric acid	44	110	.008
Do	53	260	.013
Do	96	520	.017
Do	810	520	.013

The invention in each of its several forms provides a simple and inexpensive contact means which is capable of quickly extinguishing an arc drawn between the contacts during circuit interruption under load or overload conditions.

While the invention has been described in accordance with the provisions of the patent statutes, it is to be understood that various changes in the proportions and materials used may be made without departing from the spirit of the invention. It is desired, therefore, that the appended claims be given the broadest reasonable interpretation permissible in view of the prior art.

I claim as my invention:

1. Electrical contact means comprising a pair of separable contacts at least one of which contains a conducting material and a substance which gives off an arc extinguishing gas when acted on by an arc, and means of insulating material associated with said contact means for keeping the arcs drawn during separation of the contacts on the face of the contacts.

2. An electrical contact composed of an intimate mixture of finely divided particles of conducting material and powdered boric acid compressed into a solid composite mass.

3. An electrical contact comprising silver and powdered boric acid, said boric acid being substantially uniformly distributed through the silver.

4. An electrical contact comprising an intimate mixture of finely divided silver and powdered boric acid compressed into a solid composite mass.

5. An electrical contact comprising an intimate mixture of finely divided silver and powdered boric acid compressed into a solid composite mass, said contact containing from about 50% to 90% by weight of silver and from about 50% to 10% by weight of boric acid.

6. An electrical contact comprising an intimate mixture of finely divided silver and powdered boric acid compressed into a solid composite mass, the boric acid content ranging from about 50% to 80% by weight.

7. An electrical contact comprising an intimate mixture of finely divided graphite and powdered boric acid compressed into a solid composite mass.

8. An electrical contact comprising an intimate mixture of finely divided graphite and powdered boric acid heated and compressed into a solid composite mass.

9. An electrical contact comprising an intimate mixture of finely divided particles of graphite and powdered boric acid compressed into a solid composite mass, the boric acid content ranging from about 40% to 50% by weight.

10. Electrical contact means comprising a pair of contacts which open and close in air, at least one of said contacts comprising a member of conducting material having a number of capillary passages extending therethrough impregnated with a liquid which evolves an arc extinguishing fluid in the presence of an arc, said member being disposed in contact with a body of said liquid to maintain said passages filled with said liquid.

11. Electrical contact means comprising a pair of contacts which open and close in air, at least one of said contacts being composed of porous metal having a large number of continuous capillary voids substantially uniformly distributed therethrough impregnated with a liquid which evolves an arc extinguishing fluid when acted on by an arc for extinguishing arcs drawn by said contacts, said porous metal contact being disposed in absorbent relation with a body of said liquid to maintain said voids filled with said liquid.

12. Electrical contact means comprising a pair of contacts which open and close in air, at least one of said contacts having a large number of capillary passages extending therethrough, said contact being disposed in absorbent relation with a body of liquid which evolves an arc extinguishing fluid when acted on by an arc.

13. Electrical contact means comprising a pair of contacts which open and close in air, at least one of said contacts having a large number of capillary passages extending therethrough filled with oil, said contact being disposed in absorbent relation with a body of oil to maintain said passages filled with oil.

14. Electrical contact means comprising a pair of contacts which open and close in air, at least one of said contacts comprising a member of conducting material having a large number of capillary passages extending therethrough filled with an arc extingishing liquid, said member being disposed in contact with a body of said arc extinguishing liquid to maintain said passages filled with said liquid.

15. Electrical contact means comprising a pair of contacts which open and close in air, at least one of said contacts being composed of porous conducting material containing up to 40% voids forming a large number of continuous capillary passages extending through the material of said contact, said contact being disposed in absorbent relation with a body of liquid which evolves an arc extinguishing fluid when acted on by an arc to maintain said passages filled with said liquid.

16. Electrical contact means comprising a pair of contacts which open and close in air, at least one of said contacts having a large number of continuous small passages extending therethrough filled with a liquid which evolves an arc extinguishing fluid when acted on by an arc, and means for automatically feeding said liquid to said contact to maintain said passages filled with said liquid.

17. An arc extinguishing electrical contact composed of an intimate mixture of finely di-

vided particles of conducting material and finely divided particles of a solid substance which evolves large quantities of an arc extinguishing fluid when acted on by an arc, said mixture being compressed into a solid composite mass.

18. In a circuit interrupting device, a contact capable of emitting an arc extinguishing fluid in the presence of an arc embedded in an insulator also capable of emitting an arc extinguishing fluid in the presence of an arc, said insulator having a portion disposed adjacent the face of said contact so as to be acted on by arcs drawn from said contact.

19. In a circuit interrupting device, a contact member capable of emitting a fluid in the presence of an arc, and means providing a funnel-shaped wall at one end of said contact member around the contact face of said member, said wall being composed of an insulating material and capable of emitting a fluid when acted on by an arc.

20. In a circuit interrupter, a contact member containing a non-fluid substance which emits a fluid in the presence of an arc, and means providing a funnel-shaped wall at one end of said contact member surrounding the face of said contact, said wall being composed of an insulating material and capable of emitting a fluid in the presence of an arc.

21. In a circuit interrupter, a contact member containing a material which emits a fluid in the presence of an arc, and an insulator providing a funnel-shaped wall about one end of said contact member, said funnel-shaped wall being capable of emitting a fluid in the presence of an arc.

22. An electrical contact means comprising a pair of separable contact members disposed in fixed relation when in engagement with each other, at least one of said contact members containing a non-gaseous substance confined in said contact member which generates an arc extinguishing gas when acted on by an arc for extinguishing arcs drawn between said contact members, and means providing a funnel-shaped wall about one end of said contact member.

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