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2,704,381

ARC CHUTE

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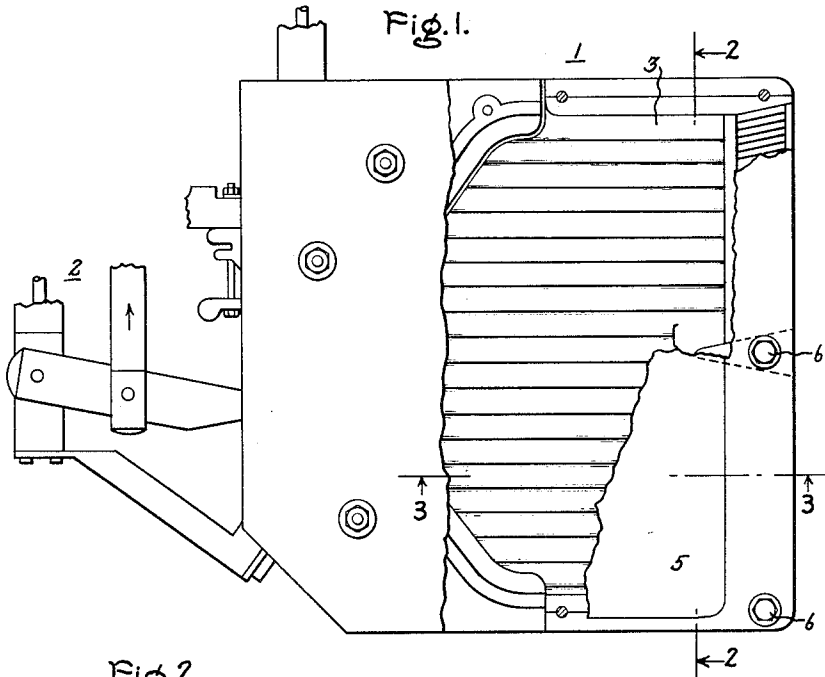


Fig. 2.

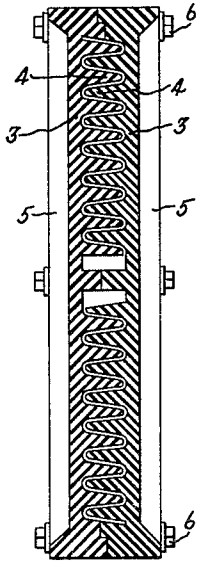


Fig. 3.

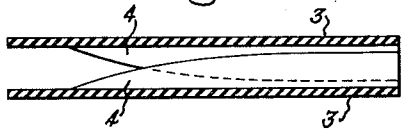
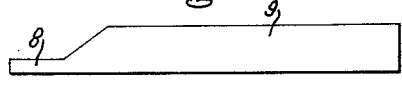


Fig. 4.



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ARC CHUTE

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12 Claims. (Cl. 18—47.5)

The present invention relates to arc chutes or shields commonly used in blowout type circuit breakers, such as magnetic or gas blast circuit breakers, for the purpose of confining and extinguishing the arc drawn between the opening electrical contacts of such devices. It is particularly concerned with an improved inorganic molding composition for the manufacture of such arc chutes.

In blowout type circuit breakers, the arc chute is so designed that the arc will be confined in a relatively small space during the extinguishment thereof, and it is, of course, important that the chute be made of some arc- and heat-resistant material which will aid in the interruption of the circuit by cooling the arc to extinguishing temperatures. The design of a typical chute is shown in the accompanying drawing, in which Fig. 1 illustrates a circuit breaker in partial sectional view including an arc chute of the type with which the present invention is concerned; Fig. 2 is a cross-sectional view taken along line 2—2 of Fig. 1; Fig. 3 is a view taken along line 3—3 of Fig. 1; and Fig. 4 is a view in cross section of a slab or block of molded heat-resistant insulating material which, by suitable machining, is converted to a chute of the desired shape and size.

In Fig. 1 there is illustrated a circuit breaker comprising an arc chute 1 which in the circuit breaker is associated with a pair of relatively movable contacts, not shown. Relative movement between these contacts is obtained by means of an operating mechanism generally indicated at 2. The arc chute 1 is in two sections which together form spaced side walls 3 with each side wall having on the side facing the other wall a plurality of parallel fins 4 integral with the side wall. The sections are suitably clamped together by means of members 5 and bolts 6 to form a chute-like structure with the fins 4 extending perpendicularly into the chute opening in staggered interleaved relation with respect to each other to form an extended sinuous or zigzag passageway for the arc as is best shown in Fig. 2 of the drawing. The detailed operating mechanism of the circuit breaker is not part of the present invention and, therefore, has not been particularly described herein. For such details, reference is made to Patent 2,293,513—Linde as describing a representative circuit breaker in which the chutes of the present invention are employed.

A preferred material for the manufacture of arc chutes for electric air circuit breakers is of the type described and claimed in Patent 2,366,485—Brink et al. The insulating material is an inorganic composition essentially comprising concentrated (at least 60%, and preferably 75%) ortho-phosphoric acid and asbestos of the chrysotile type. In addition to the asbestos and phosphoric acid, the composition may also contain substantial quantities of zircon, talc or other filler.

As described in the Brink et al patent, the asbestos-phosphoric acid compositions can readily be hot-molded. During the molding, there is a reaction between the phosphoric acid and the asbestos so that the molded product can be extracted from the mold. In the manufacture of the large chutes, it has been common practice to hot-mold the asbestos-phosphoric acid compositions into the form of slabs or blocks approximating the shape of the final chute section and thereafter to machine the slabs to the desired shape. For example, the asbestos-phosphoric acid compositions are ordinarily molded into the form of a block or slab having the approximate cross section shown in Fig. 4 of the drawing. Such a slab is composed of a thinner section 8 and a thicker section

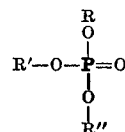
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9. After hot-molding, a plurality of grooves are cut in the thicker portion 9 of the slab at spaced intervals to form the fins 4 of the arc chute section. The machined articles are then subjected to a heat treatment for the purpose of further removing any water from the molded product and completing the cure or hardening reaction between the asbestos and phosphoric acid. Such a heat treatment is ordinarily carried out at temperatures from about 250° to 700° F., preferably about 600° F., for a period of time ranging from about 8 to 12 hours. Finally, it is also the practice to flame condition the finned surface of the chute exposed to the arc in order to partially vitrify or glaze the machined areas and thereby improve the arc interrupting properties of the chute. The flame conditioning treatment ordinarily comprises playing an oxy-acetylene or other high temperature flame over the surface of the chute until a glazed or fused film is obtained.

In practice, it has been found that arc chutes prepared by this process have exhibited considerable warpage during the baking cycle following the machining operation and to a greater extent during the flame conditioning process. Considering the size of the chute sections, it is quite obvious that any significant warpage will prevent proper alignment of the arc chute sections when clamped together in the form shown in Fig. 2 of the drawing.

The present invention is based on the discovery that the warpage problem can be entirely eliminated or substantially alleviated by including in the composition from which the chutes are molded from about 3 to 10%, by weight, of an organic ester of orthophosphoric acid based on the weight of the composition. While the effect of the organic phosphate is not completely understood, it has been found that its use has reduced losses due to warpage during baking of the machine chutes by an average of 93% while a further decrease in warpage is also obtained during the flame conditioning process. The phosphate ester does not affect the final use of the material as an arc chute or arc interrupter.

Tricresyl phosphate is a preferred phosphoric acid ester for the practice of the present invention. However, other organic esters of ortho-phosphoric acid may also be employed in place of or in combination with the tricresyl phosphate. Such esters have the general formula



where at least one and preferably three of the radicals R, R' and R'' are the same or different hydrocarbon radicals, such as alkyl, aryl, alkaryl, aralkyl and alkoxy-allyl, etc. radicals and the remainder, if any, are hydrogen atoms. Examples of such compounds are tri-ethyl phosphate, tributyl phosphate, tri-2-ethylhexyl phosphate, tributoxyethyl phosphate, tri-phenyl phosphate, cresyl diphenyl phosphate, tri-dimethyl phenyl phosphate, diphenyl mono-o-xenyl phosphate, tri-p-tert-butylphenyl phosphate, mono-cresyl phosphate, di-cresyl phosphate and the like.

The advantages of the present invention will become more apparent when it is considered that chutes 20" in length molded from a composition consisting of 52 parts zircon, 35 parts asbestos and 18 parts of 75% phosphoric acid will, on the average, show a warpage of about 80 mils over the 20" length during the baking cycle following the machining operations, and an additional 180 mils during the flame conditioning treatment. However, the addition of 4½%, by weight, of tri-cresyl phosphate to this molding composition before molding reduced the average warpage during the baking cycle following the machining operation to less than 20 mils and the additional warpage after the flame treatment to an average of about 130 mils.

The invention is, of course, not limited to any specific phosphoric acid-asbestos composition and zircon, talc and other inert fillers may be included along with the asbestos and phosphoric acid. However, it is desirable for best results that the phosphoric acid and asbestos be

present in certain proportions. The preferred molding compositions will ordinarily contain about 1 part, by weight, of concentrated ortho-phosphoric acid for each 1.7 to 3.5 parts, by weight, asbestos with the optimum ratio depending to some extent on the texture of the asbestos, i. e., the fiber diameter and length, and the nature of any filler which may be included in the composition. Zircon is a preferred filler and may be present in amounts from 0 to 4 parts, by weight, zircon for each part asbestos. Talc or other fillers may replace part or all of the zircon. In general, the phosphate ester, because of its cost, is not employed in amounts substantially exceeding about 5%, by weight, of the molding composition.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A hot-molding thermosetting composition comprising a reaction mixture of chrysotile asbestos, concentrated ortho-phosphoric acid having a concentration of at least 60% and from 3 to 10%, by weight, of a phosphate ester.

2. A molding compound containing, by weight, about one part concentrated ortho-phosphoric acid, from 1.7 to 3.5 parts chrysotile asbestos, and 3 to 10%, by weight based on the combined weight of acid and asbestos, of an organic ester of phosphoric acid.

3. The molding compound of claim 2 in which the organic ester of phosphoric acid is a tri-aryl phosphate.

4. The molding compound of claim 2 in which the organic ester of phosphoric acid is tri-cresyl phosphate.

5. A thermoset molded product comprising a heat and pressure reacted mixture of chrysotile asbestos fibers, concentrated ortho-phosphoric acid and from 3 to 10%, by weight, of an organic ester of phosphoric acid.

6. The thermoset molded product of claim 5 in which the organic ester is tricresyl phosphate.

7. An arc chute for air circuit breakers comprising the molded product of claim 5.

8. An arc chute for air circuit breakers comprising the molded product of claim 6.

9. A thermoset molded product produced by reacting under heat and pressure a mixture of chrysotile asbestos

fibers, zircon, concentrated ortho-phosphoric acid and from about 3 to 10%, by weight, tri-cresyl phosphate.

10. In the manufacture of an arc chute by a process which comprises hot-molding a reaction mixture of chrysotile asbestos and concentrated phosphoric acid and machining one surface of the molded body to form thereon a plurality of spaced projections followed by a baking of the machined product at an elevated temperature, the step of including in the reaction mixture from 3 to 10% of an organic ester of phosphoric acid for the purpose of preventing warpage of the machined product during the baking step.

11. The method of alleviating warpage of a machined hot-molded reaction mixture of ingredients essentially consisting of chrysotile asbestos and concentrated phosphoric acid during the subsequent baking of the machined product at elevated temperatures which comprises the step of including in the hot-molded mixture from 3 to 10%, by weight, of an organic ester of phosphoric acid.

12. In the manufacture of arc chutes by a process which comprises hot-molding a composition essentially comprising chrysotile asbestos and concentrated ortho-phosphoric acid into the form of a slab, machining the slab into the form of an arc chute having a plurality of fins extending from one surface thereof, baking the machined product for the purpose of removing moisture therefrom and finally playing a flame on the machined surface to obtain a glazed surface coating thereon, the improvement which comprises including in the hot-mold-composition from 3 to 10%, by weight, tri-cresyl phosphate for the purpose of alleviating warpage during the baking and flame treating operations.

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