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[11] 3,928,210
[45] Dec. 23, 1975

[54] **FIRE PROTECTIVE COMPOSITION FOR USE WITH ELECTRICAL CABLES**

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[22] Filed: **Oct. 1, 1974**

[21] Appl. No.: **510,887**

Related U.S. Application Data

[63] Continuation of Ser. No. 218,237, Jan. 17, 1972, abandoned, which is a continuation-in-part of Ser. No. 880,813, Nov. 28, 1969, Pat. No. 3,642,531.

[52] **U.S. Cl.** ... **252/8.1;** 260/29.2 EP; 260/29.2 TN; 260/29.6 R; 260/29.6 MN; 260/29.6 MP; 260/29.1 T; 260/42; 260/42.17; 260/42.18; 260/815; 106/15 FP; 428/290; 428/302; 428/382; 428/383; 428/921

[51] **Int. Cl.**[2] **C09K 3/28**

[58] **Field of Search** ..... 252/8.1; 106/15 FP; 260/29.1 T; 260/42; 260/42.17; 260/42.18; 174/120 C, 120 SR, 121 A, 122 G; 428/290, 428/302, 921, 382

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[57] **ABSTRACT**

A self-extinguishing fire protective composition for use with electrical cables is disclosed. The composition includes a water based resinous emulsion, organically bound halogen and non-combustible fibers.

14 Claims, 2 Drawing Figures

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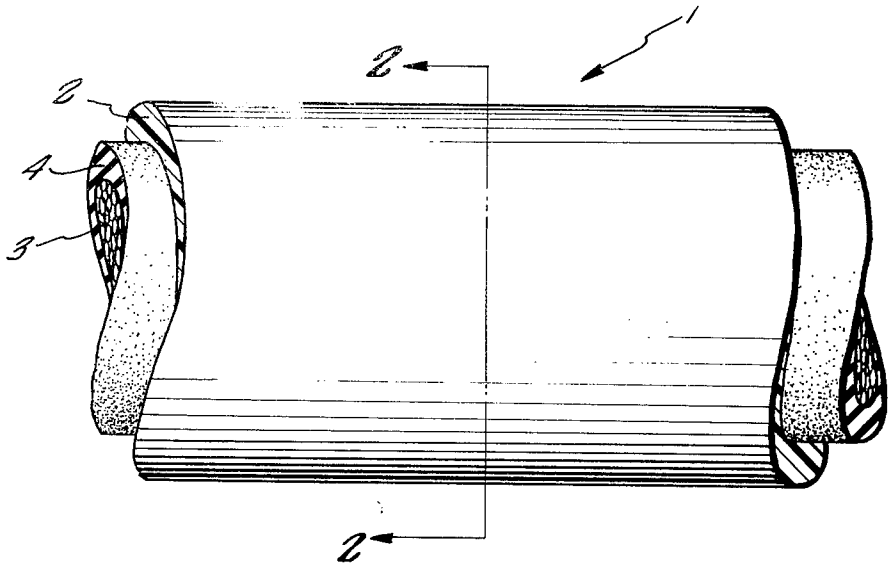


FIG. 1

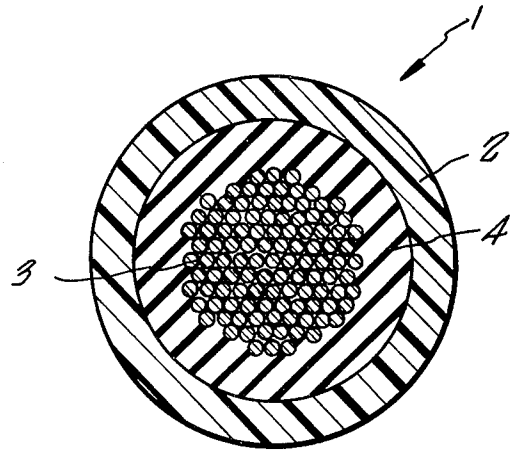


FIG. 2

FIRE PROTECTIVE COMPOSITION FOR USE WITH ELECTRICAL CABLES

This is a continuation, of application Ser. No. 218,237, filed Jan. 17, 1972, now abandoned, which is a continuation-in-part of co-pending application, Ser. No. 880,813, filed Nov. 28, 1969, now U.S. Pat. No. 3,642,531, entitled "WATER BASED FIRE PROTECTIVE COMPOSITION APPLIED TO ELECTRICAL CABLE."

BACKGROUND OF INVENTION

In electrical utilities and other installations where large numbers of electrical cables are used, there is a constant, very serious danger of fire developing due to the heavy current passing through the cables and the heat which is produced when overloading occurs. Also, such cables frequently are operated under high voltage which can cause arcing among adjacent cables.

Since a typical utility may contain thousands of linear feet of cable, the danger thus created by the fire is enormous. Moreover, the cables are totally destroyed which results in a loss of production and also necessitates a sizable expenditure to replace the cables and other damaged equipment or buildings. In the case of nuclear generating stations, the danger posed by the threat of fire is further and dramatically increased.

When the electrical cables have a coating of polyvinyl chloride, there are additional disruptive results of fires. The high chlorine content of polyvinyl chloride (which may have a theoretical hydrochloric acid content of about 56 percent by weight) is freed and combines with the humidity of the air or with water which is used for fire extinguishing to form hydrochloric acid which can penetrate concrete foundations and attack the steel reinforcement.

To protect the cables against fire and to minimize the destructive results of fires, a coating of a fire protective material can be applied to the exterior surface. One example of a formulation which has performed well is a chlorinated rubber composition described in U.S. Pat. No. 2,938,937. Such composition, however, is formulated with a volatile organic solvent such as toluene or naphtha. The use of organic solvents, of course, is not desirable since solvent fumes can be hazardous to applicators of the coating. This is especially undesirable when the cables are in underground vaults. Organic solvents have also been found to cause neoprene and butyl rubber insulation on the cables to swell when a thick coating is applied.

It is accordingly highly desirable to have a fire protective composition which does not require the use of an organic solvent and which contains as little chlorine content as possible. To provide such a composition, however, which also is capable of providing satisfactory fire protection when applied to electrical cables, is exceedingly difficult since the composition must protect the cable for several minutes, in some instances as long as **30** minutes, during the fire and prevent propagation of flames beyond the original heat source. The composition must also be capable of providing a coating on the cable which is sufficiently flexible to allow handling of the cables without breaking of the coating and to permit access to and removal of individual cables from a cable tray. The composition should also be capable of protecting electrical cables against the hazards of fire after immersion in water for prolonged periods of time, and should not significantly diminish

the current carrying capability of the cables, i.e., the coating will not cause significant heat buildup within the coated cables.

SUMMARY OF INVENTION

The present invention thus provides a fire protective composition which, upon application, forms a self-extinguishing fire barrier and does not significantly retain heat within an electrical cable during normal operation. The composition includes a water based resinous emulsion, organically bound halogen, as for example, a halogenated hydrocarbon, and non-combustible fibers.

A principal object of this invention is thus the provision of a fire protective composition which is highly effective in preventing propagation of flames and spreading of a fire when applied to combustible substrates.

Another object of this invention is to provide a fire protective composition which is capable of being formed into a flexible film which permits the cable to be handled easily and which may conveniently be removed from the cable.

A still further object of this invention is to provide a fire protective composition which does not include an organic solvent.

Another object of this invention is to provide a fire protective composition which will not cause swelling of insulation on electrical cables nor affect the electrical or physical properties of the cable insulation in any significant manner.

It is yet a further object of this invention to provide a fire protective composition which may contain only a relatively small chlorine content.

Other objects, features, and advantages of this invention will be apparent to those skilled in the art after a reading of the following more detailed description.

DESCRIPTION OF PREFERRED EMBODIMENTS

The water based resinous emulsion is preferably a thermoplastic such as a polyvinyl acetate emulsion, GRS rubber, natural rubber latex, methacrylate and acrylate resins and co-polymers, elastomeric polyurethanes, polyvinyl and polyvinylidene chloride and co-polymers, and co-polymers of such materials as vinyl acetate and vinyl chloride and polyvinyl acetate and ethylene. Water emulsified epoxy resins may also be used, as can polystyrene and acrylonytrile-butadiene-styrene polymers. The composition must have sufficient resinous emulsion to produce a coherent plastic film or coating when the composition is applied to electrical cables and also one which adheres well to the surface of cable insulation but which can be easily removed. Accordingly, although the quantity of resinous emulsion solids and other ingredients will vary somewhat, as explained in more detail hereinafter, at least about 1.5 weight percent of resinous emulsion solids, preferably at least about 4 percent, will be used, based on the total weight of the composition. In general, the quantity of resinous emulsion solids will be kept relatively low, with sufficient resin being used to provide satisfactory physical properties and a coating which is tough and sufficiently flexible to permit easy handling of coated cables and which contains as little combustible material as possible. Normally, the resinous emulsion solids should not exceed approximately 35 to about 45 weight percent with about 25 weight percent being a generally preferred maximum due to

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asbestosclaims.law/library/22306/3

economical considerations, although in some instances, up to approximately 65 percent may be used.

The composition also includes a compound which serves as a source or organically bound halogen to help impart flame-retarding or self-extinguishing properties to the composition. Examples of such suitable materials are halogenated hydrocarbons, hydrocarbons, particularly chlorinated and brominated hydrocarbons, with the chlorinated hydrocarbons being generally preferred because of economic considerations. Examples of such halogenated hydrocarbons include chlorinated paraffin, such as that available from Diamond Shamrock Corporation under the tradename designation "Chlorowax **70"** which contains from 68 to 73 weight percent chlorine, chlorinated napthalene, chlorinated terphenyl, mixtures of such materials, hexabromocyclodecane, tribromobenzene, polytetrafluoroethylene, chlorotrifluoroethylene, and perchloropentacyclodecane. Other compounds which are suitable sources of organically bound halogen may also be used, such as tetrabromophthalic anhydride, tris (2,3 dibromopropyl) phosphate, tris beta chloroethyl phosphate, and chlorinated biphenyl. Also, if polyvinyl chloride or polyvinylidene chloride is used as the resinous emulsion, such material, of course, likewise serves as a suitable source of organically bound halogen in the composition, thereby making it unnecessary to include a second such material. In such case, the quantity of resinous emulsion may be increased an appropriate amount to compensate for this. For example, if the composition normally contained 35 weight percent resin emulsion and 5 percent halogen, 40 percent resinous emulsion could be used, although it will generally be unnecessary to do so.

The quantity of the compound serving as the source of organically bound halogen will also vary but will normally be within the range of from about 0.5 percent by weight, based on the total weight of the composition, to about 18 weight percent, with from about 1 to about 15 weight percent being the generally preferred range.

The composition will also preferably include a plasticizer to provide flexibility for the coating, although with some emulsions, such as elastomeric polyurethanes and rubbers, it may not be necessary to use a plasticizer. If a plasticizer is used, the selection of a particular plasticizer, of course, depends upon the particular emulsion which is used, with suitable plasticizers being those generally used to plasticize such emulsions. For example, if a polyvinyl acetate resinous emulsion is used, suitable plasticizers include tris beta chloroethyl phosphate, chlorinated biphenyl, butyl benzyl phthalate, dibutyl phthalate, tricresyl phosphate, triphenyl phosphate, cresyl diphenyl phosphate, tritoyl phosphate or mixtures thereof. Normally, the quantity of plasticizer will be relatively small, within the range of from about 1 to about 5 weight percent based on the total weight of the composition, although, to provide greater flexibility, up to approximately 20 weight percent may be used. In the case of polyvinyl chloride, approximately equivalent amounts of resin and plasticizer may be used.

The composition also includes non-combustible fibers, which are normally inorganic fibers such as asbestos or glass. Other such inorganic fibers, as for example, carbon, quartz or talc fibers, may also be used, although asbestos and glass are the preferred inorganic fibers. Also, nonflammable organic fibers may be used, such as the nylon fibers available from E. I. duPont de Nemours and Company under the trade designation "Nomex" and the phenolic fibers available from Carborundum Company under the trade designation "Kynol." The fibers generally perform two functions when the composition is applied to electrical cables as a coating, namely, to reinforce the coating so that the coating remains in place during the intermediate temperatures which may occur in a fire and to remain in place after the resinous emulsion has been consumed by the action of the fire and thus continue to protect the cable jacket by insulation and radiation of heat. With these objectives in mind, the total quantity of non-combustible fibers which may be included in the composition may vary over a considerable range, as for example, from about 2.5 weight percent to about 70 weight percent. In general, if a composition is desired which will provide a coating having greater reinforcement capability as explained above, larger quantities of fibers will be used, but in general the preferred range is from about 5 to about 50 weight percent.

In one preferred form, the composition includes non-combustible fibers of different lengths, i.e., short fibers of about 1/32 inch or less in length and relatively longer fibers of up to about ½ inch in length, the shorter fibers generally comprising from about 20 to about 80 weight percent of the total weight of the mixture of fibers, and preferably from about 50 to about 70 weight percent. Particularly good results have been obtained when both the long and short fibers are asbestos as it is believed that the asbestos fines or short fibers together with the long fibers form a tough film, that is, a dense interwoven network, which remains about the cable insulation surface after burning. Such structure, in combination with the carbonaceous residue of the decomposed binder, is believed to facilitate removal of heat by radiation and at the same time to limit the access of oxygen to flammable cable surface.

Preferably the fire protective composition also includes an antimony containing compound, such as antimony trioxide. Generally, about 0.5 to about 15 weight percent, and preferably from about 2 to about 5 weight percent, of the antimony compound will be used. The antimony oxide is believed to function in combination with the organic halogen during burning by interfering with the normal combustion process, or to limit burning, possibly by reacting with the halogen, as for example, chlorinated hydrocarbon, to form antimony pentachloride, a heavy gas which forms at the boundary of the burning surface and thus prevents oxygen from getting to such surface.

The fire protective composition may also include various inert inorganic fillers, such as calcium carbonate or silica or other such stable inorganic materials. The quantity of fillers will normally be kept within the range of approximately 5 to about 20 weight percent, based on the total weight of the composition. Similarly, the composition may also include organic or inorganic pigments such as titanium dioxide, ferric oxide, etc., to provide a desired color. The quantity of such pigment will, of course, be relatively small, generally no more than approximately 4 weight percent.

If desired, other additives to improve fire retardancy may be included in the composition, such as bismuth compounds and inorganic boron compounds such as zinc borate. Only relatively small amounts of these compounds will be used, generally on the order of a maximum of approximately 10 percent by weight.

The composition may be applied as a fluid or as a mastic by various methods, including spraying, brushing, trowelling, gunning, etc. Depending upon the form of the composition, the composition will contain the requisite amount of water, slightly greater quantities of water being required if a sprayable composition is to be produced. In general, the percent of total solids of the composition may vary from approximately 25 percent solids up to approximately 90 percent. For economical reasons, the generally preferred range will be from about 45 percent to about 80 percent by weights of total solids, based on the total weight of the composition.

The composition may also contain minor amounts of various additives to stabilize and protect the emulsion, such as wetting agents, defoaming agents, fungicides, etc. The quantity of such ingredients will usually be within the range of from about **1** to about 5 percent by weight.

It is advisable to clean the surface to which the coating is to be applied if it contains excessive oil or grease contamination. The surface should also be free of excess loose dirt and dust. When the composition is applied to electrical cables, the coating should be approximately ⅛ inch in thickness. To attain such a coating, the initial thickness should be approximately 3/16 inch when the wet composition is applied as it will shrink approximately 30 percent in drying. If the fire hazard is minimal, the thickness of the coating may be only approximately 1/16 inch, and conversely, if a strong fire hazard exists, the coating may be approximately ¼ inch thick. Depending upon the thickness applied and the atmospheric conditions, the composition will usually dry to touch between 1 and 2 hours, and after approximately 4 hours, the cable may be handled or removed. Complete drying requires up to approximately 3 days, and consequently, fire testing should not take place until at least 3 days after application since traces of moisture left on the inside of the coating could expand and loosen adhesion.

After drying, the water, of course, will have evaporated and the resulting coating, in one formulation, will comprise the following materials in the indicated approximate percentages:

Resin solids	20.25 wt. %
Chlorinated hydrocarbon	7.98 wt. %
Plasticizer	3.99 wt. %
Inorganic Fibers	39.40 wt. %
Inorganic Fillers	19.06 wt. %
Antimony compound	9.31 wt. %

The percent of the various ingredients in the dried coating will vary, of course, depending upon the resinous emulsion, plasticizer, fillers, and fibers used, which in turn depends upon the intended use of the composition and economic and performance requirements, as explained above. In general, the dried coating will contain, based on the total weight of the coating, from about 5 to about 75 weight percent resin solids from the emulsion, with from about 5 to about 30 weight percent being generally preferred, about 1.5 to about 20 weight percent of the organically bound halogen, and from about 3 to about 75 weight percent non-combustible fibers. If a plasticizer is used, the dried coating will normally contain from about 1.5 to about 7.5 weight percent of the plasticizer. Similarly, if inorganic fillers, pigments, wetting agents, etc., or an antimony compound is used, the dried coating will contain from about 5 to about 30 percent and from about 1 to about 20 weight percent respectively of such materials.

It will be readily apparent to those skilled in the art that the ratio of the non-volatile components is the same in the dried film as in the wet composition, and accordingly, such persons will experience no difficulty in ascertaining the appropriate composition for use in a given situation. By way of illustrative example, utilizing a 50 percent total solids wet composition, to achieve a dried coating within the general limits described above, the wet composition will contain from about 2.5 to about 37.5 weight percent resinous emulsion solid, from about 1 to about 10 weight percent organically bound halogen, and from about 3 to about 40 percent non-combustible fibers.

Referring to the accompanying drawings:

FIG. **1** is a fragmentary perspective view of an electrical cable having a coating of the composition applied thereto; and

FIG. **2** is a cross-section view taken on line **2—2** of FIG. **1.**

In the drawing, the numeral **1** denotes generally a piece of electrical cable having a coating **2** of fire protective composition thereabout. In this particular form, the cable core includes a plurality of metal wires **3** having an insulation coatng **4** thereon, which may be neoprene rubber, butyl rubber, polyvinyl chloride, cross-linked polyethylene, etc. As shown most clearly in FIG. **2,** the coating **2** of fire protective composition surrounds the cable and is adhered to the insulation coating **4.**

The invention will be better understood by reference to the following specific but illustrative example.

EXAMPLE

Utilizing the general procedure previously described, approximately 26 percent of a 50 percent solids polyvinyl acetate water emulsion, about 5 percent by weight chlorinated paraffin and about 2.5 weight percent tris beta chloroethyl phosphate plasticizer were mixed about 23 percent additional water with stirring at room temperature for approximately 15 minutes to produce a substantially uniform dispersion. Approximately 7 percent by weight of calcium carbonate filler, 3.5 percent titanium dioxide pigment and approximately 6 percent antimony trioxide were then added and mixed thoroughly for approximately 30 minutes. Approximately 27 percent by weight of asbestos fibers, consisting essentially of about 16 percent of asbestos fines having a length of 1/32 inch or less and about 11 percent of asbestos fibers of up to approximately ½ inch in length, were then added to the emulsion and mixed thoroughly for approximately 60 minutes.

After the composition was prepared as above, it was applied by spraying with standard spray coating apparatus to an 8 foot horizontal cable tray containing approximately 20 insulated electrical cables. The coating was applied to one half of the cable tray, top and bottom, to provide approximately ⅛ inch thickness of coating. The remainder of the cable tray and cables was not coated. The fire protective coating was permitted to dry for 2 days, and the test rig was then positioned in a wind protected area so that wind direction would not influence the results. Burlap bags soaked in transformer oil were then wrapped around the cables and ignited with a propane blow torch. The burning time of the heat source was approximately **6** minutes on the

section of the tray which had been coated as described, after which the fire had burned out. On the uncoated cables, the fire did not burn out until the insulation had been totally decomposed and the metal cables charred and badly damaged. In contrast to this, the coated cables, after being permitted to cool, were inspected and found to be substantially unharmed and suitable for further use.

Tests have also been performed on electrical cables coated with the fire protective composition of this invention to determine whether the coating affects the current carrying capability of the cables, as determined by the temperature rise in the cable during operation. It has been found that such coating does not reduce significantly the ampacity, the reduction being generally on the order of only between 2 and about 5 percent, which is not sufficient to de-rate the cables, the temperature of the insulation on the cables increasing only approximately 2 percent with a ⅛ inch thickness coating of the fire protective composition.

In addition to the previously described qualities, the fire protective composition of this invention is odorless and non-toxic and has a Shore A hardness of up to about **85.** An unsupported 1/16 inch thickness film passes a 1.8 inch mandrel bend per ASTM D **1737-62.** A 1/16 inch film on aluminum is capable of withstanding an impact of at least 24 inches per pound on a Gardener Impact Tester.

Although the foregoing illustrative example could be duplicated herein utilizing the other ingredients previously mentioned and different ratios of the same, the invention is amply demonstrated by the foregoing. Accordingly, for the sake of brevity of disclosure, further illustrative examples will not be set forth herein.

As will be appreciated from the foregoing, the fire protective composition of this invention is very effective in preventing the spreading of fire and thus of protecting electrical cables from the destructive effects of fires. Also, the coating provided by such composition is flexible and does not interfere in any way with the normal use of the installed cables. Additionally, the composition does not cause a significant temperature rise in the cables during operation and has also been found to be stable as a coating over long periods of time.

I claim:

1. A self-extinguishing fire protective composition for the coating of electrical cables containing from about **45** to about **80** weight percent total solids, based on the total weight of said composition, said composition consisting essentially of from about 4 to about 45 weight percent emulsion solids of a water based resinous emulsion selected from the group consisting of polyvinyl acetate emusions, GRS rubber, natural rubber latex, methacrylate and acrylate resins and copolymers thereof, elastomeric polyurethanes, polyvinyl chloride, polyvinylidene chloride, polyvinyl chloride and polyvinylidene chloride copolymers, vinyl acetate and vinyl chloride copolymers, polyvinyl acetate and ethylene copolymers, water emulsified epoxy resins, polystyrene and acrylonitrile-butadiene-styrene polymers, said resinous emulsion binding said composition upon application to electrical cables in a flexible cohesive structurally integral protective coating, about 1 to about 15 weight percent of a compound containing organically bound halogen selected from the group consisting of halogenated hydrocarbons, tetrabromophthalic anhydride, tris (2,3-dibromopropyl) phosphate, trisbetachloroethyl phosphate and chlorinated biphenyl to impart flame retarding properties to said composition, about 5 to about 50 weight percent of non combustible fibers, said fibers remaining in place about an electrical cable during a fire after said binder decomposes and reinforcing and maintaining the physical integrity of a protective coating formed from said composition upon application to electrical cables, about 1 to about 20 weight percent of a plasticizer for said water based resinous emulsion, and from about 0.5 to about 15 weight percent of an antimony oxide containing compound, said composition forming a coherent structurally integral fibrous reinforced self-extinguishing fire protective coating about the surface of electrical cables after application to the same to prevent the spread of a fire from its place of origin without affecting adversely the ampacity of such coated cables.

2. The composition of claim **1** in which said resinous emulsion is a polyvinyl acetate emulsion.

3. The composition of claim **1** in which said organically bound halogen is a halogenated hydrocarbon.

4. The composition of claim **1** including approximately 5 to about 20 weight percent of inert inorganic fillers.

5. The composition of claim **3** in which said halogen is a chlorinated hydrocarbon.

6. The composition of claim **1** in which said fibers are inorganic fibers.

7. The composition of claim **6** in which said composition contains approximately 27 weight percent of asbestos fibers.

8. The composition of claim **7** in which said fibers include from about 20 to about 80 weight percent of the total weight of said fibers of relatively short fibers having a maximum length of approximately 1/32 inch.

9. The composition of claim **1** including a maximum of approximately 10 percent by weight of zinc borate to improve fire retardancy.

10. The composition of claim **1** in which said noncombustible fibers are inorganic fibers selected from the group consisting of asbestos, glass, carbon, quartz and talc fibers.

11. The composition of claim **1** in which said noncombustible fibers are organic fibers selected from the group consisting of nylon and phenolic fibers.

12. The composition of claim **1** in which the remainder of said asbestos fibers have a maximum length of about ½ inch.

13. The composition of claim **1** in which said composition contains from about 2 to about 5 weight percent of said antimony compound.

14. The composition of claim **13** in which said composition contains from about 4 to about 25 weight percent of said water based resinous emulsion solids.

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