May 19, 1936. H. C. DONALDSON, JR., ET AL 2,041,052

FIREPROOF INSULATING COMPOUNDS

Filed Nov. 8, 1934

Fig. 1.

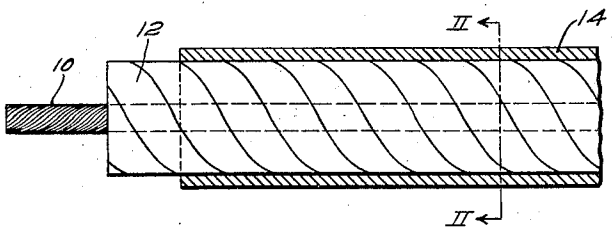


Fig. 2.

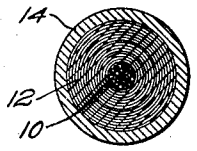
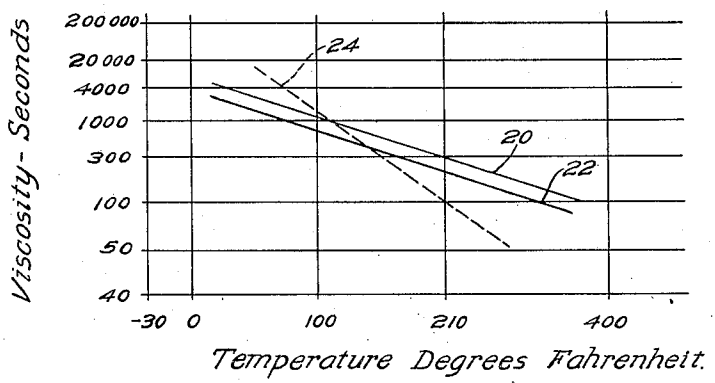


Fig. 3.



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FIREPROOF INSULATING COMPOUNDS

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Application November 8, 1934, Serial No. 752,106

7 Claims. (Cl. 252—1)

Our invention relates to fluid-like insulating compounds of fireproof nature and it has particular relation to compounds of this character which are suitable for impregnating the insulation of metallic sheathed electrical cables.

Such cables are extensively utilized in present day low-voltage network power-distribution circuits many of which are installed in congested city office buildings and in other locations where hazards to public safety and of operating efficiency require that the dielectric fluid utilized to impregnate the cable insulation be fire and explosion-proof. Consequently, it is desirable to eliminate oil and to substitute dielectrics that are non-inflammable, but yet avoid introducing other deleterious qualities.

While there have been developed fireproof insulating fluids which are relatively satisfactory for use in transformers and other like apparatus, when attempted to be applied as an insulation saturant for metal-sheathed cables, these compounds have proved highly unsuitable, they possessing objectionably low and non-uniform viscosities, high evaporation losses and a marked tendency to crystallize. For the named application there thus exists a distinct need for compounds having special and unusual characteristics not required by other applications.

Generally stated, the object of our invention is to provide fireproof insulating compounds which overcome the disadvantages above named and which possess additional advantages to be particularized hereinafter.

A more specific object of our invention is to raise the viscosity of fireproof insulating mixtures to thereby render them more suitable for cable impregnating service.

Another object of our invention is to reduce the variation in the viscosity of such compounds upon changes in their temperature.

An additional object of our invention is to minimize the tendency to evaporate which insulating compounds of named class possess.

A still further object of our invention is to reduce the tendency of such compounds to crystallize when subjected to low temperatures or because of an evaporation of the lighter constituents thereof.

We have discovered that certain of the fireproof insulating compounds already developed for use in transformers and other like electrical apparatus may be made suitable for cable impregnating service merely by adding thereto relatively small quantities of substances, such as polymerized styrene or aluminum naphthenate, which in a substantial degree act to raise the viscosity of the fluid, improve the uniformity of its viscosity with temperature change, decreases the rate of evaporation, and retard crystallization. In practicing our invention we provide fireproof compounds having the characteristics desired for cable impregnation by the making of such additions to certain preferred fireproof mixtures.

For further explanation of our invention, reference will be made to the accompanying drawing, in which:

Figure 1 is a view, partially in section and elevation, of a metal sheathed electrical cable for the impregnation of the insulation of which the compounds of our invention are particularly well suited;

Fig. 2 is a view, taken on line II—II of Fig. 1, showing a cross-section of the cable structure; and

Fig. 3 is a diagram of curves illustrating the improved characteristics possessed by certain of the impregnating compounds of our invention.

Referring to the drawing, the cable illustrated in Figs. 1 and 2 comprises a centrally disposed electrical conductor 10 about which is wrapped a plurality of layers of fibrous material as insulation 12 to assure proper mechanical and electrical separation from a protective outer surrounding sheath 14, which conventionally is in the form of a tube of lead or other like metal. To raise the effectiveness of the electrical insulating properties of the material 12, which conventionally may be in the form of layers of suitable paper sheet, and also to prevent an absorption of moisture by and a formation of gas pockets in this material, it is customary to thoroughly impregnate it with insulating fluid, oil or other like flammable compounds having in the past been utilized for this purpose.

With the advent of fireproof insulating liquids for electrical apparatus, and an appreciation of their superiority from a standpoint of safety, continuity of service and general effectiveness, attempts have been made to utilize these compounds, already successful in their application to other electrical equipment where a high or uniform viscosity is not essential, as saturants of cable insulation. In the past, all such attempts, within our knowledge, have proved unsuccessful, principally, as before mentioned, because of the tendency of the fluids to lower their viscosity with rising temperature and flow out of the cable insulation, their relatively high rates of evaporation when exposed to the atmosphere, and their

low resistances to crystallization under certain conditions.

We have discovered that these objections may be overcome by adding to certain preferred basic fireproof mixtures relatively small quantities of materials which materially modify the compound characteristics. For use as such modifying agents, polymerized styrene, in the form of a powdered resin, and aluminum naphthenate have proved the most effective and hence are the materials which we prefer.

An example of fireproof mixture, previously developed for application as a heat transfer and insulating fluid for electrical apparatus, which may be modified in accordance with the principles of our invention to produce a satisfactory cable impregnating compound is given by the below presented Formula 1:

	Per cent.
Trichlorbenzene—$C_6H_3Cl_3$—(predominantly 1.2.4 isomer)	52.8
Halogenated naphthalene (Halowax) about 54% chlorine	13.4
Halogenated naphthalene (Halowax) about 58% chlorine	13.4
Halogenated naphthalene (Halowax) about 62% chlorine	13.4
Diphenyl oxide—$(C_6H_5)_2O$—or phenyl ether	7.0

It will be noted that to make this basic mixture, which is more completely described in a copending application Serial No. 656,852, by James G. Ford, filed February 15, 1933, and assigned to the same assignee as this invention, halogenated naphthalenes are introduced into trichlorbenzene and diphenyl oxide. The viscosity of this mixture is relatively low, even at low temperature, it being of the general order of 38 seconds Saybolt at 100° F., and it decreases rapidly as the temperature is raised.

We have found that when polymerized styrene, for example, is added to the ingredients of Formula 1 in percentages ranging up to 10% by weight, marked changes in these viscosity characteristics result, the general nature of the resulting characteristics being indicated by curves **20** and **22** of Fig. 3, which respectively apply to the compound of Formula 1 when 10% and 8% of the mentioned modifying material is added thereto. Such an addition acts to materially raise the viscosity throughout the entire range of working temperatures and in addition makes it much more uniform with temperature change. Thus, at 100° F. the 10% addition elevates the viscosity from about 38 to approximately 1200 Saybolt seconds. While greater additions effect further elevations, they also tend to so decrease the content of chlorine as to objectionably impair the fireproof characteristics of the mixture.

In Fig. 3 we have also illustrated at **24** the viscosity-temperature curve which applies to mineral oil of one of the heavy insulating grades, considered most suitable for cable impregnation. It will be noted that this curve is much steeper than curves **20** and **22** which are representative of the characteristics possessed by our improved fireproof compounds. The unmodified halogenated mixture of Formula 1 varies its viscosity with temperature change even more widely than does the mineral oil referred to, hence the improvement effected by our invention is indeed substantial.

Comparable benefits may also be realized by a similar addition of aluminum naphthenate, the effect being to render the compound sufficiently viscous at the maximum operating temperatures (about 75° to 100° C.) encountered in the cable operation to effectively prevent any appreciable amount of flow in the cable. For a modification of the straight halogenated compounds, of which Formula 1 is representative, we have found, however, that the polymerized styrene effects the greatest benefits.

Nor are these benefits restricted to changes in the viscosity characteristics, inasmuch as an addition of the modifying agents serves also to minimize the evaporation losses when the compound is exposed to the atmosphere and also retards crystallization at low temperatures after an evaporation of certain of the lighter constituents of the compound. The resulting mixtures are, therefore, substantially more stable and of correspondingly greater utility in a wide variety of applications, of which cable impregnation is but one.

Another example of a fireproof heat transfer and insulating mixture which may be benefited by an addition of a modifying agent in accordance with our invention is given by Formula 2:

	Per cent
Trichlorbenzene (predominantly 1.2.4 isomers)	26.4
Chlorinated naphthalene	20.1
Diphenyl oxide	3.5
Chlorinated diephenyl oxide (preferably the isometric mixture of the hexachlor compound)	50.0

We have found that apparently due to the presence of chlorinated diphenyl oxide in this mixture, the characteristics may be even more markedly improved than those of Formula 1 upon an addition of up to 10% of polymerized styrene. For example, the resulting mixture is found to have a much lower rate of evaporation at ordinary temperatures, its resistance to crystallization is exceedingly high at low temperatures, and it has no tendency to deposit crystals as a result of evaporation of its lighter constituents.

A still further example of a compound capable of being benefited by a modification in accordance with the principles of our invention is given by Formula 3:

	Per cent
Trichlorbenzene (prodominantly 1.2.4 isomers)	55.6
Chlorinated naphthalene	32.4
Hexachlorbenzene	2.1
Tetrachlorbenzene	2.1
Heavy lubricating oil of mineral grade (120 seconds Saybolt at 210° F.)	7.6

Upon an addition of up to about 10% of aluminum naphthenate to this basic mixture, benefits comparable to those already discussed in connection with the two previous examples may be realized, naphthenate proving especially effective with this particular mixture because of the presence therein of the mineral oil. The mixture of Formula 3 contains such a selection and proportion of ingredients as to make available as much chlorine as possible, the availability of which is one measure of the fire and explosion-proof qualities of the compound. For the purpose of improving the characteristics of this mixture, polymerized styrene or crude rubber may also be used, though with slightly decreased effectiveness.

Although we have shown and described certain specific embodiments of our invention, we are fully aware that many modifications thereof

are possible. Our invention, therefore, is not to be restricted, except insofar as is necessitated by the prior art and by the scope of the appended claims.

We claim as our invention:

1. A fireproof compound of dielectric nature comprising not less than 15% of trichlorbenzene and a quantity of polymerized styrene sufficient to substantially raise the viscosity of the compound and to make this viscosity more uniform with temperature change.

2. A fireproof dielectric in the form of a highly viscous liquid at ordinary temperatures which comprises 1.2.4 trichlorbenzene in a predominating proportion and from 2% to 12% of polymerized styrene the effect of which is to raise the viscosity of the base-material compound and to make this viscosity more uniform with temperature change.

3. A fireproof compound of dielectric nature comprising trichlorbenzene and halogenated naphthalene in predominating proportions, a small quantity of diphenyl oxide, and an additional quantity of polymerized styrene sufficient to substantially raise the viscosity of the compound and to make this viscosity more uniform with temperature change.

4. A fireproof compound of dielectric nature comprising trichlorbenzene, chlorinated naphthalene and chlorinated diphenyl oxide in predominating proportions and a quantity of polymerized styrene sufficient to substantially raise the viscosity of the compound and to make this viscosity more uniform with temperature change.

5. A fireproof compound of dielectric nature comprising not less than 15% of trichlorbenzene and from 2% to 12% of polymerized styrene.

6. A fireproof compound of dielectric nature comprising trichlorbenzene and halogenated naphthalene in predominating proportions, a small quantity of diphenyl oxide, and from 2% to 12% of polymerized styrene.

7. A fireproof compound of dielectric nature comprising trichlorbenzene, chlorinated naphthalene and chlorinated diphenyl oxide in predominating proportions and from 2% to 12% of polymerized styrene.

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