

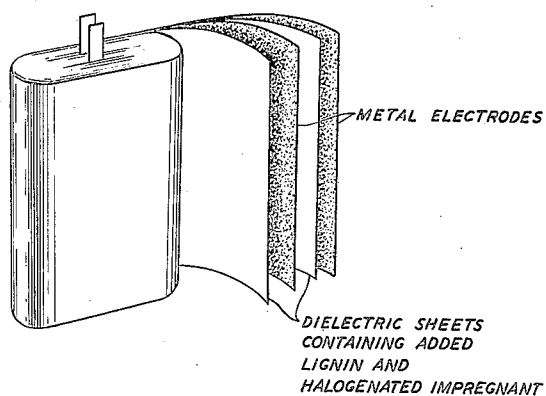
Dec. 25, 1945.

D. A. McLEAN

2,391,687

STABILIZATION OF ELECTRIC CONDENSERS

Filed Jan. 9, 1941



INVENTOR
D. A. McLEAN
BY *T. H. Jackson*
ATTORNEY

UNITED STATES PATENT OFFICE

2,391,687

STABILIZATION OF ELECTRIC
CONDENSERS

David A. McLean, Chatham, N. J., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application January 9, 1941, Serial No. 373,733

8 Claims. (Cl. 175-41)

The present invention relates to electrical insulating materials made up of paper fibres and to electrical apparatus containing such insulation. It also relates to electric condensers and dielectrics for electric condensers. More particularly, it relates to electric apparatus having dielectrics containing halogenated materials and containing substances which tend to decrease the rate of deterioration of these dielectrics.

It is an object of the present invention to prolong the life of electrical apparatus, more particularly electric capacitors, which employ dielectrics containing organic substances which possess halogen atoms within their molecules. Other objects will be apparent from the description which follows.

Halogenated aryl compounds and more particularly the halogenated aromatic hydrocarbons such as chlorinated diphenyl and chlorinated naphthalene are known to be useful electrical insulating materials because of their relatively high thermal stability, resistance to oxidation, non-inflammability, low conductivity and other valuable properties. Most of the halogenated aromatic hydrocarbons used commercially are made up of polar molecules and therefore possess a high dielectric constant which makes them especially useful in capacitors.

Despite these advantages dielectrics containing such compounds often deteriorate at a faster rate than do the dielectric materials which do not contain halogens, particularly when employed under moderately elevated temperatures, high electrical stress or both. This deterioration may manifest itself in one or more of three ways. The leakage current may rise to an unduly high value or in the case of condensers operating on alternating current the power factor may rise unduly. The deterioration may also result in the complete breakdown of the dielectric within a short time causing a short circuit of the apparatus.

The present invention is based upon the discovery that when paper is used as a dielectric in electric condensers impregnated with halogenated organic compounds, the rate of deterioration of the dielectric is materially affected by the lignin content of the paper and upon the discovery that the rate of deterioration of dielectrics containing halogenated organic compounds may be retarded by the addition of lignin.

Lignin is a natural plant material which occurs in trees and other woody plants along with

the cellulose fibres. It is obtained commercially as a by-product in the manufacture of paper from wood as in the kraft, soda and sulphite process. In the manufacture of paper pulp from wood a portion of the lignin remains in the pulp and the remainder is discharged from the process in the form of waste liquor. Of the constituents of the wood which pass into the waste liquor, roughly one half is composed of lignin and the other half is composed of other waste products. This liquor is often discharged as waste or used only for its fuel value.

The lignin which is commercially available is recovered from this waste liquor produced in the manufacture of paper. A suitable form of lignin for purposes of the present invention is the substance known as "Meadol." This lignin is produced by bubbling carbon dioxide through a body of spent soda black liquor for a number of hours until substantially all of the lignin is precipitated. The precipitated lignin may then be separated by filtration from the remaining liquor. The resulting lignin is a thermoplastic solid which is insoluble in water and insoluble in the halogenated aromatic compounds or similar compounds.

The manner in which the practice of the present invention may be carried on will be better understood by reference to the drawing in which the figure represents a perspective view of a conventional rolled type condenser. Such a condenser, which is shown in the drawing by way of illustration, is made up of two metal electrodes formed of a suitable metal foil, such as aluminum foil or tin foil, separated by two dielectric sheets, the whole being rolled into the form shown in the drawing. The dielectric sheets for the purposes of the present invention may be made up of a porous spacer such as linen, cotton or kraft condenser paper, stabilized by the addition of lignin and impregnated with a halogenated organic compound such as chlorinated diphenyl or chlorinated naphthalene. Such condensers are ordinarily prepared by interleaving metal foil electrodes with sheets of paper, rolling the interleaved sheets into the form shown in the drawing and then subsequently impregnating the paper spacers with the halogenated impregnant by any suitable means, such as vacuum impregnation.

The lignin may be introduced into the condenser dielectric by any suitable method for the purpose of retarding deterioration. Thus before the manufacture of the condenser the condenser paper may be dusted with finely divided lignin.

The paper so dusted may then be used in the manufacture of a condenser as described above. A substantial increase in the life of the condenser may ordinarily be obtained by this method.

However, it is preferable that the condenser paper be enriched in lignin by the addition of lignin to the pulp used in the manufacture of the paper. Thus lignin may be added to any suitable paper pulp such as kraft, linen or cotton pulp and sheets of condenser paper may be subsequently formed from the pulp in the conventional manner. This procedure has the additional advantage that the lignin, due to its thermoplastic nature, flows during the supercalendering operation in the manufacture of the paper thus producing a more uniform and non-porous paper than would be obtained in the absence of the lignin. These characteristics make the paper additionally desirable for use in the electrical condensers.

When lignin is added to paper pulp for the purposes of the present invention, it is desirable that it be added in amounts such that the lignin content of the finished paper is from about 10 per cent to about 25 per cent by weight or higher up to as high as 50 per cent by weight or even higher in some instances. The upper limit to the desirable amount of lignin present in the paper is set only by the ability of the pulp to be formed into a coherent sheet of sufficient thinness for the purpose contemplated. The addition of lignin in much smaller amounts than 10 per cent by weight, so as to produce papers containing only a few per cent of lignin, will produce a noticeable improvement in stability over similar paper to which lignin has not been added.

Wood pulp papers, such as kraft paper, as produced by the present commercial processes may often contain lignin in amounts up to 6 per cent or slightly higher. Linen and cotton papers on the other hand have very low lignin contents. In general, kraft paper undergoes deterioration less rapidly than linen or cotton paper when used as a condenser dielectric impregnated with halogenated organic compounds.

The addition of a small amount of lignin to linen and cotton papers, for instance, will decrease materially the rate of deterioration of condenser dielectrics made up of these papers impregnated with halogenated organic compounds even though the lignin content of the linen or cotton paper, after being enriched, is lower than that which would normally occur in kraft paper. By this means a condenser paper may be produced which possesses a stability at least as good as kraft paper and also possesses the advantages of linen paper and cotton paper, or other alpha cellulose papers, over kraft paper in being made up of fibres which have a higher initial dielectric breakdown strength and a lower power factor than kraft paper. It is, therefore, to be understood that the present invention includes within its scope the addition of lignin in small amounts to condenser paper, as well as the addition of lignin in amounts sufficient to bring the lignin content of the finished paper up to the more desirable amounts of 10 per cent to 25 per cent or even higher.

In place of adding lignin itself to paper pulp the same result may be accomplished by adding lignin-rich materials to the pulp. A suitable lignin-rich material to be added for the purposes of the present invention is the substance avail-

able commercially and known as hydrolyzed wood. Hydrolyzed wood is produced by forming a pulp of raw wood fibres, hydrolyzing a part of the cellulose in the fibres and removing the hydrolytic products, thus increasing the proportion of lignin to cellulose remaining in the fibres. The substance thus produced has a lignin content up to 40 per cent by weight of the solid constituents. As in the case of lignin the hydrolyzed wood may be added in any suitable amount to any suitable paper pulp such as kraft, linen or cotton pulp and the resulting mixture may be formed into paper sheets in the conventional manner. Alternatively the hydrolyzed wood itself may be formed into a pulp and made directly into paper sheets without the addition of other pulps.

The lignin-rich condenser papers produced as described above may be interleaved with any suitable foil, such as aluminum foil or tin foil, and formed into electrical condensers in any suitable manner such as that described above and may subsequently be impregnated with any suitable halogenated organic compound, such as chlorinated diphenyl or chlorinated naphthalene.

Although the invention has been described above as being directed principally to electrical condensers impregnated with halogenated aromatic hydrocarbons, such as chlorinated naphthalene or chlorinated diphenyl, it is to be understood that the use of lignin-rich papers will be advantageous in electrical condensers impregnated with any halogenated organic compound which by virtue of its halogen content tends to cause unduly rapid deterioration of the dielectric. Moreover, the use of lignin-rich papers will be found desirable not only for condenser dielectrics but also for other insulating purposes in other electrical apparatus wherein the insulating paper is exposed to an electric potential and is impregnated with a halogenated organic compound which by virtue of its halogen content tends to cause unduly rapid deterioration under the conditions of operation. As examples of such use, kraft paper enriched in lignin or linen paper enriched in lignin, as described above, may be wrapped about an electrical conductor so as to form an insulating covering and may be impregnated with a halogenated aromatic compound such as chlorinated naphthalene or chlorinated diphenyl. For the insulation of electrical conductors it is not necessary that paper sheets be formed but the paper pulp, enriched in lignin or having a lignin content sufficient to produce an insulating layer containing at least 10 per cent by weight of lignin, may be formed directly into an insulating layer on the conductor in the conventional manner for the production of pulp insulation.

The beneficial effect of lignin in improving the life of condenser dielectrics or other insulating materials impregnated with halogenated organic compounds is not confined to paper dielectrics. Any porous spacer, such as a textile fabric, may be improved for use as a dielectric material impregnated with a halogenated organic compound by the incorporation of a suitable amount of lignin in any suitable form. For some dielectric purposes where a dielectric sheet is maintained in contact with a halogenated organic compound and where extremely thin sheets are not required, it may be possible to eliminate the fibrous material completely and to employ sheets formed substantially entirely of lignin.

Other modifications of the devices and the pro-

cedures described above, which are intended to be purely illustrative, will be apparent to those skilled in the art and are intended to be included within the scope of the present invention, which is to be limited only by the scope of the appended claims.

What is claimed is:

1. An electrical insulating element comprising a body of paper fibres impregnated with a non-gaseous halogenated organic compound which possesses good electrical insulating properties and which by virtue of its halogen content tends to cause unduly rapid deterioration of the insulating element during use, said element containing at least 10 per cent by weight of lignin to retard said deterioration.

2. An electrical insulating element comprising a body of paper fibres containing at least 10 per cent by weight of lignin and impregnated with a halogenated aromatic hydrocarbon.

3. The article described in claim 2 wherein the halogenated aromatic hydrocarbon is selected from the group consisting of chlorinated diphenyl and chlorinated naphthalene.

4. A condenser dielectric comprising paper, the fibers of which are obtained solely from linen pulp, said dielectric being impregnated with a halogenated organic compound selected from the group consisting of chlorinated diphenyl and chlorinated naphthalene, said dielectric containing at least 10 per cent lignin by weight of the paper.

5. An electric condenser comprising metal armatures separated by a paper spacer containing over 10 per cent lignin and impregnated with a substance selected from the group consisting of chlorinated diphenyl and chlorinated naphthalene.

6. An electric condenser comprising metal armatures separated by a dielectric comprising a paper spacer containing at least 10 per cent by weight of lignin and impregnated with a non-gaseous organic compound containing a chlorinated aromatic ring which possesses good electrical insulating properties and which by virtue of its halogen content tends to cause unduly rapid deterioration of the dielectric during the operation of the condenser.

7. The electric condenser described in claim 6 wherein the organic compound is a chlorinated aromatic hydrocarbon and the metal armatures are formed of a metal selected from the group consisting of aluminum and tin.

8. An electrical condenser comprising metal armatures separated by a paper spacer containing at least 10 per cent by weight of lignin and impregnated with a halogenated aromatic hydrocarbon which possesses good electrical insulating properties and which by virtue of its halogen content tends to cause unduly rapid deterioration of the dielectric during use.

DAVID A. McLEAN.