

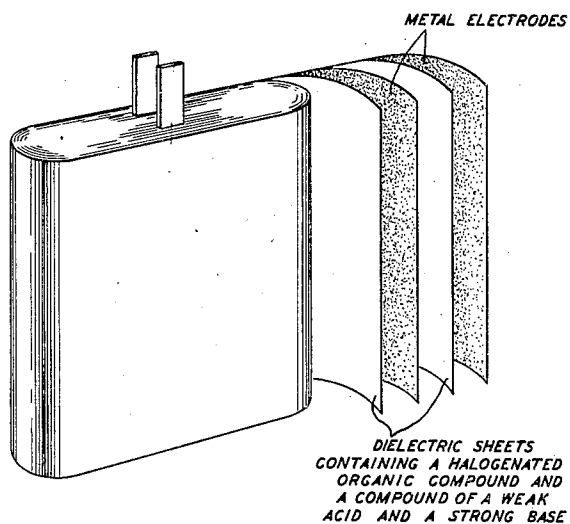
Dec. 25, 1945.

D. A. McLEAN

2,391,688

MANUFACTURE OF ELECTRICAL CONDENSERS

Original Filed Aug. 31, 1938



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

## UNITED STATES PATENT OFFICE

2,391,688

MANUFACTURE OF ELECTRICAL  
CONDENSERS

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

Application November 14, 1940, Serial No. 365,642, which is a division of application Serial No. 227,652, August 31, 1938. Divided and this application December 10, 1941, Serial No. 422,311

11 Claims. (Cl. 175-41)

This invention relates to electrical condensers containing novel dielectric materials. More particularly, it relates to electrical condensers having dielectrics containing or impregnated with halogenated materials which tend to break down slightly to form halogen acids and also containing substances which tend to increase the life of the dielectric. This application is a division of the application of David A. McLean, Serial No. 365,642, filed November 14, 1940, which is a division of the application of David A. McLean, Serial No. 227,652, filed August 31, 1938.

It has been found that certain halogenated substances or more particularly, certain halogenated organic compounds, chiefly halogenated aromatic or cyclic hydrocarbons such as the chlorinated hydrocarbons, chlorinated naphthalene and chlorinated diphenyl, are very desirable materials for condenser dielectrics. Ordinarily they are employed by impregnating them in porous spacers such as paper, textiles or other cellulosic materials. The resultant dielectrics possess a high dielectric constant, high resistance, low dielectric loss and high chemical stability.

According to the present invention, it has been found that the life of condensers containing this type of dielectric can be considerably prolonged and that the ultimate failure of the dielectric, particularly when the condensers are operating under direct current potentials and at elevated temperatures, can be postponed by incorporating in the dielectric materials which act as stabilizers for the halogenated materials.

The ultimate failure of the dielectric appears to be due to disintegration of the compounds comprising it. Inspection of an impregnated paper dielectric of this type after failure shows it to be spotted with carbonized and decomposed areas.

Although the invention is not to be limited to any theory of operation, it is believed that the failure of the dielectric is due to the fact that the halogenated dielectric materials, such as chlorinated naphthalene and chlorinated diphenyl, although they are ordinarily considered stable, tend to decompose slightly, particularly under the influence of an electrical field, to form traces of halogen compounds, chiefly hydrohalogen acids, such as hydrochloric acid. This decomposition process is autocatalytic in that the trace of hydrohalogen acid formed tends to accelerate the further decomposition of the halogenated compounds. The presence of this hydrohalogen acid, which acts as an electrolyte, decreases the resistance of the dielectric in the areas in which it is concentrated and, in the case of an impregnated

paper dielectric, the combined electrical and chemical action causes the destruction of the cellulose of the paper spacer.

The presence of free acid is also objectionable because it causes corrosion of the metal electrodes. When aluminum electrodes are employed, as is often preferable, reactions involving traces of hydrochloric acid are particularly objectionable since the aluminum together with the hydrochloric or other hydrohalogen acid forms aluminum chloride or other aluminum halide. Aluminum chloride, for example, is known to be a catalyst for the destruction of halogenated organic compounds and, therefore, causes the formation of additional hydrochloric acid. Both the aluminum halide and the hydrohalogen acid act to cause the breakdown of the cellulose in the paper spacer and consequent failure of the dielectric.

It is an object of the present invention to increase the life of condenser dielectrics containing halogenated materials. Broadly this is accomplished by incorporating in the dielectric a substance capable of reacting with the generated hydrohalogen acids to form substantially inert and preferably non-electrolyte substances. Only very small amounts of these materials are required to be added since, if the small amount of generated acid is neutralized or rendered inactive, the autocatalytic action of the acid is prevented so that the decomposition of the halogenated substances is much less rapid.

The manner in which the present invention may be applied to condensers may better be understood by reference to the accompanying drawing which shows a roll type condenser made up of two electrodes separated by a dielectric material.

The substances used for rendering the hydrohalogen acids inactive according to the present invention are the salts of weak acids with strong bases. The salts of weak acids with stronger bases function by reacting with the halogen acids to form a halide of the base, thereby setting free the weak acid, both of which resulting substances are substantially inert. However, since these salts are electrolytic to a mild degree, it is desirable that the amount added be kept below about 2 per cent, in general, to prevent an impairment of the electrical properties of the dielectric. Preferably the amounts of added salts lie between about .2 per cent and about 2 per cent. The neutralizing salts are preferably salts of alkali metals or of alkaline earth metals, such as sodium, potassium, lithium, calcium, magnesium or strontium, with weak organic or inorganic acids such as boric acid,

carbonic acid, oxalic acid or acetic acid or with the very weakly ionizable organic acid substances contained in pectin, gum arabic, cherry gum or other carbohydrate gums, or with the acid derivatives of the carbohydrates such as, for example, the gluconic or uronic acids. Carbohydrates, which contain hydrogen atoms of very weakly acidic nature in that they are replaced by the basic metals upon reaction with hydroxides of these metals, may also be employed in the form of compounds with these basic metals. Since the pectins, gums and carbohydrates are the least ionizable of the available substances, salts of these substances are the preferable ones. For economic reasons, the metallic compounds with gum arabic, particularly the calcium compounds with gum arabic are preferable. The commercial gums and pectins available on the market ordinarily contain small amounts of metallic constituents, chiefly calcium and magnesium, in organic combination with their acid constituents. However, preferably they are enriched in these metallic constituents before being added to the dielectric. They should contain at least about 1 per cent of metallic constituents and preferably about 3 per cent or more. Although in general the salts of a weak acid with a strong base should not be added to the dielectric in an amount greater than about 2 per cent, nevertheless, when a compound of a base with a pectin, a gum or a carbohydrate is used, the substance may be added in amounts between about .2 per cent and about 5 per cent.

The stabilizers above referred to may be added to the dielectric in any suitable manner. For instance, when a porous spacer such as paper, a textile or other cellulosic material is employed, it may be impregnated with a solution or suspension of the stabilizer in water or other suitable medium.

When a paper spacer is used the stabilizer may conveniently be incorporated in the paper pulp prior to the formation of the paper sheet. This is a desirable method of incorporating the soluble salts since soaking of the finished paper in aqueous solutions tends to weaken and disintegrate it.

Any of these methods may be employed to form a condenser, as for example, the type shown in the drawing. Fig. 1 shows a rolled condenser made up of alternate layers of metal foil, such as aluminum or tin foil, and dielectric material. This condenser may be prepared by incorporating the desired stabilizer in a sheet of cellulosic material, such as paper, and placing the desired number of dielectric sheets between two or more metal sheets. The alternate layers of dielectric and metal electrodes may then be rolled into the condenser shown in Fig. 1 and impregnated with the halogenated impregnating medium. The condenser may then be placed in a protecting case or otherwise utilized as desired.

As a specific example of the formation of a condenser by this method, several sheets of thin linen condenser paper are soaked in a 1 per cent aqueous solution of gum arabic containing about 5 per cent calcium in organic combination. After the sheets have become thoroughly saturated they are removed and passed through heated rolls to remove the excess solution and dry the paper. A condenser is then formed in the usual manner using the paper as a dielectric and aluminum sheets as electrodes. The condenser is then impregnated by a suitable process, such as vacuum impregnation, with chlorinated naphthalene

maintained at a temperature somewhat above the melting point of the chlorinated naphthalene. When the paper has become thoroughly impregnated, the condenser is removed and allowed to cool.

Obviously the impregnation of the paper with the gum arabic and the subsequent drying may take place as a continuous procedure by passing a continuous sheet of paper from a roll through the impregnating bath and subsequently through a series of rolls.

A similar procedure may be employed with solutions of other stabilizing salts. For example, a 3 per cent solution of calcium gluconate may be employed in place of the gum arabic solution. Chlorinated diphenyl may be employed as the halogenated impregnant with either of the above-mentioned procedures. Alternatively, water soluble materials such as calcium gluconate or gum arabic containing about 5 per cent calcium in organic combination are incorporated in a linen paper pulp in an amount sufficient to give about 2 per cent of the stabilizer in the finished paper. The pulp is then formed into a sheet, dried and calendered according to the usual procedure for making paper. The paper is then formed into a condenser as described above and impregnated with chlorinated naphthalene or chlorinated diphenyl.

In place of incorporating the water-soluble materials in the pulp prior to the formation of the sheet, solutions of these materials may be sprayed on the sheet formed from the pulp prior to drying. Thus gum arabic containing about 5 per cent calcium in organic combination, calcium gluconate, calcium acetate, magnesium acetate, or similar materials may be dissolved in water and sprayed upon a sheet of linen paper before it passes through the drying rolls. They are used in concentrations and amounts sufficient to insure the desired concentration in the finished sheet, for instance about 2 per cent.

Although the invention has been described in its more specific aspects, it is to be understood that it is of broad application and is not limited to any theory of operation, the scope of the invention being limited only by the scope of the appended claims.

What is claimed is:

1. An electric condenser comprising metal armatures separated by a dielectric comprising a chlorinated aromatic hydrocarbon which tends to break down to form hydrogen chloride during the operation of the condenser at elevated temperatures and a relatively small amount of a compound of calcium with the acidic constituents of gum arabic.

2. An electric condenser comprising a pair of electrodes separated by a dielectric comprising a halogenated aromatic hydrocarbon which tends to break down to form a hydrohalogen acid during the operation of the condenser at elevated temperatures and a relatively small proportion of gum arabic containing a strong inorganic base combined with its acidic constituents.

3. An electric condenser comprising a pair of electrodes separated by a dielectric comprising a halogenated aromatic hydrocarbon which tends to break down to form a hydrohalogen acid during the operation of the condenser at elevated temperatures and a relatively small proportion of a carbohydrate gum containing a strong inorganic base combined with its acidic constituents.

4. An electric condenser comprising a pair of electrodes separated by a dielectric comprising

chlorinated naphthalene and a relatively small proportion of a compound of the acidic constituents of a carbohydrate gum with a strong inorganic base.

5. An electric condenser comprising a pair of electrodes separated by a dielectric comprising chlorinated diphenyl and a relatively small proportion of a compound of the acidic constituents of a carbohydrate gum with a strong inorganic base.

6. An electric condenser comprising metal armatures separated by a dielectric containing chlorinated naphthalene and a relatively small proportion of gum arabic containing calcium combined with its acidic constituents.

7. An electric condenser comprising metal armatures separated by a dielectric containing chlorinated diphenyl and a relatively small proportion of gum arabic containing calcium combined with its acidic constituents.

8. A condenser dielectric comprising paper impregnated with a chlorinated aromatic hydrocarbon and containing a carbohydrate gum having its acidic constituents combined with a strong inorganic base.

9. A condenser paper for forming condenser dielectrics comprising paper containing a compound of a strong inorganic base with the acid substances contained in a carbohydrate gum.

10. A condenser paper for forming condenser dielectrics comprising paper containing a compound of a strong inorganic base with the acid substances contained in gum arabic.

11. A condenser dielectric comprising paper impregnated with a chlorinated aromatic hydrocarbon and containing a small proportion of gum arabic containing calcium combined with its acidic constituents.

DAVID A. McLEAN.