

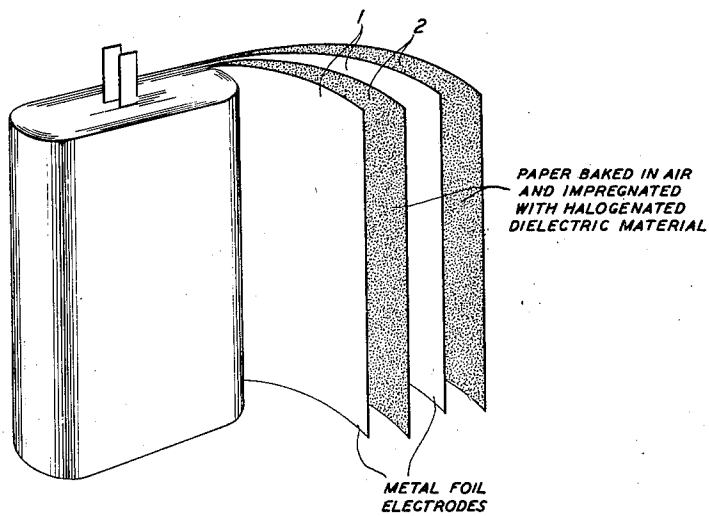
March 8, 1949.

L. EGERTON

2,463,756

MANUFACTURE OF ELECTRICAL APPARATUS

Filed March 22, 1944



INVENTOR
L. EGERTON

BY

B. H. Jackson

ATTORNEY

UNITED STATES PATENT OFFICE

2,463,756

MANUFACTURE OF ELECTRICAL APPARATUS

Lawson Egerton, Summit, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application March 22, 1944, Serial No. 527,659

9 Claims. (Cl. 117—60)

1

This invention relates to methods of producing electrical apparatus in which metal conductors are insulated by paper impregnated with halogenated dielectric materials and in which the paper insulation has improved life and improved electrical resistance. This invention relates particularly to methods of manufacturing electrical condensers having their electrodes separated by paper spacers impregnated with halogen-containing compounds.

Halogenated aryl compounds and more particularly halogenated aromatic hydrocarbons are known to be useful electrical insulating materials for impregnating paper insulation 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. Chlorinated naphthalene and chlorinated diphenyl are, at the present time, the most widely used substances of this class.

Despite these advantages, paper insulations impregnated with such compounds often deteriorate at a faster rate than do paper insulations impregnated with 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 on the discovery that, when the paper of which the insulation is made is baked in air prior to impregnation with the halogenated compound, the electrical resistance, the life of the dielectric and the power factor at elevated temperatures are improved, particularly in electrical condensers. These characteristics improve as the temperature of air baking is increased and as the time of baking is increased.

The baking of the paper may be done before or after the manufacture of the electrical apparatus of which it is a part, but should be done before impregnation.

Steady improvement in the properties occurs from the start of the baking operation, finally

2

reaching a maximum after a period of time. The rate of improvement increases with higher temperatures. The baking should be done at temperatures of at least 220° F. since at lower temperatures the rate of improvement is so slow as to render the process impractical. Several days baking will produce substantially the maximum improvement at this temperature.

In general the process is considerably more satisfactory if the baking is carried out at temperatures above 250° F. since at these higher temperatures substantially the maximum improvement is obtained in twenty-four hours or less. The upper limit for baking temperature is that set by the undesirable deterioration of the paper. It is ordinarily not desirable to use baking temperatures substantially above 300° F.

The most satisfactory temperatures have been found to be those in the vicinity of 275° F. to 280° F. At these temperatures, close to the maximum improvement obtainable by air baking results from baking for from eight to sixteen hours. In general, baking at even higher temperatures should be continued for at least eight hours, although obviously the heating may be limited to shorter times if a smaller fraction of the greatest possible improvement is satisfactory. At all temperatures the heating period may be as long as desired, provided that excessive deterioration of the paper does not result.

One form of the electrical apparatus manufactured according to the present invention is shown in the accompanying drawing, in which the single figure represents a perspective view of a rolled foil type condenser partially unrolled to show its construction.

This condenser is made up of two sheets of metal foil 1, 1 interleaved with two spacers of baked condenser paper 2, 2 impregnated with a halogenated dielectric material. Each spacer may be made up of several sheets of condenser paper. This condenser is manufactured by interleaving the foil electrodes and the spacers, rolling on a mandrel, removing from the mandrel and flattening, baking in air as described above and then vacuum impregnating with the halogenated impregnant. Alternatively, the paper may be baked prior to interleaving with the metal foil and rolling.

Such condensers, when made of kraft paper baked at 275° F. for sixteen to twenty-four hours and impregnated with chlorinated diphenyl, have shown lives (under accelerated life tests) which are eight to ten times as long as unbaked condensers. Baking at 275° F. produces condensers

3

having insulation resistances considerably higher than those of unbaked condensers. Baking at lower temperatures, preferably for longer periods of time, and baking at higher temperatures, produce the same type of improvement. The improvement is presumably produced by a reaction between the oxygen of the air and constituents of the paper, as shown by the fact that baking in a vacuum does not give any substantial improvement in life or insulation resistance.

Some improvement also results with other papers, such as cotton or linen papers or the various other papers available for electrical insulation, and with other halogenated impregnants, although the degree of improvement varies somewhat with the composition of the impregnant. The improvement imparted by the process of the present invention appears to be greatest for those papers (of any one kind) which, without the air bake, produce condensers having the shortest lives and the lowest electrical resistances. The process of the present invention, therefore, tends to lend uniformity to the apparatus produced.

The improvement obtained by the present invention is cumulative with the corresponding improvements obtained by other means as, for instance, by the addition of anthraquinone or other quinones, nitroaromatic compounds, sulphur, selenium or maleic anhydride to the halogenated impregnant. Therefore, when these stabilizers are added to the apparatus of the present invention a considerably greater improvement in life and insulation resistance is obtained.

The discussion above has dealt primarily with the effect of baking on papers to be used in electrical condensers. It is obvious that this same treatment will be of value in improving the insulation of other pieces of electrical apparatus, such as cables, in which the insulation comprises paper impregnated with a halogenated dielectric material. In transformers, for example, where the layers of the coils are separated from each other by sheets of paper and the coils are insulated from the core by sheets of paper, the whole being impregnated with a halogenated dielectric liquid, it is advantageous to employ paper baked as described above.

Although the invention is most valuable as applied to paper insulation impregnated with those relatively stable halogen-containing compounds in which the halogen is present as a substituent on a benzene ring, such as chlorinated naphthalene, chlorinated diphenyl, chlorinated diphenylene oxide, chlorinated benzenes, chlorinated toluenes, chlorinated xylenes, tetrachlorofluorotoluene and pentamethylfluorotoluene, the present invention will result in the improvement of any insulation made up of paper impregnated with any halogenated organic compound as, for instance, the halogenated straight chain aliphatic hydrocarbons, the halogenated alicyclic hydrocarbons, the halogenated oxygen-containing organic compounds and other halogen-containing compounds which by virtue of their halogen content tend to cause deterioration of the dielectric. Obviously, the present invention is most concerned with those halogenated impregnants which are normally liquid or solid. However, in so far as the mechanism of deterioration is similar for paper insulations permeated with normally gaseous halogenated organic compounds, improvement will be effected by the present invention.

Although the invention has been described in

4

terms of its specific embodiments, certain modifications and equivalents 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 reasonable scope of the appended claims.

What is claimed is:

1. In a method of manufacturing electrical condensers made up of metal armatures separated by paper impregnated with a halogenated aromatic hydrocarbon dielectric material, said paper being selected from the group consisting of kraft, linen and cotton papers, the steps comprising baking said paper in air at a temperature of at least 20° F. for a substantial period of time prior to impregnation, and impregnating said fibers with said halogenated aromatic hydrocarbon dielectric material.

2. In a method of manufacturing electrical condensers made up of metal armatures separated by kraft paper impregnated with a substance selected from the group consisting of chlorinated naphthalene and chlorinated diphenyl, the steps comprising baking said paper in an atmosphere consisting of air at a temperature between about 275° F. and about 280° F. for at least eight hours, and subsequently impregnating said paper with said substance selected from the group consisting of chlorinated naphthalene and chlorinated diphenyl.

3. In a method of manufacturing electrical condensers made up of metal armatures separated by paper formed of vegetable fibers and impregnated with a halogenated aromatic hydrocarbon, the steps comprising baking said paper in an oxygen containing atmosphere at a temperature of at least 220° F. for a substantial period of time prior to impregnation and impregnating said paper with said halogenated aromatic hydrocarbon.

4. In a method of manufacturing electrical condensers made up of metal armatures separated by kraft paper impregnated with a halogenated aromatic hydrocarbon, the steps comprising baking said paper in an oxygen containing atmosphere at a temperature of at least 220° F. for a substantial period of time prior to impregnation and impregnating said paper with said halogenated aromatic hydrocarbon.

5. In a method of manufacturing electrical condensers made up of metal armatures separated by paper impregnated with a chlorinated aromatic hydrocarbon, said paper being selected from the group consisting of kraft, linen and cotton papers, the steps comprising baking said paper in air at a temperature above 250° F. but not substantially above 300° F. for a substantial period of time prior to impregnation and impregnating said paper with said chlorinated aromatic hydrocarbon.

6. In a method of manufacturing electrical condensers made up of metal armatures separated by kraft paper impregnated with a chlorinated aromatic hydrocarbon, the steps comprising baking said paper in air at a temperature between about 275° F. and about 280° F. for a substantial period of time prior to impregnation, and impregnating said paper with said chlorinated aromatic hydrocarbon.

7. The method described in claim 6 wherein the chlorinated aromatic hydrocarbon is chlorinated diphenyl.

8. The method described in claim 6 wherein the chlorinated aromatic hydrocarbon is chlorinated naphthalene.

5

9. In a method of manufacturing electrical apparatus containing electrical insulation made up of cellulosic paper fibers impregnated with a halogenated aromatic hydrocarbon, the steps comprising baking said paper fibers in an oxygen containing atmosphere at a temperature of at least 220° F. for a substantial period of time prior to impregnation, and impregnating said fibers with said halogenated aromatic hydrocarbon.

LAWSON EGERTON. 10

6

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,026,316	Kohman	Dec. 31, 1935
2,058,846	Waterman	Oct. 27, 1936