

UNITED STATES PATENT OFFICE.

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INSULATING LIQUID.

No Drawing.

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This invention relates to liquid insulating compositions, more especially to insulating oils adapted for use in oil circuit breakers, oil switches and the like, it being among the objects of this invention to provide an insulating liquid which shall be superior to similar compositions hitherto used.

Insulating oils for the above purposes are required to withstand considerable heat generated by arcing when a switch or circuit breaker is opened and, in order to render the insulating oil capable of withstanding such severe conditions, it has been proposed to render the oil partially non-inflammable by the addition thereto of non-inflammable liquids in various proportions. It has also been proposed to render the insulating liquid less inflammable by halogenating the same, particularly in substituting for the insulating oil an insulating liquid consisting mainly of chlorine compounds of hydrocarbons, such as ethane, methane or benzol.

It has been well known that, when an arc discharge passes through an insulating liquid, gassing occurs, the amount of gas liberated by the decomposition of the liquid by the heat of the arc depending upon the energy of the arc, the time of contact with the liquid and the composition thereof. The relation of the quantity of gas liberated per unit of energy has been measured and it was considered to be the same for all classes of hydrocarbons.

I have found, after a long series of experiments, that the amount of gas produced by an arc passing through an insulating liquid, one component of which is an insulating oil, depends upon the composition of the liquid and the chemical structure of the components thereof. I have found that, with an increase in molecular weight of the halogenated compounds of a series, such as the aliphatic or aromatic, the volume of gas liberated per unit of energy decreases and I have further discovered that, with an increased halogen content of a series of hydrocarbons, the gas liberated from the insulating medium also decreases.

I have determined that, for circuit-breaker and oil-switch application, mixtures of oils and chlorinated hydrocarbons produce better insulating liquids than when

used alone or individually. I have, for example, produced a mixture of a transformer oil with tetrachlormethane or carbon tetrachlorid to which some hexachlorbenzol has been added, which provides an excellent dielectric. Such a mixture is capable of withstanding a considerable amount of arcing without material deterioration and with the production of a relatively small amount of gas and some carbon which may readily be removed by filtration. By utilizing the chlorinated hydrocarbon mixtures with insulating oils in varying proportions, the degree of gassing under known arcing conditions may be readily controlled.

In determining the relative gassing of various compounds, I produce a high-frequency, high-voltage-arc-discharge between electrodes separated a suitable distance and immersed in the compound being tested. Generally, the best results are obtained by using an arc discharge having a frequency of approximately 330,000 and a maximum voltage of 100,000. The results show that oils of higher molecular weights and oils halogenated to a higher degree give off less gas due to decomposition of the oil than the lighter oils or less halogenated oil, as shown in the following table.

Substance.	Gas per K. W. Sec.
Gasoline 68°	113.3
Wemco A (insulating oil)	92.1
Wemco B	81.9
Wemco C	72.7
Benzol	45.5
Monochlorbenzol	18.5
Orthodichlorbenzol	4.6
Dichlormethane	19.3
Chloroform	15.5
Carbontetrachloride	4.2

The values given in the table hold for the particular voltage and frequency specified and vary somewhat therefrom in commercial applications. However, the results in commercial applications are substantially proportional to those specified.

There is a consistent decrease in gas evolution per KW. sec. with the increase in molecular weight of the hydrocarbons. In both the chlorinated aliphatic and aromatic hydrocarbons, there is a decided decrease in gas evolution per KW. sec. as the halogena-

tion increases. A number of mixtures of mineral oils with halogenated compounds have been made and subjected to the arcing treatment. Liquids of comparatively high breakdown strength having a very low gas evolution and which are practically non-inflammable have thus been produced for circuit-breaker and oil-switch application.

The disrupted oils not only give off gas but an appreciable quantity of saturated and unsaturated compounds are formed, together with members of the same series lower in molecular weight, and some free amorphous carbon. The dielectric strength of the oil mixture diminishes very slowly as the arcing process is continued. The carbon formed is readily separated by filtration and the oil is thereby brought back to its former insulation value. A sample of orthodichlorobenzol which was tested had an initial breakdown of 21 kilovolts at .1" gap. After continued arcing for an hour, it fell to a value of 11 kilovolts. It was then well shaken with MgO, CaO and a small quantity of decolorizing carbon and was then filtered. The breakdown voltage of the material was then 22 kilovolts. Switch oil may be similarly quickly rejuvenated.

My invention provides a liquid having excellent insulating qualities which, upon rupture of an arc therein, produces a minimum amount of gas which allows the arc to be quickly extinguished owing to the small quantity of ionized gas present and gives a minimum amount of corrosive gases.

The diminished volume of gases formed by the arc discharge eliminates the phenomenon of re-ignition and thereby greatly reduces the fire hazard. Since a small amount of gas is formed, the pressure in the apparatus, which tends to cause disruption thereof, is also reduced below the pressure that would be produced if oil alone were present. These and other advantages of my invention will be apparent to those skilled in the art.

I claim as my invention:

1. A liquid insulating composition comprising hydrocarbon mineral insulating oil and a chlorinated methane derivative and a chlorinated benzol derivative therein.

2. A liquid insulating composition comprising hydrocarbon mineral insulating oil and carbon tetrachloride and hexachlorbenzol therein.

3. A liquid insulating composition comprising hydrocarbon mineral insulating oil mixed with a chlorinated saturated-hydrocarbon derivative and a chlorinated benzol derivative which, on arcing, produces a relatively small volume of gas per unit of energy expended.

4. A liquid insulating composition comprising hydrocarbon mineral insulating oil mixed with carbon tetrachloride and a chlorinated benzene derivative which, on arcing, produces a relatively small volume of gas per unit of energy expended.

5. A liquid insulating composition comprising hydrocarbon mineral insulating oil mixed with hexachlorbenzol and chlorinated saturated hydrocarbon derivative which, on arcing, produces a relatively small volume of gas per unit of energy expended.

6. A liquid insulating composition comprising mineral insulating oil mixed with carbon tetrachloride and hexachlorbenzol.

7. A liquid insulating composition comprising mineral insulating oil mixed with a chlorinated saturated-hydrocarbon derivative and a chlorinated benzol derivative which, on arcing, produces less than (20 cc.) of gas per K. W. sec. of energy.

8. A liquid insulating composition comprising mineral insulating oil mixed with a chlorinated saturated-hydrocarbon derivative and a chlorinated benzol derivative which, on arcing, produces less than (5 cc.) of gas per K. W. sec. of energy.

In testimony whereof, I have hereunto subscribed my name this 18th day of October 1921.

CLARENCE J. RODMAN.