

UNITED STATES PATENT OFFICE

2,190,018

IMPREGNATED PAPER INSULATION FOR ELECTRIC CABLES

William A. Del Mar, Greenwich, Conn., assignor to Phelps Dodge Copper Products Corporation, Dover, Del., a corporation of Delaware

Application August 22, 1939, Serial No. 291,313

4 Claims. (Cl. 154-2.6)

My invention relates to paper insulated cables, more particularly to impregnated paper insulation, and has for its object to produce a cable oil which is non-sludging and will not crystallize out, be light colored and possess valuable electrical characteristics not heretofore attained with rosin or other similar resins.

In preparing electrically insulated cables, it is customary to wrap the conducting metal wire with suitable paper or cellulosic material which has been impregnated with what is known as cable oil. This cable oil may be a solution of rosin in a petroleum oil. This oil must not sludge out nor separate on standing and it must be stable under conditions of preparation, storage and impregnation of paper. Wood rosin, although soluble in paraffin or naphthenic petroleum oils, often sludges out and/or crystallizes out on standing. This wood rosin is a commercial form of abietic acid and when used in cable oil its functions are to assist the oil in "wetting" the paper fibers, to increase its viscosity and to render the oil more stable under the influence of electrical discharges. Rosin, however, has the effect of increasing the power factor of the oil at high temperatures and consequently of the cable, at the higher operating temperatures.

I have discovered that by substituting for rosin, a hydrogenated product of rosin, a low power factor of the oil is attained at all temperatures and that in addition, the stability of the oil under the influence of electrical discharges, is greatly improved. This is particularly true with respect to power factor stability. For instance, one batch of bright stock paraffin base oil was mixed with 15% rosin and another with 15% hydrogenated rosin. Both were subjected to electrical bombardment in a Nederbragt cell, as described in Trans. A. I. E. E., 1937, vol. 56, pp. 1302-3, for 450 minutes and the power factor measured before and after. The results were as follows:

| Oil with addition of— | Power factor at 100° C. | | | |
|-------------------------|-------------------------|--------|-------------------|--------|
| | Before bombardment | | After bombardment | |
| | 100° C. | 60° C. | 100° C. | 60° C. |
| Wood rosin..... | 6.50 | 1.50 | 10.00 | 0.70 |
| Hydrogenated rosin..... | 0.55 | 0.05 | 1.55 | 0.13 |

Stability tests in the Nederbragt cell also give a measure of the relative merits of oils with respect to evolution of gas under electric stress. These tests show that hydrogenated rosin materially retards the evolution of gas. For in-

stance, the addition of 15% by weight of hydrogenated rosin to the oil described above reduces the gas evolution to 77% of the amount with pure oil. In this respect, however hydrogenated rosin is somewhat inferior to wood rosin, the corresponding figure for which is 69%.

In Figure 1, I show a Nederbragt cell test curve recording the gassing characteristics in relation to the per cent of hydrogenated rosin. It will be noticed that the stability against gassing increases with the proportion of hydrogenated rosin. The curve shows the gassing in a 450 minute run under glow discharge. Temperature of test=30° C., initial carbon dioxide gas pressure=1.0 millimeter of mercury, sixty cycle current=1.0 milliampere.

The use of hydrogenated rosin, however is not merely a substitution of hydrogenated rosin for ordinary rosin. The latter material increases oil stability with increasing proportion of rosin up to at least 35%. Only the excessive viscosity of the compound limits the proportion to around 15%. Hydrogenated rosin, however, if used on this basis would lead one into trouble as we have found that its usefulness as a stabilizer is confined to a narrow range, as shown by Figure 2 which shows a curve giving the relation between the power factor stability of oil compound in the Nederbragt cell test and the proportion of hydrogenated rosin used in the oil. The power factor stability is indicated by the rise of power factor, measured at 85° C., produced by subjection to electrical discharge in the cell. The narrow dip in the curve corresponds with the stable range of proportions of hydrogenated rosin. I therefore make my cable with the proportions of hydrogenated rosin corresponding with the dip in the curve.

Taking into account all the properties of the materials, I prefer to use 10% hydrogenated rosin and 90% of oil, but I obtain satisfactory results with proportions from 5 to 20% of hydrogenated rosin.

Cables made with 10% hydrogenated rosin compound have been subjected to accelerated aging tests in comparison with cables made with 15% wood rosin compound and as expected from the Nederbragt cell tests, the cable power factor readings show a greatly enhanced stability. While the rise of power factor in the first ten load cycles does not differ very greatly from that with wood rosin, subsequent load cycles show a much less rise of power factor.

Furthermore the cable goes through many more load cycles before failure. In a typical