United States Patent Office

3,067,063
Patented Dec. 4, 1962

3,067,063
INSULATED CONDUCTOR

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Filed Dec. 5, 1955, Ser. No. 551,193
4 Claims. (Cl. 117—232)

This invention relates to the manufacture of insulated electrical conductors of the type in which the insulation is an organic enamel of the kind known in the trade as wire enamel. More particularly, the invention relates to an improved insulated conductor of this type and a method of making the same, the insulation of the conductor being characterized by excellent resistance to refrigeration liquids and gases of the chlorofluoro type, particularly monochlorodifluoromethane (Freon 22).

As pointed out in Jackson and Hall Patent 2,307,588, 15–19 polyvinyl formal ("Formvar") can be reacted with cresol formaldehyde resin to produce a resinous composition of outstanding properties for insulation of wire used in the winding of electrical motors, transformers and coils. This type of wire is commonly identified in the trade as "Formvar, Formex," and has found wide use in the electrical industry in many types of applications. One of the useful features of the polyvinyl formal-cresol resin when used as a wire insulation is its ability to resist chemical attack by dichlorodifluoromethane (Freon 12), so that the wire can be used for hermetic refrigerator motors in refrigerating systems having this liquid as a refrigerant. In these motors, the windings are in direct contact with the gas and liquid refrigerant.

Recently, however, monochlorodifluoromethane (Freon 22) has been used as a refrigerant. This refrigerant, being a more active solvent, has been found to soften the conventional wire insulation made of polyvinyl formal-cresylic resin, and has been responsible in many cases for failures of electrical motors which in service are subjected to the gas or liquid refrigerant. The refrigerant softens the insulation and causes subsequent copper-to-copper failure. Also, it has been found that the conventional insulation of the polyvinyl formal-cresylic resin type has a tendency, when immersed in Freon 22 and then subjected to heat, to blister badly from the fast evaporation of the Freon 22 absorbed in the insulating film.

We have discovered that a wire insulation having unusual resistance to the more active Freon refrigerants, such as monochlorodifluoromethane (Freon 22), can be produced by combining a resinous condensation product of an aldehyde and a partially or completely hydrolyzed polymerized vinyl ester with a reactive isocyanate resin which is compatible therewith. The new insulation exhibits practically complete insolubility in the liquid or gaseous refrigerants and can be used to particular advantage as an insulation for copper wires for winding refrigerator motors using Freons which normally soften the conventional polyvinyl formal-cresylic resin insulated wire. Not only does this new insulating composition exhibit unusual resistance to Freon 22, but it does not sacrifice the essential properties required for an insulated wire, and for all practical purposes produces an insulated

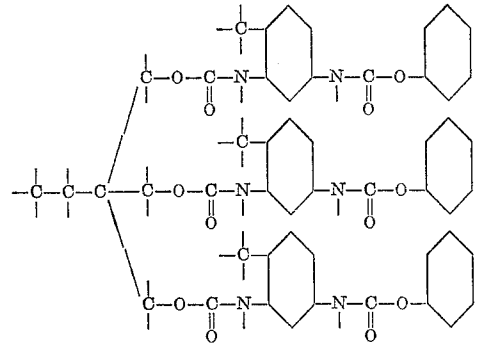
wire equivalent to the conventional types of "Formvar" wire based on the polyvinyl formal-cresylic resin mixture. Moreover, the new insulated wire is capable of being soldered without stripping at approximately 100° F. lower than the conventional "Formvar" type wire, and it has unusual resistance to chlorinated solvents such as trichloroethylene. It is possible with this insulating composition to produce fine wires which will solder without removal of the insulation, thus enhancing its value as an insulated wire.

In addition to its excellent resistance to refrigerants such as Freon 22 and its good solderability, the new wire insulation is tough, hard and flexible and has good abrasion-resistance, moisture resistance and thermal aging properties. The insulation also has high dielectric strength and good chemical resistance generally.

According to the invention, the resinous composition comprising the hydrolyzed polymerized ester aldehyde condensation product and the reactive isocyanate is dissolved in a suitable solvent and coated on the wire, as by any conventional wire enameling procedure. The solvent is then evaporated and the coating rapidly cured as by baking at high temperature.

The resinous hydrolyzed polymerized ester aldehyde condensation product mentioned above is described in Reissue Patent No. 20,430 dated June 29, 1937, and it may be produced as shown in this patent. The production of the various vinyl acetals, including the 15–95 polyvinyl formal, is well known in the art. The resin we prefer is the conventional 1595E polyvinyl formal, although other polyvinyl formals can be used. The 1595E polyvinyl formal contains 5–6% of polyvinyl alcohol and 9.5%–13% polyvinyl acetate, and is described more particularly in an article entitled "The Manufacture, Properties and Uses of Polyvinyl Formal" by A. F. Fitzhugh et al., which appeared in the Journal of Electrochemical Society, vol. 100, No. 8, August 1953. Other suitable polyvinyl formals are also described in this Fitzhugh et al. article.

The isocyanate resin previously mentioned is preferably the "blocked" isocyanate generally described as a tri-adduct of toluene di-isocyanate, the NCO groups of which have been closed by a stabilizer such as a phenol grouping. The chemical structure of one such "blocked" isocyanate can be written as follows:



Other means of blocking the isocyanate may be used as long as the resulting product after unblocking at wire