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FRICTION MAGNET WIRE

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This invention relates to insulated electrical conductors of the so-called magnet wire type and has particular reference to a novel insulated conductor of this type having an outer film coating of high frictional characteristics for coil winding, and the like, whereby the desired winding form can be maintained due to the inherent frictional characteristic of the insulation.

In the manufacture of electrical coils, particularly those used in large volume in radio, television and other electronic applications, it is desirable to wind quickly and economically a coil of the lattice type commonly identified as a universal-wound or basket-weave. Basically, the wire is wound with a rapid traverse going from one side of the coil to the other side of the coil in approximately 180° rotation of the coil. Although magnet wires provided with conventional film insulation such as "Formvar," enamel, "Sodereze," nylon, etc., have been used in some of the simpler of these applications, it has generally been necessary to add adhesive during winding to hold the wire in place. For the more complicated higher pile coils, such as those identified as "flybacks" in television sets, it has been necessary to use a wire insulation including a textile, such as silk, nylon or other fibrous materials which give the wire surface sufficient friction or "grip" to prevent the coil from falling apart during winding.

The disadvantages of the conventional wires for winding universal lattice coils have been the high cost of the textile-insulated wires, coupled with their poor electrical characteristics, and the unreliability and inconvenience of the adhesive method used for film-insulated wires. The use of fabric-covered wires, because of their high cost, has necessitated redesign of many of these coils using the conventional layer-winding, paper-section technique, with resultant design disadvantages.

The principal object of the present invention is to provide a magnet wire which overcomes the above-noted disadvantages.

An insulated wire made according to the invention comprises a basic insulation in the form of one or more layers of a resinous film insulation, such as "Formvar," enamel, "Sodereze," nylon, etc., coated on the conductor, and a continuous outer film of a highly pigmented composition including a non-conducting resinous binder containing a pigment filler in an amount which is at least 30% by weight of the resin binder. The binder may be any conventional film type of insulation. Although various pigment fillers may be used, the filler is preferably selected from the group consisting of clay, metallic oxides, metallic silicates, amorphous silica, and metallic carbonates, and the filler preferably has a particle size of 0.5 to 50 microns. Because the amount of pigment present in the outer film is at least 30% by weight of the resin binder, the pigment gives the surface of this outer film a frictional characteristic which enables the wire to hold its position in a coil or other winding without resort to special measures for this purpose.

We are aware that it has been proposed heretofore to incorporate pigment fillers in organic compounds for insulating conductors. However, such fillers have been used heretofore in relatively small amounts sufficient only to color, extend or reinforce the organic insulating compound or to increase its heat or flow resistance or its durability, without appreciably affecting its electrical insulating characteristic. According to the present invention, the pigment filler is present in the outer film in a relatively large amount sufficient to impart a definite frictional characteristic, as previously described. Moreover, even if the nature and amount of the pigment tend to reduce the dielectric strength of the outer film, the insulating property of the underlying film of basic insulation is not affected by the pigment. Also, while the relatively high proportion of pigment in the outer film reduces its flexibility, this effect is counteracted by the flexible underlying film of basic insulation.

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As previously mentioned, both the inner layer of basic film insulation and the resin binder of the outer friction film may be any of the conventional varnish or film type of insulating compounds. Among these compounds are polyvinyl formals such as those known in the trade as "Formvar" (described in Reissue Patent No. 20,430, dated June 29, 1937, Jackson and Hall Patent No. 2,307,-588, and 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); the conventional adipic hexamethylene diamine polymer known as nylon; a mixture of resins based on isocyanate and conventionally called polyurethanes, which consists of the reaction of Mondur S (blocked isocyanate) with Multron R–2 (one of a group of di-acids plus polyols which provide varying ratios of free OH groups for cross-linking with the isocyanate) and other resins containing free OH or active hydrogen groups, known in the trade as "Sodereze"; and other insulating varnishes and enamels.

In the manufacture of the new magnet wire, the resinous basic insulation is applied to the conductor in a continuous film, preferably by dissolving it in a suitable solvent, coating the solution on the conductor (as by means of dies through which the conductor is drawn) and then baking the insulation on the conductor in a conventional enameling oven. It is usually desirable to apply several coatings of the resinous compound in this manner, so that the layer of basic insulation is made up of several continuous superimposed films on the conductor. The outer film, comprising the highly pigmented resinous binder, may be applied in the same manner as the film of basic insulation. The basic insulation provides a flexible support for the outer friction film and serves as the primary insulating medium.

The bare wire may be conveniently insulated, according to the invention, by stringing it in a conventional enameling oven to which the wire is fed through dies for applying the coatings of the basic insulation and frictional insulation in sequence, so that the wire passes from one die to the next by way of the oven where the coating from the previous die is baked or cured to a hard film. The basic insulation may be applied in several films from a series of such dies, and the final die, of course, applies the solution of the highly pigmented binder. If desired, the latter solution may be applied in two or more coatings from respective dies, so that the outer layer of frictional insulation is made up of multiple films of the highly pigmented binder. For example, the bare wire may be provided with eight coats applied in this manner, six of which are coats of the basic film insulation and the other two of which are coats of the highly pigmented binder.

The pigment, such as chrome oxide, titanium dioxide, or aluminum silicate, may be ground into the binder solution which is then applied as the outer coating or coat-