CLASSIFICATION OF

FILM COATED MAGNET WIRE

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Western Electric must love film coated Magnet Wire - we use so much of it. We are undoubtedly the largest user of fine gage film coated wire in the country and probably the world. This is indicated by the fact that we as a company used 11,600,000 pounds of film coated copper wire in 1963. Of this, Buffalo manufactured 6,800,000 pounds. All of this simply says that in the past 3 years or so we have used enough film coated wire to reach the sun - about 30,000,000 miles per year. It must certainly be one of the most commonly used commodities in the System.

Magnet Wire is by definition any wire which is used for electromagnetic purposes and as such includes textile, paper, various film insulated wires and combinations thereof.

Commercially, Magnet Wire is rated according to the temperature at which it can be continuously used. The ratings are comparative and empirical, since they are based upon experience with Formvar enameled wire, about which a great fund of knowledge is available. It was found that for the very commonly used 18 AWG heavy Formvar enameled wire, a twist test could be made which would correlate very well with historical data regarding machine operation. This resulted in IEEE 57 in which twisted pairs are heat aged under prescribed conditions. The time for the breakdown voltage to drop to a predetermined value at each of several test temperatures is established, the data plotted and the regression line determined. The temperature at which this line crosses the 20,000 hour life line is taken as the temperature rating for the wire. These ratings are divided into the following classes: 90, 105, 130, 155, 180, 200 and over 220.

Table I indicates how the various insulating materials are distributed in these classes.

The vast majority of telephone applications are limited to Class 105 because of the necessity for people to work in the switching areas. However some interest is being shown by the power transformer engineers for higher temperature materials such as glass-silicone and the polyester film insulations.

Magnet Wire Ratings

90	105	130	155	180	200	220
Silk	Oleoresinous	Polyester (Alkanex Type)	Polyesters (Dacron Type)	Silicone	Dual Coat Polyester	Polyimide
Cotton	Formvar	Epoxy		Da-Glass	Teflon	
Paper	Nylon	Nylon-Polyurethane		Glass Silicone		
	Polyurethane			Dual Coat Polyester		
	Acrylate					
	Lecton					

Within the Class 105 range Western Electric used the following quantities of wire in 1963:

Oleoresinous	-	8,900,000 pounds
Formvar	-	840,000
Nylon	-	836,000
Polyurethane	-	813,000

By far the largest amount of wire used within the Company is the thin grade oleoresinous enameled wire. It is the oldest of the materials available and borders on being traditional. It has been the least expensive by quite a margin for many years. This margin is changing as a result of an extremely competitive situation in the industry at large and the expiration of the Formvar patent. The reduced margin, incidentally, results in a much less favorable "Make Vs. Buy" position so far as additional enameling and related facilities or operations within the Company are concerned. Oleoresinous enameled wire has a long history of satisfactory use. Particularly where no great abrasion resistance is encountered in coil winding and uniform winding tensions are used as is the case in the majority of our coils.

Formvar was introduced in the late '30's and has found widespread use, primarily because of its ability to withstand winding abuse and because it could be applied in heavy films. It is relatively inert and is compatible with most impregnating materials. It has been particularly suitable for motor coils, transformers, toroids and similar applications where abrasion resistance, adherence, flexibility and high cut-thru are desired. Because of its excellence in these areas, it became the most generally used insulation until about eight years ago when polyesters and polyurethanes were introduced. Since that time, polyester insulations have in general replaced Formvar since they allow for the same price and higher operating temperatures - Class 180 and 200 - depending on the polyester. The greater heat stability means that smaller wires and less iron are required in electromagnetic devices. This allows miniaturization and at the same time introduces cost reduction possibilities.

The other side of the coin was the rapid acceptance of polyurethane enameled wire. These materials have good abrasion resistance - comparable to Formvar - and above all are "solderable". These materials are excellent electrically and except for alcohol and acetone are inert to solvents and impregnants. They possess excellent moisture resistance characteristics, while nylon wire is badly degraded by the absorption of moisture. (The dielectric loss is about 1/10 of that of nylon for 100 cycles at 25°C and 50% R.H.). This has resulted in decreased use of nylon and broader acceptance of polyurethane. Nylon, however, continues to find use. It is used in great quantities as an overcoat material for Formvar, Polyurethane, Polyesters, and Acrylics because of its low coefficient of friction and excellent windability. This overcoated material is used extensively for such difficult winding applications as toroidal coils. The nylon-polyurethane system is rated by some suppliers as Class 130 material.

A relative newcomer to the Magnet Wire Field is the "Acrylate" enameled wire which offers the price advantage of oleoresinous enameled wire and which is solderable at high temperatures - about 900°F. as compared with the 740°F. required by our specification. While this material shows some thermoplasticity, its cut-thru is about the same as Formvar's and has been found to be a suitable replacement for it in many applications.

There has been increased use of multiple coatings in magnet wire to provide desired physical characteristics. Dual coat polyester systems are used to obtain better heat shock and solvent shock characteristics. This has resulted in the general replacement of "Thermaleze F" with "Polythemaleze 180 and 200". Probably the earliest of the overcoats was "Butvar" and related materials which were used to provide a bondable coating. This allowed the convolutions of a coil to be coalesced together by solvent or by heat to form a self-supporting coil. The yoke coil of a TV set is a good example of the application of this type wire. A partially cured epoxy is some times used for this purpose, with coalescing being accomplished by the application of heat.

Thermal rating of wire is of great importance to both the user and to the producer. Western Electric is therefore concerned with both the price and the factors contributing to it. For this reason I would like to touch on some of the factors which influence cost.

We have, over a period of time, worked to provide you with greater weights of fine gage wire per spool, and have had some success. The price of this success has been the cost of shaving the copper rod prior to drawing and amounts to 1-1/2¢ per pound of wire. This price is in our Bulletin cost. Incidentally, this operation has resulted in reduced slivers and related pinholes. Further reduction in pinholes would probably entail an increased cost of lower magnitude.

As an example of the cost of restricted enamel increase tolerances, we, for several years, made a 29 AWG heavy polyurethane enameled wire for Hawthorne. A restricted tolerance range placed upon us resulted in an increase of wire scrap of about 8%. In this instance we were in and out of production within a single Bulletin period and the increased cost due to scrap was never reflected in the wire price. With such an operation, quality is inspected into the product by cutting off one end of the quality distribution curve. The costs are accordingly increased. If there is a use for the outsized material, the loss is reduced by the elimination of scrap. This does not, however, eliminate the cost of "miking" and sorting the wire for "increase" and for bare wire on a 100% basis. We anticipate that such a requirement would result in an increased cost in the order of a cent or two per pound. Another location requested 40 AWG wire with a "minimum to nominal" enamel increase and indicated that it was not practicable to use the standard "increase" range. Since this was polyurethane enameled wire which we ordinarily obtain commercially, we went out for bids. Our lowest bidding contract source quoted us a price premium of 8¢ per pound; while others who were not participating in this business had idle machines which they wanted to occupy. The net result of this reopening of bidding was a lower cost. In this connection Western has been fortunate for the past two years that the magnet wire market has been very, very soft.

While negotiations have started (6-64) for new contracts to become effective in the fourth quarter of this year, it is too early to have any indication of which way the market will go. There is, however, some evidence of stiffening, as indicated by the request of suppliers for minimum quantity orders for specials such as non-standard colors for polyurethane, non-commercial wire lubrication and so on. The price of copper has also been increased within the past few months.

While a premium price of several cents a pound may be acceptable to you as coil winders and individuals, consider an across-the-board possibility for about 12,000,000 pounds of wire where the increased cost to the Company would amount to several hundred thousand dollars per year for restricted tolerances. This figure, together with the possibility of being limited to a single source of supply is not in keeping with Western's policy of minimizing costs. It is for these reasons that we urge that you use wherever possible specification grade wire.

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