

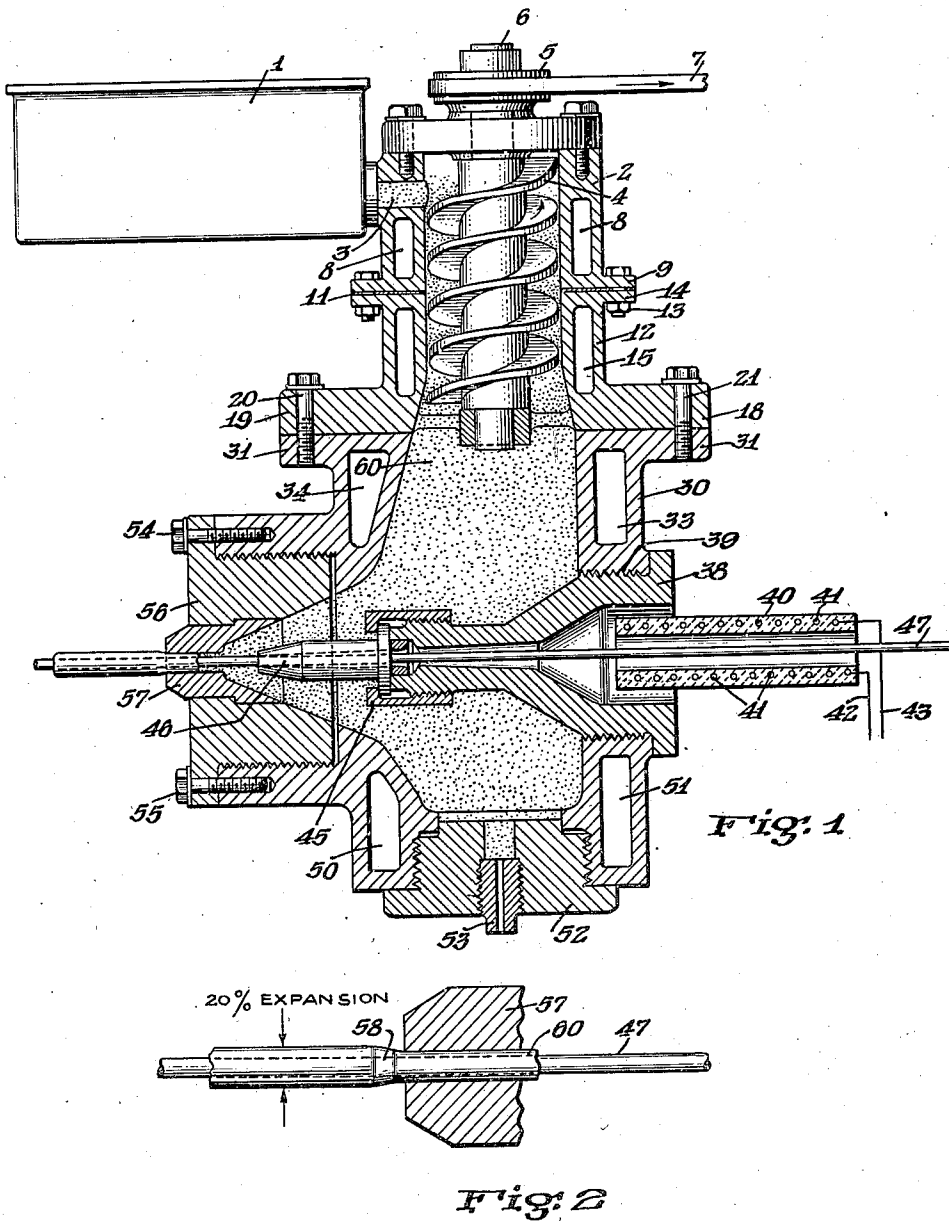
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METHOD OF COATING WIRE WITH PLASTIC COMPOSITIONS

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METHOD OF COATING WIRE WITH
PLASTIC COMPOSITIONS

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My invention relates to a plastic composition and to a method of coating metallic conductors with such plastic composition and more specifically it relates to a method of coating a metallic conductor with a plastic composition comprising in large part ethyl cellulose in combination with plasticizers and wax. The wire is coated with this plastic composition according to a specific method involving temperature control of the wire and temperature control of the plastic material within certain definite ranges, and specific controls with respect to the length of the extrusion die and the expansion of the plastic composition.

In the past, it has been customary to coat wire with rubber to produce an insulating and protective covering for the conductor. Because of the nature of rubber, however, rather bulky coating must be effected to obtain sufficient dielectric strength and to obtain the necessary properties in the final wire or cable. In many instances, it is highly desirable that a wire with the maximum of conductor diameter and minimum of insulation covering be employed. This is particularly so in machine wiring.

It is highly desirable to have a thin insulating covering for wire with a high dielectric strength. Thus, in addition to conserving space, which in many instances is of great importance, the cost of shielding may be materially reduced when thin insulating coverings are employed.

When lead shields are employed as for mechanical protection or for grounding when multiple wires are employed within a single shield, less lead is necessary to cover a thinly covered wire than to cover a thickly covered wire. Since the cost of lead is a material factor in the cost of protective coverings, reduction in the amount of lead necessary is of great importance.

Therefore, because the plastic composition which I shall set forth may be used in the form of a much thinner covering than the customary rubber insulating covering, a saving is effected first in the material costs because of the employment of the lesser quantity of insulating covering and secondly, in the lead or similar sheathing since less lead is necessary because such a thin insulating covering is used.

When large conductors are to be insulated, as for example bus bars, certain specific problems arise. Bus bars carry an extremely heavy load of high amperage. A great deal of heat is developed and it is important that such heat be dissipated as much as possible since the heat detrimentally affects the current carrying ca-

capacity of the conductor. Such conductors, therefore, may be made hollow so that the heat may be dissipated internally to a certain degree. It is obviously of great advantage that the heat be dissipated externally also. If, however, a heavy insulating coating be employed, such dissipation of heat cannot be effected as rapidly as desired. For this reason, the thin highly dielectric insulating coverings of my invention are of great importance in connection with the insulation of heavy conductors of this nature.

Further, it is desirable that the covering of the wire have an aesthetically attractive coloring, and it is well known that the ordinary rubber insulating is dull and black.

Although it has been suggested that metallic conductors be coated with insulation materials comprising certain plastics, such attempts have been found lacking in producing satisfactory results according to the methods employed.

The plastic covering of my invention is resistant to alkalis such as are present in the soil, especially in the western half of the country. This resistance to alkalis is exceptional in the case of the ethyl cellulose insulating covering composition of my invention. It is of particular importance since such insulating coverings are often carried through the ground and are necessarily exposed to the effect of the alkalis. In addition to soil alkalis, there are employed of course in many industrial chemical processes such as the manufacture of viscose and rayon alkali reagents. It is desirable that the wiring in machines used in connection with these reagents or adjacent these reagents be resistant and unaffected by such alkalis. This property has not been found in many plastic compositions which may have been suggested for this purpose. The plastic composition of my invention is found resistant to weak acids and oxidation. The ethyl cellulose composition is very stable and as shown herein is especially adapted for insulating coverings for electric conductors.

The prior art of coating conductors with plastic was deficient in that the plastic coatings lacked the necessary bend and crease properties, were not sufficiently water and moisture vapor proof, and became hard and subject to rupture under low temperature conditions such as winter temperatures (a serious difficulty). When a remedy for these deficiencies was attempted, the desirable high breakdown found in the present invention was not even approached.

I have found that by employing certain compositions to be hereinafter set forth and by em-

playing certain controls in the coating process, I may coat a metal conductor with the plastic compositions of my invention and obtain a wire with a high insulating value and an exceptionally low thickness of insulation. Further, the insulation material may be pigmented for aesthetic purposes.

The composition which I employ comprises:

Composition:	Parts by weight
Ethyl cellulose (45% ethoxy) -----	100
Chlorinated diphenyl -----	20
Dibutyl phthalate -----	10
Paraffin wax -----	2
Castor oil -----	20
Triphenyl phosphate -----	15
Solvent -----	1 to 5

The ethyl cellulose which I employ is preferably of a 43 to 45 per cent ethoxy content. Preferably, I employ a 45% ethoxy ethyl cellulose. The ethyl cellulose then has about two to two and one-quarter molecules of ethoxy to each cellulose molecule. The viscosity of the ethyl cellulose is preferably about 150 centipoises.

In place of the ethyl ether of cellulose, I may employ the benzyl ether of cellulose. The benzyl ether of cellulose provides an insulating cover with a breakdown of 2200 volts per mil while the ethyl ether has a breakdown of 1800 volts per mil. This ether cellulose composition such as I have set forth has a great flexibility even below zero degree centigrade. This is of great importance in view of the low temperatures to which such insulating coverings are commonly subjected. This low temperature flexibility is in marked contrast to other plastic compositions, notably cellulosic esters such as cellulose nitrate and cellulose acetate. My plastic composition further is relatively non-inflammable. This low inflammability is further decreased by the employment of suitable plasticizers such as the tricresyl and triphenyl phosphate.

I have found that if I preheat the wire and contact this preheated wire with heated plastic under pressure that a good union of plastic and metallic conductor is obtained. The plastic coated wire is drawn through a die. The length of the die which produces the best results is a length equal to about three times the diameter of the die opening. The wire with the plastic covering is drawn through a die at such a speed and under such pressure as will produce about a twenty per cent expansion of the coating. When a metallic conductor is coated with an insulating composition as set forth, of a thickness of 30 mils, the insulation has a breakdown value of 1800 volts per mil.

It is an object of my invention to provide a novel process for coating wire with an insulating plastic composition.

It is a further object of my invention to coat a wire with an insulating composition comprising ethyl cellulose, chlorinated diphenyl, wax, plasticizer and castor oil.

It is a further object of my invention to provide a novel process of coating wire in which I preheat the wire before applying the insulating plastic composition.

It is a further object of my invention to provide a novel process of coating wire by preheating an insulating composition and applying the preheated plastic composition to a preheated wire.

It is a further object of my invention to provide a novel process for coating wire with an

insulating composition in which the coated wire is passed through a die having a length approximately three times the diameter of the die opening.

It is a further object of my invention to provide a novel process of coating a wire with a plastic composition in which the speed of the wire and the pressure with which the plastic composition is applied thereto is so regulated as to produce an expansion of approximately twenty per cent upon emergence of the coated wire from the die.

Figure 1 is a cross section and partial perspective showing the extrusion apparatus for carrying out this invention.

Figure 2 is a perspective view of the wire showing the expansion that occurs as the coated wire emerges from the die.

Referring now more specifically to the drawing, in Figure 1 is shown a hopper 1 in which the plastic composition of my invention is loaded. Attached to the hopper and communicating therewith is a barrel 2 with an opening 3. In the barrel 2 is a screw pusher 4 which is driven by means of a pulley 5 mounted on the shaft 6 driven by a belt 7. In the walls of the barrel 2 is a heating chamber 8 through which hot fluids flow in order that the contents of the barrel may be maintained at the proper temperature. Attached to the flange 9 of the barrel 2 is a collar 12. The collar 12 is attached to the barrel 2 by means of the bolt 13 through the flange 9 and the flange 14. An intervening gasket 11 insures a tight joint between the parts. The screw pusher 4 extends down through the collar 12. The collar 12 is heated by the heating chamber 15. The collar 12 terminates in extensions 18 and 19 through which run the bolts 20 and 21. The collar 12 is attached to the head 30 by means of the extensions 31 and 32 of the head 30 and the similar extensions 18 and 19 of the collar 12, the bolts 20 and 21 securing the extensions. The heating chambers 33 and 34 of the head 30 maintain the plastic material 60 within the head at the proper temperature.

Within the head 30 is a guide holder 38. The guide holder 38 is screwed into the head at 39. Positioned within the guide holder 38 but outside of the head 30 is a heating means 40 with wires 41 connected by the electric circuit 42 and 43. Mounted on the guide holder 38 and secured thereto by means of the engaging means 45 is a guide 46 through which passes the wire 47. At the bottom of the head 30 are additional heating chambers 50 and 51 to insure a proper temperature of the plastic 60 within the head. At the bottom of the head 30 is a cap 52 with a plug 53 screwed therein. Secured firmly to the head 30 by the bolts 54 and 55 is a die holder 56. Within the die holder 56 is a die 57.

In Figure 2 is shown a wire 47 driven through the die 57 with the plastic 60 coated thereon. This detailed showing indicates the predetermined expansion which takes place when the plastic coated wire emerges from the die. The expansion is indicated at 58.

In operation the plastic 60 is loaded through the hopper 1 and from there it travels through the opening 3 into the barrel 2. In the barrel 2, it is engaged by the pusher 4 driven by a suitable power source through belt 7. In the barrel 2, the plastic is raised to a temperature of 150° to 175° F. The heating fluid and the speed of the pusher are carefully regulated so that this temperature range is achieved by the plastic in the

barrel. The preferred temperature in the barrel is about 160° F.

From the barrel 2 the plastic is led through the collar 12 where it is raised to a temperature of about 250° to 275° F. The preferred temperature at this point is about 260° F. From the collar the heated plastic is passed into the head where its temperature is raised still further to a temperature of about 300° to 375° F. The preferred temperature at this point is about 330° F.

A wire 47 which has passed through the customary wire straightening apparatus is led through the heating means 40 in order that the wire may be brought to such a temperature so that upon contacting the plastic 60, it will be at a temperature of 250° F. The wire then travels through this heating means, passes through the guide holder 30 and the guide 46 and emerges therefrom to pass through the die 57 and be coated with the heated plastic 60.

An important feature of my invention lies in the fact that a die is employed which has a length of approximately three times the diameter of the die opening. This particular length is critical and it has been found that the relation of the length of the die with respect to the diameter of the die opening as set forth produces exceptional results in the final product. The speed of the wire travelling as indicated is carefully regulated to produce an expansion of approximately twenty per cent in the plastic coating as the wire and coating emerge from the die. This expansion of twenty per cent is the preferred expansion although the expansion may range from 10 to 25 per cent. Again, this speed of the wire with respect to the expansion obtained is critical in that the product produced according to this method is far superior to that produced when this control is neglected. When a coating of approximately 25 mils has been applied to the wire, an expansion of about five mils should be procured. The temperature ranges set forth for the wire and plastic material are not merely for the purpose of softening the plastic so that it can be molded about the wire but the specific ranges I have set forth appear to be critical in that if such ranges are neglected an inferior product is obtained.

In the composition, the chlorinated diphenyl which I employ is a mixture of the di- and tri-chlorinated diphenyl; the diphenyl group may represent a mixture of diphenyl and di-tolyl. This compound imparts in addition to slow burning properties, a plasticizing effect upon the insulating composition that in the process set forth does not excessively soften the composition so as to obtain an undesired low viscosity but at the same time has sufficient plasticizing effect to obtain proper molding with respect to the conductor. In lieu of the castor oil which is employed in this composition, I may use more dibutyl phthalate, as for example five extra parts dibutyl phthalate. As a solvent for the composition indicated I employ a mix comprising approximately 80 per cent of ethyl alcohol and twenty per cent of toluol. Another solvent composition which I may employ comprises fifty per cent of acetone and fifty per cent of benzol.

In the plastic insulating composition in which ethyl cellulose is a principal constituent, I preferably use 45 to 65 parts of plasticizer. This range has been found to produce entirely superior results.

When a wire is coated according to the process set forth with an insulating plastic composition

coating, such conductor has been found to have a breakdown of approximately 1800 volts per mil for a thirty mil thickness.

The temperatures and temperature ranges which I have set forth are the temperatures which must be actually set up in the wire and in the plastic. The temperatures which must be applied are usually higher so that these proper temperature ranges of the materials are maintained. The applied temperatures depend upon the speed of the operation and the volume of material. The temperatures have been given as of the materials since that, of course, is the only true test with respect to the process involved.

The plastic coated wire thus produced has a high insulating value as indicated. Further it is substantially non-inflammable and has remarkable resistance to water and moisture vapor.

The coating has sufficient hardness for all ordinary uses and, at the same time, because of its plastic nature, can be subjected to flexing and indeed a bending of about 360 degrees without cracking the insulating coating.

Further, because both of the composition itself and the method of applying the composition to the wire set forth only a relatively thin insulating coating is required in comparison to the coatings heretofore necessary. Because such thin coating can be used a marked saving is effected both in sheath material and because so little space is required for the insulated wire. This is of particular importance, as for example in machine and cable work.

I claim:

1. The method of coating a conductor which comprises preheating a conductor, heating ethyl cellulose plastic, coating the conductor with the heated ethyl cellulose plastic by leading the conductor surrounded by the ethyl cellulose plastic through a die where the length of the die is substantially three times the diameter of the die opening.

2. The method of coating a conductor which comprises preheating a conductor, heating ethyl cellulose plastic, coating the conductor with the heated ethyl cellulose plastic by leading the conductor surrounded by the ethyl cellulose plastic through a die under such pressure and at such speed as to effect about twenty per cent (20%) expansion of the extruded ethyl cellulose plastic about the conductor.

3. The method of coating a conductor which comprises heating ethyl cellulose plastic to substantially about 150° to 175° F., raising the temperature of the ethyl cellulose plastic to substantially about 250° to 275° F., still further heating the ethyl cellulose plastic until it reaches a temperature of substantially about 300° to 375° F., preheating a conductor and coating the heated conductor with the heated ethyl cellulose plastic.

4. The method of coating a conductor which comprises heating ethyl cellulose plastic to substantially about 160° F., raising the temperature of the ethyl cellulose plastic to substantially about 260° F., still further heating the ethyl cellulose plastic until it reaches a temperature of substantially about 330° F., preheating a conductor and coating the heated conductor with the heated ethyl cellulose plastic.

5. The method of coating a conductor which comprises heating ethyl cellulose and plasticizer composition to substantially about 150° to 175° F., raising the temperature of the ethyl cellulose

and plasticizer composition to substantially about 250° to 275° F., still further heating the ethyl cellulose and plasticizer composition until it reaches a temperature of substantially about 300° to 375° F., preheating a conductor and coating the heated conductor with the heated ethyl cellulose and plasticizer composition.

6. The method of coating a conductor with an ethyl cellulose plastic by extruding the ethyl cellulose plastic about the conductor in a die which comprises heating the ethyl cellulose plastic in a barrel until the ethyl cellulose plastic reaches substantially about 150° to 175° F., moving the ethyl cellulose plastic into a collar, heating the ethyl cellulose plastic in the collar until the ethyl cellulose plastic reaches a temperature of substantially about 250° to 275° F., moving the heated ethyl cellulose plastic into a head, heating the ethyl cellulose plastic in the head until a temperature of substantially about 300° to 375° F. is reached, heating a conductor, surrounding the heated conductor with the ethyl cellulose plastic at the temperature of substantially about 300° to 375° F. and extruding the ethyl cellulose plastic coated conductor through a die at such speed and under sufficient pressure so that an expansion of substantially about twenty per cent (20%) of the ethyl cellulose plastic is obtained when the plastic is released from the confinement of the die.

7. The method of coating a conductor with an ethyl cellulose, wax and plasticizer composition, the ethyl cellulose having a 43% to 45% ethoxy content and the plasticizer being used in substantially the proportion of from 45 to 65 parts of plasticizer to 100 parts of ethyl cellulose, by extruding the ethyl cellulose, wax and plasticizer composition about the conductor in a die which comprises heating the ethyl cellulose, wax and plasticizer composition in a barrel until the ethyl cellulose, wax and plasticizer composition reaches substantially about 150° to

175° F., moving the ethyl cellulose, wax and plasticizer composition into a collar, heating the ethyl cellulose, wax and plasticizer composition in the collar until the ethyl cellulose, wax and plasticizer composition reaches a temperature of substantially about 250° to 275° F., moving the heated ethyl cellulose, wax and plasticizer composition into a head, heating the ethyl cellulose, wax and plasticizer composition in the head until a temperature of substantially about 300° to 375° F. is reached; heating a conductor, surrounding the heated conductor with the ethyl cellulose, wax and plasticizer composition at the temperature of substantially about 300° to 375° F. and extruding the conductor coated with ethyl cellulose, wax and plasticizer composition through a die at such speed and under sufficient pressure so that an expansion of substantially about twenty per cent (20%) of the ethyl cellulose, wax and plasticizer composition is obtained when the plastic is released from the confinement of the die.

8. The method of extruding an ethyl cellulose plastic under pressure through a die about a base material wherein the ethyl cellulose plastic is impelled under pressure by a screw pusher, which comprises maintaining the ethyl cellulose plastic in a relatively stiff condition while it is being impelled by the screw pusher, increasing the fluidity of the ethyl cellulose plastic after it has left the screw pusher by raising the temperature of the ethyl cellulose plastic and increasing the fluidity of the ethyl cellulose plastic still further as it is extruded through said die about said base material whereby a substantial back pressure is built up in the ethyl cellulose plastic and deleterious leakage about said screw pusher is prevented, and controlling the speed of the base material so that about a twenty per cent (20%) expansion of the extruded ethyl cellulose plastic is effected.

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