Method of Coating Insulated Wire or the Like and Apparatus Therefor

Filed Feb. 16, 1932

Inventor

Albert T. Candy, Jr.
By Williams, Bradbury, McClellan & Hinkle

Hitgs.
Inventor

Albert T. Candy, Jr.

By Williams, Bradbury
McCaleb & Hinkle
Atty's.
My invention relates to a method of coating insulated wire or the like and apparatus therefor. It relates also to a method of making insulated wire—especially in colors.

While certain features of my invention are applicable to impregnation of a continuous strand-like material it is particularly concerned with the problem of coating where the material to be deposited is coated as a film of larger coated diameter than the object being coated. Many features of my invention are applicable to continuous coating processes for strand-like objects other than wire, but I here illustrate it particularly applied to insulated wire for electrical purposes. As applied to insulated wire, my application is especially concerned with coating an insulated wire, the fabric braid of which has previously been impregnated.

In insulated wire, the fabric braid has customarily been impregnated with a weather-proofing material—frequently a wax-like material such as paraffin or a'pitch such as asphaltum pitch—to protect the rubber insulation beneath the braid. More recently stearin pitch, or some other flame-retarding composition has been used either as the impregnation or as an auxiliary coating on the previously mentioned impregnation, to check the tendency of the braid to sustain combustion and carry flame along the wire in the event of fire. When the impregnation or resulting surface has been pitch-like, the wire has been given a final coating of paraffin to restore the surface characteristics of the wire which were found desirable when the braid was treated only with a paraffin impregnation. The desirable characteristics of the paraffin or other wax-like surface are its lubricating qualities, which enable the wire to be drawn through circuitous conduits without danger of abrasion, and a generally non-sticky surface, which avoids danger of the convolutions of wire on a spool or coil sticking together in warm weather as would be the case with a pitchy surface.

A paraffin coating on pitch has certain objections, even apart from the difficulties of applying it properly, among them: the paraffin, while normally transparent, has a tendency to flake off and also to form more or less opaque regions where it has been subjected to incidental scraping action, with the result that the appearance is not uniform and to a greater or less extent any color beneath the coating is dulled; the die or washer through which the paraffin coated wire is passed often acts unevenly leaving bared or even abraded regions on the braid; the coating may be contaminated with the impregnation or other underlying material; the paraffin is inflammable and therefore in any event a very objectionable feature, making it necessary to keep the paraffin film at a minimum of thickness; and, considering the ultimate diameter of the wire as the working limit, whatever thickness is taken up by the paraffin film is so much less thickness of fire-retarding material. It has also been proposed to impregnate the braid with paraffin or a substitute wax and to coat this with a flame-stop material such as stearin pitch, the theory being that the melted stearin pitch, being applied at a higher temperature than the melting point of the paraffin, will melt the paraffin and some of it will find its way through the coating of stearin pitch sufficiently to make the surface of the coating non-sticky without destroying its fire-retarding quality. This also has its objections: the difficulty of controlling the intermixture of the paraffin with the pitch; the inability to secure a uniform mixture of the paraffin throughout the coating, for the minimum content of paraffin will obviously be at the surface and that if sufficient to serve its function there, there is an excess of paraffin further in from the outer surface of the coating which would destroy the flame-retarding quality of the coating at such regions.
and thereby cut down its total fire-retarding effectiveness; the braid is left, for the most part, wholly impregnated with the paraffin which constitutes virtually a candle the burning of which is checked only by a very thin film of fire-retarding material which itself has, for the most part, too great a paraffin content to be effective; and the inability to produce colored wire without greatly increased cost.

One object of my invention is to provide and produce a wire which overcomes these objections in paraffin-over-pitch and in pitch-over-paraffin wires, but which will still give the desired non-sticky, lubricated, "slick finished" surface while retaining a relatively fire-retarding character.

I achieve this solution to the problem by using an impregnation and a coating, the compositions of which in general are substantially the same or at least wherein the impregnation is as non-sticky as the coating and the coating is as flame-retarding as the impregnation. To this end, the impregnation and coating compositions which I use preferably contain both stearin pitch, or a substitute, and paraffin, or a substitute, there being enough wax-like material to make the composition non-sticky and slippery and to impart a "slick finish" and enough stearin pitch or a substitute to make the composition nevertheless sufficiently flame-retarding. Apart from the aspect of coloring the wire (which I shall presently discuss), the advantages of using a coating composition having substantially the formula or characteristics of the impregnation, as compared with a coating of paraffin or substitute wax-like material, include: the greater flexibility of the coating; more fire repellant protection; elimination of inflammable surface film; better binding of the coating to the impregnation; and rendering immaterial the possibility of contamination between the coating and impregnation.

Referring now to the problem of code wire in the assortment of colors required by the trade, where the impregnation composition includes pitch—and stearin pitch is most frequently used to give a flame-retarding character to the wire—the color given the wire is black, or at least very dark. Pigments are too expensive to make it feasible to add sufficient quantities to the impregnation composition. Hence it has been proposed to paint the impregnated wire before adding the transparent paraffin coating. This has numerous objections: the added expense of another process; the cost of the paint itself; the cost of the additional apparatus necessary for the paint dipping; the dulling effect of the paraffin, even though normally transparent, over a bright color; the increased tendency toward white flaky superficial appearance of the paraffin coating and its tendency to flake off—due to the poor binding with the smooth surface of the paint; and, in some instances, crumbling of the paint itself.

Thus another object of my invention is the provision and production of a wire which is colored, wherein these objections are avoided and where the additional expense of coloring the wire is minimized and the color is made of lasting brightness without danger of streaking by superficial abrasion. To this end, I use, in so far as practicable, the same base composition or formula for the impregnation that I do for the coating and I add the pigment to the coating only. This gives an ample thickness of colored film, but as the amount of coating composition used per thousand feet of wire is considerably less than the amount of impregnation used per thousand feet, a great saving in the cost of pigment is effected as compared with the coloring of both compositions or the use of a colored impregnation omitting a coating. My composition, when used for a colored coating; has a natural opacity which lessens the amount of pigment required.

My invention is also concerned with the method or technique of coating. The usual method of coating a wire has been to pass a considerable length of the wire back and forth over sheaves through a sizable vat containing the melted coating material, pass the strand or wire through a die, wiper or similar device to remove the excess material and to control the thickness of the coating; and then to dry it by air passing the wire over sheaves for a distance of some thirty to seventy-five feet. Some of the objections to coating by dipping are: the wire remains in the melted coating composition long enough to permit heat to be imparted to the impregnation to a point of injuring it; the coating material may be contaminated by the impregnation; the excess coating must be removed down to the desired diameter or thickness of film; the die or other means of removing the excess coating may cut through the coating and bare the impregnation; the resulting finish must be a dull, wiped surface whether or not that kind of a finish is desired; and, because the wires pass back and forth through the vat containing the coating material, it is difficult to provide proper agitators to keep the material uniform without interfering with the wire, and therefore the composition as coated often varies due to the settling out of solids.

Another method of treating, somewhat different from the dipping process, has been to pass the strand through a vat or receptacle containing the melted coating material and then—instead of passing wire up through the surface of the liquid and to the die or scraper—to pass the wire directly through a discharge die in the side wall of the vat or receptacle. From the discharge die, the wire
emerges directly into cooling water or passes through a long reach through cool air to a sheave. Such methods have been principally for impregnations. If used for coatings, they would be subject to numerous objections: To keep the melted material from running out through the discharge bore as the wire is pulled through, the bore has to be small enough to compress or squeeze the immersed wire sufficiently to seal the bore of the die. Unless the wire is squeezed so that the braid or solid part of the wire scours the bore of the die, the relatively cooler die will cause the material to congeal and deposit within its bore. This internal deposit on the bore builds up until the scouring action again takes place against the braid. Thus no control is had for the thickness of the film of material beyond the diameter of the braid. The scouring action also increases the tension necessary to draw the wire through the die. These methods would not operate effectively for coating even if the diameter of the bore of the discharge die were greater than that of the braid, for the following reason: The hot impregnation material—whether applied simultaneously with, or immediately preceding, the coating layer—would be absorbed in so great an amount per foot of wire that the resulting temperatures at the outer regions of the wire at the braid would be too high to congeal the material being applied. The die would be relatively colder. As a result the fluidity, through a cross section of the bore of the die, would be greatest—not at the surface of the braid, but at a region radially inwardly of the surface of the bore. The rapidly moving wire and the stationary parts of the die would part at the region of greatest fluidity. Since this would not be at the surface of the bore, but rather at the surface of the braid, the material could not be applied to a substantially greater diameter than the thickness of the braid, and in any event it would not be accurately controlled. Another objection to the use of these treating processes for coating relates to the problem of cooling or setting the coated material. It is necessary that the coated material set before it touches the sheave or other metal part. If the wire is to be cooled by air after it emerges from the die, a very large amount of floor space must be taken up with one straight reach of wire some thirty to seventy-five feet long before it comes to its first sheave. In those methods where the wire emerges from the die directly into a bath of cooling water, the water further chills the discharge end of the die, building up a restrictive neck within the end of the bore of the die, due to its increased congealing action with the result, already explained, of squeezing the material to be deposited down to the surface of the braid. Another objection to these processes is that it is necessary to have a coating material which melts at a lower temperature than the impregnation material.

A further object of my invention is an improved method of coating which eliminates these objections. More specifically the objects include: a uniform controlled thickness of coating film; less tension for pulling the wire through the apparatus; greater permissible speed; permitting the use of a coating material with the same or higher melting point than that of the impregnation; the use of a tempering bath of water without chilling the die with its consequent objections and before touching any metal parts such as a sheave; a slick "flake" finish for the coated wire; less dribble from the die; practically no scrapings to be returned for remelting; and adaptability to oblique or vertical positions for the traveling wire.

In the method by which I achieve these objects, I preferably pass a wire, the braid of which has been previously impregnated and cooled, a short distance through a melted body of the coating composition and thence discharge the wire through a bore of substantially the diameter desired on the finished product, through a short intervening air gap, down through the surface of, and into the body of, a tank of tempering water where it passes over sheaves and on to the winding spool. The bore of the discharge die is kept at a temperature higher than the melting point of the coating material. No cooling water comes in contact with the discharge end of the die. Hence its temperature throughout is in excess of the melting point of the coating material. The wire and its impregnation, being previously cooled, is of less temperature than the melting point of the coating material. Therefore it congeals a layer of coating material upon itself. The length of wire exposed at any one moment to the melted coating material is too short and the speed at which the wire passes is too great, to permit the body of the wire and its impregnation to be heated to any appreciable extent by the momentary submersion in the melted coating composition. Therefore, as the wire passes through the coating apparatus, the body of the wire and the impregnation do not rise in temperature enough to relinquish, by melting, the layer of coating material which has deposited upon it, but continues to accumulate a congealed layer of the material. Should this congealed layer be of greater diameter than the bore of the hot die, the layer is either scraped or melted down to the bore of the die and passes through the die with the dividing or parting at the surface of the bore. Preferably, however, the various factors are so controlled that by the time the wire enters the bore of the discharge die, the layer of congealed material has not built up to the diameter of the bore, but leaves a substantial film of liquid melted material.
therebetween, which film is preferably lessened toward the discharge end of the bore by the continued accumulation or increase of the layer of congealed material. The melted material immediately adjacent the surface makes an effective lubricant for the easy and rapid passage of the wire.

For commercial code wire the diameter of the bore of the die may be .012 inches greater than the diameter of the impregnated braid as it enters the apparatus. This provides a coating film of approximately .006 inches thick. As the wire emerges from the discharge end of the bore the greater portion of the thickness of the coating is in congealed form. The remaining portion is so thin a film that it also congeals so quickly that there is no opportunity for it to accumulate eccentrically of the wire or to drop from the wire.

Another object of my invention is apparatus for carrying out my method with its attendant advantages.

The foregoing with further objects, features and advantages of my invention are set forth in the following description of a specific preferred embodiment thereof followed by drawings wherein:

Fig. 1 is a side elevation of the coating apparatus of my invention with its associated supply reel, tempering tank and winding reel;

Fig. 2 is a plan view thereof;

Fig. 3 is a detail view of a portion of the apparatus shown in Fig. 1 but on an enlarged scale, the coating material reservoir being broken into longitudinal vertical section;

Fig. 4 is a longitudinal vertical section of the applicator itself;

Fig. 5 is a transverse section taken on the line 5—5 of Fig. 3 through the applicator and showing the control valve;

Fig. 6 is a detail elevation of the valve taken on the line 6—6 of Fig. 5;

Fig. 7 is a more or less a diagrammatic longitudinal section through the bore 265 of the discharge die 26 and upon a greatly enlarged scale; and

Fig. 8 is a side elevation of a portion of the finished wire product with the several layers progressively removed.

The apparatus shown in Fig. 1 comprises a supply reel of wire 10 to be coated, the reel 11 being mounted to unwind as it rotates against the retarding influence of the usual friction brake 12, which may be a weighted rope wrapped one or two turns about the shaft of the reel. From the reel the wire 10 is led over a sheave 13 mounted on a suitable frame 14 and through the applicator 15 down into a tempering tank 16, entering the body of tempering water 17 obliquely through its surface, thence over sheaves 18 and 19 within the vat, over a final sheave 20 and to the winding reel 21 which is driven by a pulley 22 and belt 23 from a convenient source of power. The applicator 15, referring to Fig. 4, comprises a body, which may be of steel, penetrated by a longitudinal hole 24. One end of the hole 24 is closely fitted or plugged by a cylindrical anterior die 25 and the other end by a posterior or discharge die 26 preferably somewhat longer than the anterior die. A cylindrical chamber 27 is left between the two dies. As shown in the transverse section of Fig. 5 the applicator body may be split on a plane along the axis of the dies leaving lower and upper body members 28 and 29 held together by cap screws 29 and alined by suitable dowels. The purpose in halving the body is to facilitate cleaning and the removal or substitution of the dies.

The dies have alined central bores 25b and 26b respectively. The diameter of the discharge bore 26b is substantially that of the desired over-all diameter of the coated wire. The anterior bore 25b is conveniently and preferably of the same diameter as the bore 26b, although it may be some diameter intermediate that of the bore 25b and the diameter of the entering wire. The applicator is mounted obliquely on the frame 14 in such position that the center line of the bores coincides with the center line of the straight region of wire determined, by the sheave 13 and the vat sheave 18.

As shown in Fig. 5 there is a communication between the chamber 27 of the applicator and the bottom of hopper-like reservoir 30 by means of the pipe connections 31 and 32 and a cut-off valve 33. As here shown the reservoir 30 is square in cross section, the lower part being of inverted truncated pyramidal form. The reservoir 30 is divided into an inner chamber 30i and an outer chamber 30o by a partition 34 of perforated sheet metal. The partition 34 is of square perimeter with its lower edges contacting the sloping sides of the hopper portion of the reservoir 30 and the upper edges extending to the top of the reservoir. The reservoir is heated to keep the coating material well above its melting point by any suitable heating means such as a steam jacket, or, as here shown, electric heating elements 35 mounted on the exteriors of the sloping sides of the reservoir.

The coating composition, or its ingredients, are from time to time put into the outer chamber 30o through the top of the reservoir in solid or powdered form. The partition 34 acts as a screen to prevent the passage of the composition into the inner chamber until the composition has been melted and lumps eliminated. I prefer to employ an agitator 36. It may be carried by a shaft 37 depending from a bevel gear box 38 at the top of the reservoir, the agitator shaft being driven by a motor 39.

When there is no wire in the applicator 15 the melted composition would run out
through the bores 25b and 26b. To avoid this I provide an automatic control for the valve to shut it off when the wire has run out. This control preferably is a sheave 40 riding on the wire 10 and carried at one end of a lever 41 which is pivoted at 42 on a bracket from the frame 14. The other end of the lever 41 is pivotally connected to the slotted end 43 of a link 44 connected to the end of the valve lever 45. The slot 43 in the link 44, as shown in dotted lines in Fig. 1, permits a certain up and down movement of the rider sheave 40 to compensate for the different elevations of the wire 10 between the full and empty positions of the supply reel 11, without actuating the valve. However when the wire runs off the supply reel 11, the rider lever 41 drops down to a vertical position and pulls the valve lever 45 over to closed position. This immediately cuts off further supply of coating composition to the applicator chamber 27 and leaves but a relatively small amount to run out of the bores of the dies. This slight loss may be caught by drip pans not shown. In threading wire from a new supply reel, the rider sheave is not lifted up to position on the wire until the threading has been completed and the wire is ready to be pulled through the applicator.

The body of the applicator and the dies are maintained at a temperature well above the melting point of the coating composition by electric cartridge unit heaters 46 inserted in holes drilled transversely through the body. As shown in Fig. 4 these heat units are disposed close to the dies. The dies fit the opening 24 in the body snugly so there is a good heat transfer from the body to them. One pair of cartridges is disposed opposite the anterior die 23, one opposite the chamber 27 to keep the contents hot and two pairs are disposed opposite the discharge die 26. It is particularly advisable in my method to keep the surface of the discharge bore 26c hot enough throughout its length to melt the coating composition.

In the embodiment of my invention here disclosed, the wire supplied to the applicator by the supply reel 11 consists (see Fig. 8) of the usual copper conductor 50, layer of rubber insulation 51, fabric braid 52 and impregnation 53. Many features of my invention are not particularly limited to the composition of the impregnation. Among other impregnation materials which may be used is the usual stearin pitch with little or no other ingredients added. My coating need not be applied directly over the impregnation. For example, as previously mentioned, a waterproof impregnation of asphalt and pitch is sometimes used with a coating of stearin pitch over it. Many features of my invention are applicable to the application of the final coating over this intermediate coating of stearin pitch. However one feature of my invention is concerned with the composition used as the impregnation. The material with which the wire may have been impregnated before being passed through the coating apparatus of my invention may be 35% stearin pitch, 15% of paraffin, 10% of other waxes, 15% of natural or synthetic resin and 25% of filler. This composition contains sufficient paraffin or other wax-like material to render the surface of the impregnation non-sticky and to afford a sufficient lubrication to permit its being drawn through conduits without danger of abrasion,—without losing its relatively flame-retarding quality. As here shown the wire is fed to the coating apparatus from a reel of wire which has previously been impregnated and of course cooled to room temperature. Should wire be fed to my coating apparatus directly from the impregnating apparatus, the wire should, for the fullest advantages of my apparatus and method, be properly cooled for reasons heretofore and later explained.

The coating composition employed is preferably of the same composition, except for the addition of pigment if the wire is to be colored. For certain colors, the filler of the composition may be replaced by pigments of such bulk that they themselves form fillers.

My coating method and the operation of my apparatus is as follows: A previously impregnated and cooled wire 10 is unwound from the supply reel 11, passed over the sheave 13, through the aligned bores 25b and 26b of the dies of the applicator 15, through the water tank 16, around the sheaves 18 and 19, over the sheave 20 and to the winding reel 21. Then the wire sheave 40 is lifted on to the wire 10. This opens the valve 33 and permits the melted wax to run down into the chamber 27 of the applicator. The bore 25b being somewhat larger than the wire 10, air is displaced through the bore 25b by the melted coating composition entering the chamber 27 until the level of the liquid seals off the lower edge of the bore 25b. The head of liquid composition in the reservoir 30 compresses the trapped air to raise the liquid level to a slightly higher level. I have not found it necessary to provide a vent from the top of the chamber 27 to the height of the liquid level in the reservoir 30 to remove the trapped air.

The winding reel 21 is then set in operation pulling the wire rapidly through the applicator 15. Once the wire is in motion, there is no leakage of coating composition through the anterior bore 25b, despite the clearance between the bore and the incoming wire. This is because the wire, being cold immediately starts to congeal some of the melted composition on its surface, thereby restricting the amount of clearance. The factor of
surface friction between the melted composition and the congealed composition in so small an annular region, together with the speed of the incoming wire, preclude the melted composition flowing back all of the way through the length of the bore 255.

Unless some means be provided for maintaining a constant speed (the expense of which I have not found necessary), the speed of the wire will vary because of the increasing diameter of the coil as the wire is wound. I find however that the speed used in wire treating practice is satisfactory, ranging from two hundred to three hundred feet per minute at the start, and four hundred to five hundred feet per minute at the end, of the conventional five thousand foot run, with my method, this speed may also be substantially increased.

The melting point of the composition described will range between 150° and 180° F. The reservoir is preferably maintained at a temperature of about 250° F. and the applicator at about 300° F.

The incoming wire being relatively cool— at room temperature—a layer of the melted coating composition will, as previously described, be congealed upon the surface of the wire as it passes through the chamber 27.

In Fig. 8 this congealed layer is illustrated somewhat diagrammatically. The wire passes through the relatively short chamber 27 so quickly that the congealed layer, I believe, continues to accumulate throughout the length of the discharge bore 265. The wire is not in the chamber 27 or in contact with the melted composition long enough for the cold wire to be heated even at its surface to any appreciable extent. Consequently the congealing process continues throughout the passage of any given section of the wire through the applicator. The entire coating, it will be borne in mind, is only a few thousandths of an inch thick, the thickness in the diagram of Fig. 8 being exaggerated for clarity.

Because the die is kept hotter, even at the surface of the discharge bore 265, than the melting point of the coating composition, a free fluidity of the composition will be insured at the surface of the bore, despite the congealing action. This prevents the layer of congealed coating material building up to the full diameter of the bore while the wire is in the bore. No deposit can build up on the surface of the bore tending to restrict its effective size. By maintaining an outer region of melted fluid coating compound throughout the length of the discharge bore 265, the wire is insured an excellent lubrication in its passage through the bore, with the result that greater speed can be obtained and less tension is required on the wire.

As suggested by the diagram of Fig. 8, the various factors—the temperature of the incoming wire, the temperature of the melted coating composition in the chamber 27, the temperature of the die 26, the consistency of the coating material, the speed of the wire, the length of the die 26, etc.—are so controlled that, by the time a given section of wire reaches the discharge end of the bore 265, the layer of congealed coating material has built up to such a diameter as to leave only a minimum clearance from the surfaces of the bore 265 for the outer film of fluid material. Thus as the wire emerges from the discharge end of the bore 265 it comprises the core of impregnated wire, a coating of congealed material and a surface film of liquid melted material. The surface film is preferably of considerably lesser thickness than the coating of congealed material.

The emerging film of melted material is so thin and evenly distributed that in the short interval of time available the force of gravity does not have an opportunity to concentrate the melted material on the underside of the wire to any appreciable extent. The emerging film of melted coating congeals before such aberration can take place to any appreciable extent. The rapid congealing of the emerging liquid film is due to three factors: First, the continued absorption of heat by the relatively cool body of the wire, second, the chilling effect of the air about the emerging liquid film and third, the slightly subsequent immersion in the tempered water bath 17.

By inclining the direction of travel of the wire through the applicator, the wire may continue on through the surface of the water and through the body of the water so that before it reaches the sheave 18 the coating is tempered and set. By that time the contact with the sheave will not destroy the slick “flame” finish given the wire. It is important to a proper finish of the wire that the coating be set before contacting a sheave or other part. This has presented a serious problem in the past, which has often been met by running the coated wire from a discharge die through a long air space before it touches a sheave or other part. This has required a considerable amount of factory space. It has also involved a long length of wire in the coating apparatus as a whole at any given instant. The length of wire required to “thread” a new reel of wire in the coating apparatus is generally of an unworkmanlike appearance both at the beginning and the end of the run of a reel of wire. One feature of my invention is that this “threading” length, which may be imperfect, is greatly reduced.

If desired, the wire may be polished by the usual leather or rope wiper 56 after the initial immersion in the water. Preferably, as shown in Fig. 1, this is arranged between the sheaves 18 and 19, so that the wire is im-
mersed again following the wiping. In the case of materials such as I have disclosed which have higher melting points than paraffin and therefore do not tend themselves so readily to friction wiping at high speed, a hot die may be substituted.

The inclination of the wire as it passes through the applicator may be increased or decreased as desired—even being increases to the vertical. As it approaches the vertical, the anterior die becomes unnecessary if the chamber 27 is placed at such a height or made of such a length that the head of melt material in the reservoir 30 does not cause the melted material to overflow the chamber.

The ultimate over-all diameter of the coating is substantially, but not wholly, determined by the diameter of the discharge bore. Within the length of the discharge bore there is a certain frictional lag between the film of melted material and the walls of the bore. This tends to hold back some of the liquid film, with the result that the liquid film, when it emerged from the end of the discharge bore, would be a trifle less than the diameter of the bore. This tendency however is largely offset by the pressure of the head of liquid composition in the reservoir which forces the liquid film out against the frictional lag.

The various pertinent factors—the pressure head, the speed at which the wire travels, the viscosity of the melted material and the thickness of the concealed coating in relation to the thickness of the liquid coating at the discharge end of the bore—are preferably so balanced as to produce a resulting over-all diameter of the coating the same as that of the bore.

For different sizes of wire, or for different thicknesses of coatings, anterior and posterior dies having bores of different sizes are readily substituted. Slight variations in the thickness of the coating or a given size of wire may be produced by varying whichever of the previously mentioned factors is most convenient.

While I prefer wherever feasible to use substantially the same composition (except for pigment) in the impregnation as in the coating, it is expedient, when the coating is to be of certain colors, to substitute a coating composition where the active flame-retarding ingredient is associated with a very dark pitch such as stearin pitch. The expediency of this substitution is particularly true of a white wire, and to some extent with blue and yellow wires if it is essential that the colors be bright. In such instances a base may be substituted which has a characteristically light color. Such substitution however should still preserve for the coating the characteristics of flame-retarding, non-stickiness; sufficient slipperiness and "slick" finish. The advisability or expediency of such a substitution may be determined by balancing, on the one hand, the added cost of the substitute as compared with the pitch-and-wax composition previously described, against, on the other hand, the increased cost of the relatively expensive blue, yellow or white pigments in the quantities which would be required satisfactorily to overcome the blackness of the pitch. Where substitutes are used for the coating composition, waxes, resins or other ingredients may be added to control the viscosity and melting point preferably to the same melting point as that of the impregnation.

I have previously mentioned that one of the advantages in treating the braided wire in two processes—an impregnation and a coating—even though the impregnation composition and the coating composition be the same except for pigment, is in the cost of relatively expensive pigment. This however is not the only advantage. An important advantage, apart from the phase of color, is this: If the impregnation and coating were combined into a single operation, the relatively large mass of hot melted material absorbed by the braid would so raise the temperature of the wire at the region of the braid as to preclude an effective congealing of the material toward the region of the ultimate diameter of the finished-treated wire. This would tend to prevent bringing the layer of concealed material sufficiently close to the surface of the discharge bore to secure the greatest benefits of my method whereby an accurately controlled layer of material is deposited for a considerable thickness beyond the over-all diameter of the braid.

In my coating method a relatively long discharge bore is advisable for these reasons: The surface of a short bore would be chilled more rapidly than the necessary heat could well be applied to it; the long annular space between the wire and the die affords a more accurate metering of the material being coated; the long bore gives an advantageous "ironing" effect; a long bore permits greater speed; if the bore were short, there would be less region of frictional lag of the melted film, with a result that the head of liquid material could not be so well balanced by the frictional lag, and hence the fluctuation in the liquid head by the addition of the material to the reservoir from time to time would too readily vary the outflow of melted material from the discharge bore; and, as the process of building up the layer of concealed material could not be carried forward to any appreciable extent within the length of a short bore, it would be difficult if not impossible to control the thickness of the layer of concealed material that by the time it got to the short bore it would leave an intervening space of the proper thickness for the film of melted material—if this space were insufficient there would be a damming up at the
entrance end of the short bore which would block the flow of melted material, and if the space were too great, the layer of melted material emerging from the short discharge bore would be thin to be congealed before it had flowed to the underside of the wire to form a coating of eccentric cross section and perhaps also to permit some of the liquid material to drop off the wire.

While I have described and illustrated this specific method, apparatus and article, I contemplate that many changes may be made therein without departing from the scope or spirit of my invention.

The apparatus, formula, method of making a wire, and the wire are the subject matter of my application Serial No. 643,907 filed November 19, 1902 which is a continuation in part of this application.

I claim:

1. The method of coating a wire which consists in first treating the wire to render its surface substantially non-absorbent, then continuously passing a run of the wire, thus treated and at a temperature well below the melting point of the coating material, through a short distance in a body of the melted coating material wherein the relatively cool surface of the wire causes coating material to congeal as a layer thereon, passing the wire with its congealed layer through a discharge bore of considerable length, the diameter of which is larger than the diameter of the wire to be coated by substantially twice the thickness of the desired coating, maintaining the surface of the discharge bore at a temperature higher than the melting point of the coating material to preserve a surface film of still melted material, withdrawing the wire from the discharge bore along with the film of melted coating material surrounding the layer of congealed coating material, the film being so thin that it sets without substantial aberration, and passing the wire from the discharge bore through an intervening air space and into a tempering liquid to set the coating before it touches any wire guiding part.

2. The method of coating a wire which consists in first treating the wire to render its surface substantially non-absorbent, then continuously passing a run of the wire, thus treated and at a temperature well below the melting point of the coating material, through a short distance in a body of the melted coating material wherein the relatively cool surface of the wire causes coating material to congeal as a layer thereon, passing the wire with its congealed layer through a discharge bore of considerable length, the diameter of which is larger than the diameter of the wire to be coated by substantially twice the thickness of the desired coating, maintaining the surface of the discharge bore at a temperature higher than the melting point of the coating material to preserve a surface film of still melted material, withdrawing the wire from the discharge bore along with the film of melted coating material surrounding the layer of congealed coating material, the film being so thin that it sets without substantial aberration, and passing the wire from the discharge bore through an intervening air space and into a tempering liquid to set the coating before it touches any wire guiding part.

3. The continuous method of coating a strand-like article which consists in passing the article through a body of the melted coating material wherein the relatively cooler surface of the wire causes a layer of coating material to congeal thereon, passing the wire with its congealed layer through a discharge bore of approximately the diameter of the desired coating, maintaining the surface of the discharge bore at a temperature higher than the melting point of the coating material to maintain a film of still liquid material about the layer of congealed material, withdrawing the wire from the discharge bore, with a liquid film thereon, directly into exposure to air, and congealing the film.

4. The method of coating a wire which consists in continuously, rapidly passing a run of wire at relatively low temperature into a body of melted coating material to congeal a layer of the material on the wire, passing the wire with its layer of congealed material through a discharge bore along with an outer film of still melted material, maintaining the surface of the bore at a temperature above the melting point of the material, maintaining a liquid pressure on the film of melted material to counteract frictional lag therefrom the surface of the bore, and withdrawing the wire from the discharge bore, along with the film of melted material surrounding the layer of congealed coating material, directly into exposure to air.

5. The method of coating a strand-like article which consists in continuously, rapidly passing a run of the article at relatively lower temperature into a melted body of the material to be coated, congealing a layer of the material on to the article, passing the article with its layer of congealed material through an obliquely disposed discharge bore along with an outer film of still melted material, maintaining the surface of the bore at a temperature above the melting point of the material, the liquid film in the obliquely disposed bore congealing the run downwardly to counteract the frictional lag of the film against the surface of the bore, withdrawing the article from the discharge bore, along with the film of melted material surrounding the layer of congealed material, directly into exposure to air and thence continuing.
obliquely through the surface of, and into, a body of tempering liquid.

6. The continuous method of coating a strand-like article which consists in immersing the article in the melted coating material, congealing a layer thereof on to the article, passing the article and its congealed layer through a discharge bore, maintaining a film of still melted coating material about the layer while passing through the bore with the greatest fluidity at the surface of the bore, and congealing the material of the film after it leaves the bore.

7. The continuous method of coating a strand-like article which consists in immersing the article in the melted coating material and passing the article through a discharge bore of considerable length and of approximately the diameter of the desired coating, maintaining the surface of the bore at a temperature above the melting point of the material, withdrawing the article from the bore with a film of still melted material thereon, and congealing the film after it leaves the bore.

8. The continuous method of coating a strand-like article which consists in immersing the article in a melted body of the coating material to be coated and withdrawing the article from the body through a discharge bore, the surface of which is maintained at a temperature above the melting point of the material, with a film of still melted coating material surrounding the article as it emerges from the bore.

9. The continuous method of coating a strand-like article which consists in congealing upon the surface of the article a layer of the coating material, passing the article and its congealed layer through a passage or bore with a film of the melted coating material therebetween, maintaining the surface of the bore at a temperature above the melting point of the coating material and withdrawing the article from the bore with a thin film of still melted material enveloping it.

10. The continuous method of coating a strand-like article which consists in passing the article downwardly through a bore with melted coating material surrounding the article and between it and the bore to the discharge end of the bore, the surface of the bore being maintained at a temperature above the melting point of the coating material, and counteracting the frictional lag of the melted material on the surface of the bore by maintaining the bore in a downwardly disposed direction.

11. The continuous method of coating a strand-like article which consists in passing the article downwardly through a bore with melted coating material surrounding the article and between it and the bore to the discharge end of the bore, the surface of the bore being maintained at a temperature above