April 6, 1943. E. E. NEWTON ET AL 2,315,645

PROCESS OF COATING STRANDS

Filed March 11, 1941 3 Sheets-Sheet 1

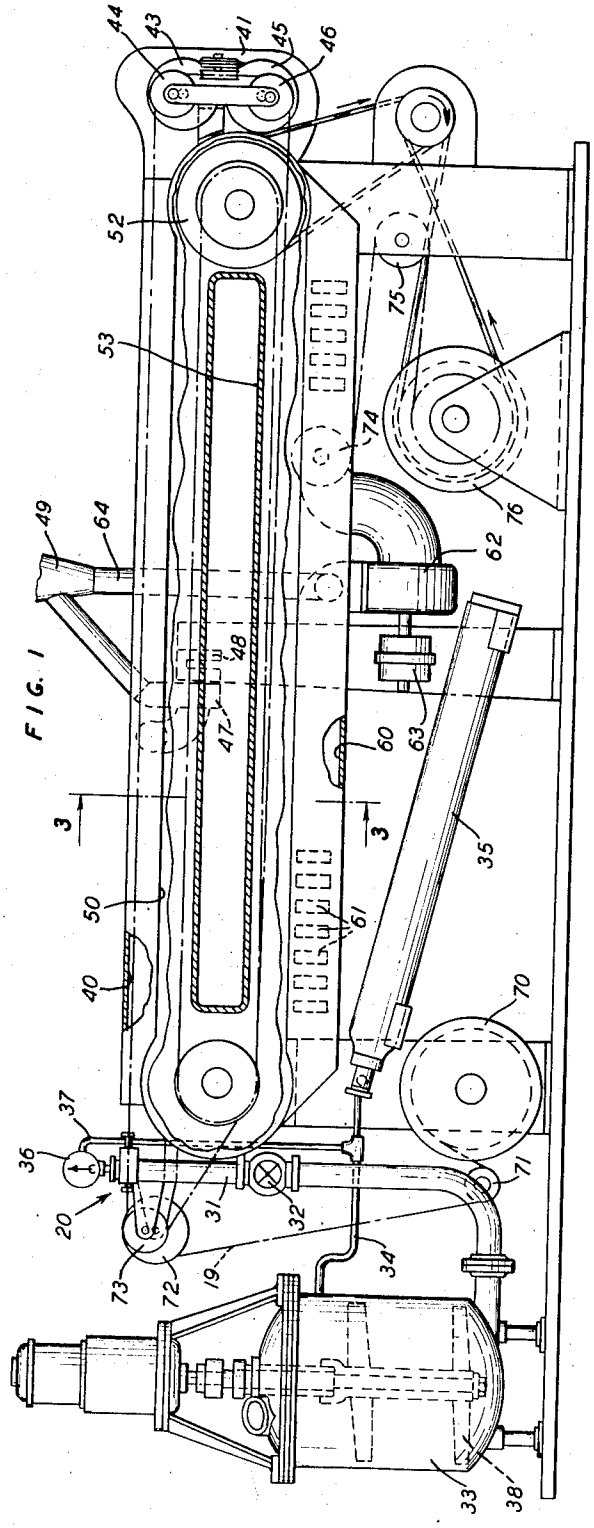


FIG. 1

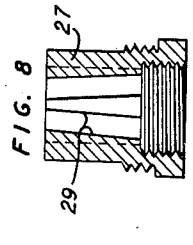


FIG. 8

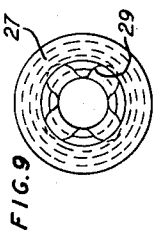


FIG. 9

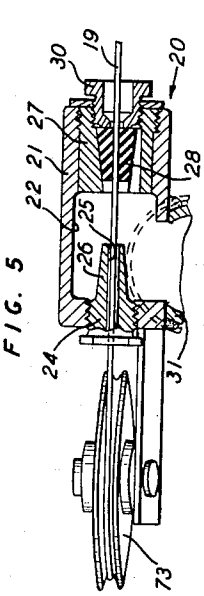


FIG. 5

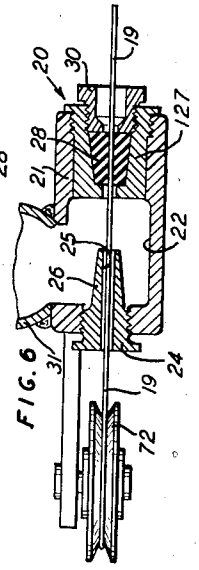


FIG. 6

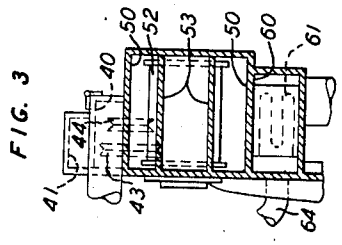


FIG. 3

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PROCESS OF COATING STRANDS

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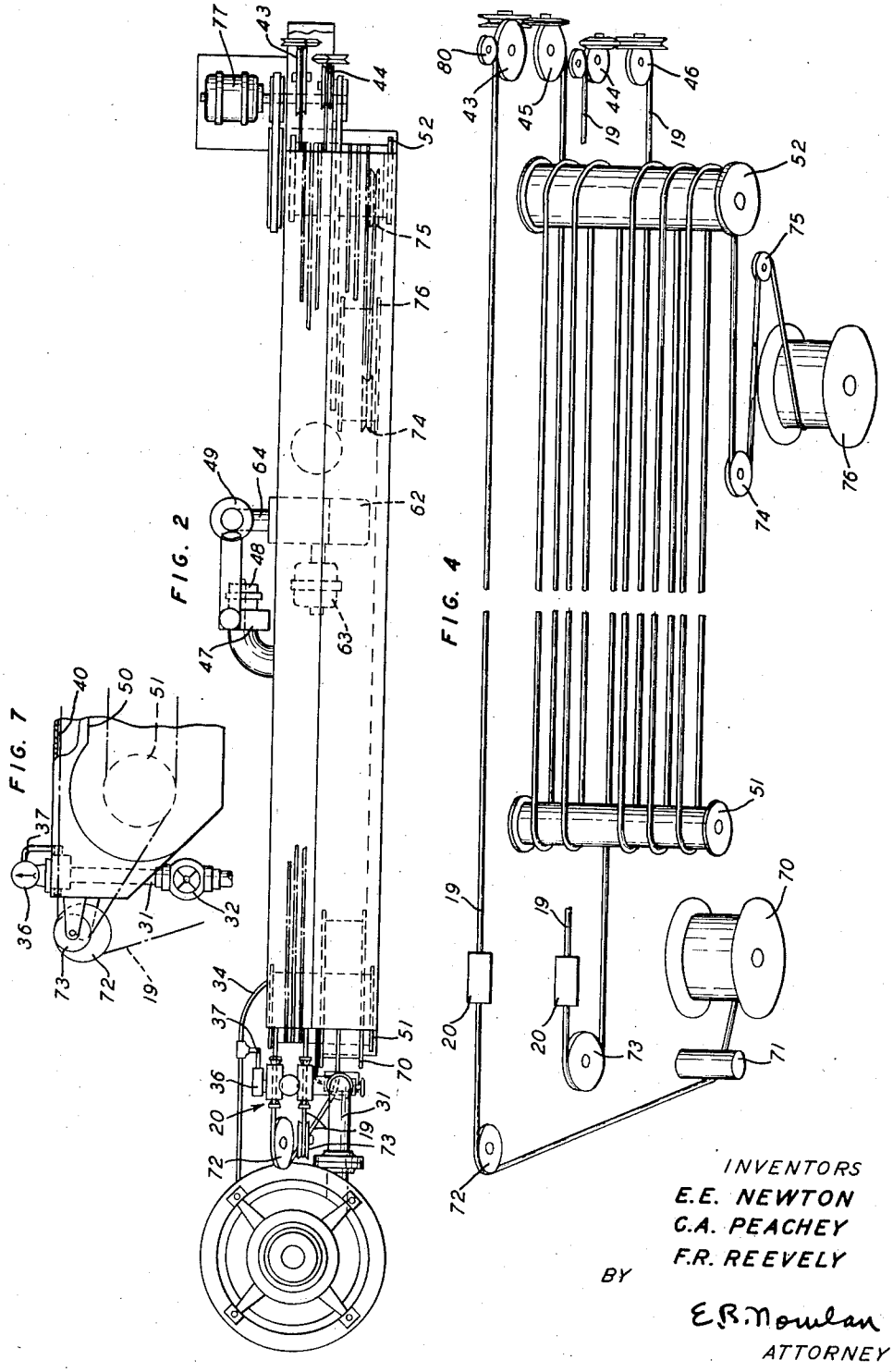


FIG. 2

FIG. 4

FIG. 7

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PROCESS OF COATING STRANDS

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FIG. 11

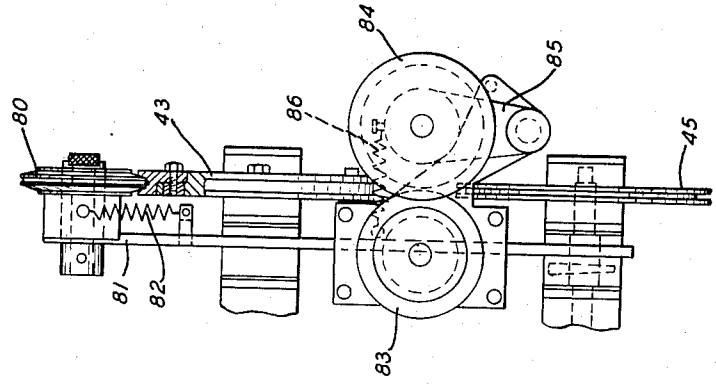


FIG. 10

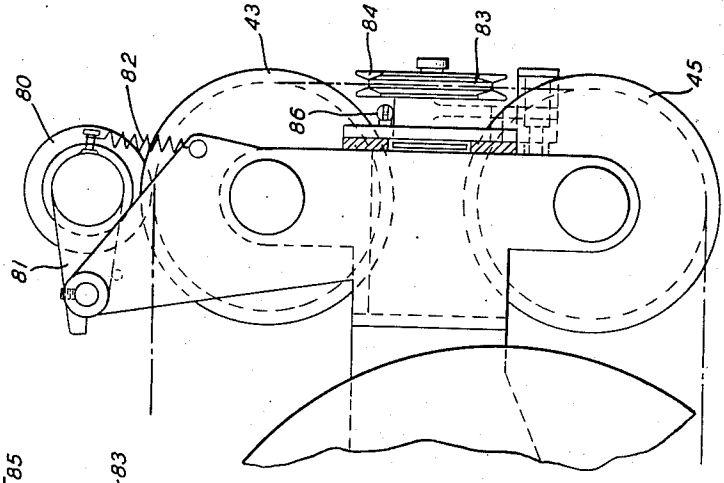


FIG. 12

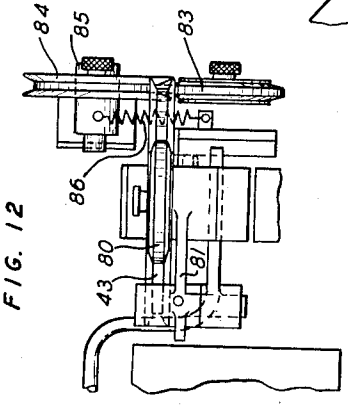
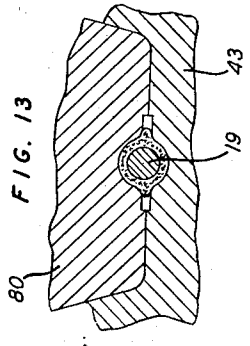


FIG. 13



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UNITED STATES PATENT OFFICE

2,315,645

PROCESS OF COATING STRANDS

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Application March 11, 1941, Serial No. 382,726

6 Claims. (Cl. 117—65)

This invention relates to a process of coating strands, and more particularly to a process for coating strands, especially electrical conductors, with viscous plastically pasty materials.

This application is a continuation-in-part of copending application Serial No. 209,396 filed May 21, 1938, by the same inventors.

Insulating sheathings on electrical conductors are made, at the present time, in a multitude of ways, some of which include the application to a bare or previously variously sheathed strand of hardenable materials applied in liquid, semi-liquid, or pasty form and subsequently hardened. Thus materials in the nature of paint, enamel, varnish, or waxes, asphalts, paraffins and the like dissolved in volatile vehicles, artificial resins hardenable by polymerization induced by heat, and other analogous materials are used for one or another specific purpose. In many such instances a solvent or vehicle is used which is volatilized to be subsequently recovered; and a considerable part of the cost of the coating operation may arise out of the volume of such solvent or vehicle to be recovered for subsequent re-use. Hence it is desirable and may be vitally important to apply the raw sheathing or sheath treating materials in a condition approaching dryness as nearly as may be practicable, i. e. as a smoothly plastic highly viscous paste, in order that the volume of vehicle or solvent circulated in the process, or perhaps wasted, may be kept low.

An object of the present invention is to provide a process simple, rapid and reliable in operation, for forming and hardening a coating of thickly viscous pasty material, such as described above, upon a strand.

With the above and other objects in view, the invention may be embodied in a method or process of coating strands which comprises the steps of applying to a strand raw coating material in a highly viscous plastic form and which material is hardenable by time and heat, subjecting the raw coated strand to a predetermined aging period in moving air or other gas at room temperature, and subjecting the aged coated strand to a gaseous heating medium at a raised temperature to harden the coating.

Other objects and features of the invention will appear from the following detailed description of one embodiment thereof in an apparatus for employing the procedure of the invention in applying a pasty, thickly viscous mixture of cellulose acetate in an acetone vehicle to a textile covered electrical conductor strand, taken in connection with the accompanying drawings in which the same reference numerals are applied to identical parts in the several figures and in which

Fig. 1 is a view in side elevation of the apparatus with a portion of one wall broken away;

Fig. 2 is a view of the apparatus in plan;

Fig. 3 is a sectional view on the line 3—3 of Fig. 1;

Fig. 4 is a diagram of the path of a strand through the apparatus;

Fig. 5 is an enlarged detached view partly in section of a preferred form of one of the twin material applicator heads;

Fig. 6 is a similar view of a modified form of applicator head;

Fig. 7 is a fragmentary view similar to Fig. 1 of a modified form of apparatus;

Fig. 8 is an enlarged detached view in section of the die of Fig. 5;

Fig. 9 is a similar end view thereof;

Fig. 10 is an enlarged view in side elevation of the pressure rolls at the right hand end of Fig. 1;

Fig. 11 is a similar view thereof in end elevation;

Fig. 12 is a similar view thereof in plan; and

Fig. 13 is a further enlarged, partial sectional view of the contact of two of the pressure rolls of Fig. 11.

The apparatus herein disclosed comprises, roughly, means to apply a viscous pasty material to a strand combined with means to harden the applied material on the strand, the two being so constructed and arranged that the process of hardening begins immediately the coating is applied with a step of preliminarily hardening at room temperature and subsequent further treatment at an elevated temperature.

The heart of the paste applying means is a twin applicator device best shown in Fig. 5 and in a modified form in Fig. 6, and generally indicated by the numerals 20. Since this is a twin, a description of one side only will suffice for both. An individual applicator comprises a cylindrical body member 21 having a chamber 22 therein, through which passes a strand 19 to be coated. The strand enters the chamber through an axially bored plug 24 mounted in the rear wall of the chamber, the bore 25 of the plug being sufficiently large to pass the strand without harmful friction. The forward end of the plug extends taperingly into the chamber as at 26. Another plug 27 (Fig. 5) or 127 (Fig. 6) is mounted in the front wall of the chamber and has housed com-

pletely therein a wiper die member 28. This member 28 is a body of soft vulcanized rubber or similar material and is given any convenient shape. The particular member 28 illustrated is an ordinary soft rubber bottle stopper of suitable size. The plug 27 or 127 is recessed to receive and support member 28 which is held in place in the plug by any suitable means such as the removable retainer 30. The plug 27 or 127 and retainer 30 are axially bored to pass the strand 19 with liberal clearance for both the strand and its raw coating. The die member 28 is formed with an axial bore of such size as to pass the strand 19 bearing a raw coating of predetermined desired thickness; and the member 28 acts to wipe off any superfluous thickness of coating.

The above description of the applicator applies equally to the showing of either Fig. 5 or Fig. 6 and is completely descriptive of the structure disclosed in Fig. 6, in which the recess of the plug 127 is of the same shape as the member 28. The plug 27 in Fig. 5 is originally made identically like the plug 127, but the walls of the recess therein are modified by having flutings or grooves 29 formed longitudinally therein.

The structure and function of these applicators per se and apart from their general combination in the structure and the function of the apparatus as a whole are no part of the present invention, being disclosed and claimed in copending application Serial No. 209,395, filed May 21, 1938, by one of the present inventors.

The apparatus herein disclosed to illustrate the method forms no part of the present invention, being disclosed and claimed in copending application Serial No. 295,024, filed September 15, 1939 by the present inventors.

An object of this arrangement is to permit the coating material under pressure to have access to the exterior of the soft member 28 to insure a uniform wiping effect.

The twin applicators 20 may conveniently be supported, as shown, upon the upper end of a vertical feed pipe 31 which serves to bring coating material to the chambers 22 as well as to support the twin applicators. A valve 32 mounted in the feed pipe serves to control the flow of coating material from a supply tank 33 through the pipe to the applicators. A supply of some inert gas, nitrogen, carbon dioxide or other similar gas according to the nature of the coating material, under pressure is fed into the upper part of the tank 33, preferably above the level of the coating material therein, through a pipe 34 from a suitable supply 35 of the compressed gas. If desired an indicating pressure gage 36 may be mounted at any convenient place and connected by a pipe 37 to the pipe 34. For many materials, coating material supply means as thus far described is satisfactory. For others it may be desirable to provide agitating means such as a stirrer 38. As such devices are familiar in many suitable forms and their structure and operation are irrelevant to the present invention, no further description is deemed necessary here. Such an arrangement will also enable the material to be compounded directly in the tank 33 if desired.

Immediately behind the pipe 31 and its supported applicators 20 is the entrance to the sheath hardening section of the apparatus. This comprises fundamentally a series of three horizontal, elongated chambers, positioned for convenience one above the other. The first, uppermost chamber 40, opens at its forward end directly opposite to and immediately behind the outlets of the two wiper dies 28 and their retainers 30. The rear end of the chamber 40 opens into a short vertical passageway 41 within which are mounted two coaxially spaced guide sheaves 43 and 44, over which coated strand from the applicators 20 after passing through the chamber 40 passes down and around another pair of guide sheaves 45 and 46 located in the lower portion of the passage 41. The chamber 40 is laterally completely enclosed, but its forward end is open to the outer air, and its rear end is completely open into the passageway 41 and so to the open air, since the passageway 41 has no wall on the side toward the beholder in Fig. 1. Air is drawn from the chamber 40, at some point between its ends, by a blower 47 driven by a motor 48 and is exhausted through a pipe 49. Fresh air at room temperature then enters the chamber through its open ends.

The second, intermediate chamber 50, may be located most conveniently immediately below and parallel to the chamber 40. The chamber 50 is preferably substantially completely enclosed on all four sides and both ends, except for apertures in its floor near each end communicating with the chamber 60 below. The rear end wall, next to the sheaves 45 and 46 is provided with small apertures, preferably barely large enough to allow strand from the sheaves 45 and 48 to pass through without harmful friction and enter the chamber 50.

Multi-grooved strand guide rollers 51 and 52 are positioned transversely across the chamber 50 near its respective ends, and strand entering the chamber from the sheaves 45 and 46 passes in a plurality of continuous loops over these rollers as hereinafter described. The forward end wall of the chamber 50 has a small aperture to allow the strand, at one point in its travel, to pass out of the chamber and over a guide sheave 73 into one of the applicators 20. The floor of the chamber 50 is also perforated at one place to allow the strand to pass out of the chamber there and to a take-up mechanism to be described later.

A long baffle 53, running lengthwise of the chamber 50 from near the rear side of the roller 51 to near the forward side of the roller 52, divides the chamber over most of its length into parallel, upper and lower passageways through which the coated strand may pass to and fro between the rollers 51 and 52.

The third, lowest chamber 60 is substantially completely enclosed except at its ends which communicate directly with the chamber 50 through apertures in the common wall of the two chambers. A series of heating elements 61 of any approved and familiar construction, e. g. steam pipes, electric resistance elements or the like, fed from some convenient source not shown, is located in this chamber to heat a current of air or other drying medium passing thereover through the chamber 60. Air may be drawn into the chamber 60 at one end from the chamber 50 and forced into the chamber 50 at its other end by any suitable means such as a blower fan 62 driven by a motor 63. This circulating air is then warmed by the elements 61. A proportion of the air thus circulated may be bled off through a pipe 64, which may conveniently communicate with the pipe 49. In the apparatus disclosed the air thus lost is replaced by leakage into the chamber through the various small apertures noted and also through the unsealed joints of its

walls, although, if desired, an appropriate aperture may be provided for this purpose.

Strand to be coated is drawn from a supply reel 70 over a tensioning roller 71 and a guide sheave 72 and passes thence through the farther (Fig. 1) of the twin applicators 20. In the chamber 22 of the applicator, the strand passes through a mass of thickly viscous plastically pasty coating material supplied to the chamber from the tank 33 under pressure provided by the compressed gas in the supply 35. The pressure of the material in the chamber 22 is controlled by the valve 32. How far the process of coating by which the strand emerges from the applicator with a sheath of raw coating material, may be termed an extrusion process or how far it is merely a matter of adhesion of the coating material to the strand it is difficult to say. The pressure is ordinarily held at such a point that, in spite of the form of the nose 26 and of the drag of the strand through the bore 25, a certain amount of the coating material is forced out through the bore 25 and accumulates on the front face of the plug 24, to be periodically removed. At the same time the pressure is held below the point at which the coating material would be forced through the bore of the member 20 in excess of the amount desired as a coating on the strand.

The raw coated strand leaving this first applicator 20 passes, without contact with any solid object until it reaches the sheave 43, through the cool drying or hardening chamber 40. During this passage the major portion of the volatile vehicle or solvent in the raw coat is removed by evaporation at the relatively low temperature in this chamber, without the formation on the coat of a superficial skin sufficiently hard and to retard subsequent removal of residual volatile matter. By the time the strand reaches the sheave 43, the partly dried sheath has become hard enough throughout its thickness to endure being carried around the sheave without damage.

Because of the fact that the coating material is thus applied as a relatively thick paste with no great volume of solvent or vehicle, this first coat may be applied in a thickness as much as five or six times as great as is practicable where the strand is simply passed through a relatively thin liquid bath of raw material. Also it becomes practicable to give this relatively thick coating sufficient hardness to endure contact with a guide sheave in the cold preliminary chamber 40 within a reasonable and practicable distance between the applicator and the sheave 43. At the same time, since this is done at relatively low temperature, solvent or vehicle is removed from the raw sheath substantially throughout its thickness and without the formation of a dry, tough and impervious skin over a still soft interior, which might slip, tear and wrinkle on the strand if it were passed over a sheave, capstan or the like, as would be the case if an equally or equivalently thick coating of the customary thin liquid preparation were used and it were attempted to harden it to the same consistency by heated air.

From the sheave 43, the strand passes under the sheave 45 and thence into the chamber 50 through which it passes without contact with any solid object until it passes up over the roller 51. Thence it travels to and fro in the chamber 50 around the rollers 51 and 52 such a number of times as is found to be necessary or desirable to harden the coating to the intended degree. The strand then passes out of the chamber 50 at its front end, over the sheave 73 and through the second applicator 20 (the nearest one in Fig. 1) where a second coating of pasty material is applied.

In passing around the rollers 51 and 52 as described, the partly dried or hardened coat has its remaining volatile matter driven out and removed by the hot air circulated through the drying chamber 50 and the heating chamber 60 by the blower 62. The air thus circulated ordinarily carries a considerable proportion of its capacity for volatilized solvent, so that, while the solvent or vehicle is ultimately substantially completely removed, the removal is effected relatively slowly and evenly throughout the thickness of the sheath, and again without the production of a thin impervious dried skin over a still moist interior. Hence when the strand emerges from the chamber 50 it has a relatively thick uniform sheath which is substantially dry of solvent throughout its thickness.

The strand then passes through the second applicator, as already described, and the new sheath is dried in the same manner as the first one, the strand passing through the chamber 40, around the sheaves 44 and 46, into the chamber 50 and back and forth around the rollers 51 and 52. This time the strand emerges from the chamber 50 through the perforation or aperture in its floor, noted above and in which is positioned a guide sheave 74. From this latter sheave the strand passes over a tension roller 75 and thence to a take-up reel 76.

The take-up reel 76 and the roller 52 are both driven by any suitable means, such as the belts indicated in Figs. 1 and 2, from a motor 77.

The roller 52, being driven as described, acts as a capstan to assist in advancing the strand through the apparatus in addition to the effect of the take-up reel 76. For this reason, the diameter of the roller 52 may preferably be made sufficiently smaller where the first passes of the strand run than where the later passes run to compensate for the sometimes unavoidable elongation of the strand due to the tension needed to advance the strand. For the same reason it may be preferable also to taper the roller 51 correspondingly or even in some cases to replace the roller 51 by a plurality of independently rotatable guide sheaves.

The drying effectiveness of the chamber 40 is dependent partly upon the room temperature and relative humidity of the air and partly upon the rapidity with which the room air is drawn through the chamber by the blower 47. It is apparently important that this drying effect be carefully controlled by adjustment of the blower speed. In some cases it may be desirable and even necessary to close even the small gap between the applicators 20 and the open end of the chamber 40 as shown in Fig. 7, where the chamber 40 is extended to substantially enclose and contain the twin applicators.

While the apparatus and procedure as thus far described may be substantially entirely satisfactory with some materials and for some purposes, in some instances it may be desirable to effect a greater degree of compactness and smoothness in the applied coating, especially where a porous sheath, e. g. of textile or paper pulp material, on the strand is to be both impregnated and coated. In such a case, means are provided at the end of the first pass of the strand, through the chamber 40, to compact and smooth the coating.

As herein disclosed, particularly in Figs. 10 to

13 inclusive, such means may comprise a pressure sheave or roller 80 mounted to ride on top of the strand passing over the top of the sheave 43. This roller 80 is mounted to be freely rotatable in a freely pivotable arm 81 supported in any suitable manner on the frame of the apparatus. A helical tension spring 82 will cause the roller 80 to press down on the strand with the requisite pressure. The roller 80 and the sheave 43 will then be grooved as best shown in Fig. 13 to form the coating over most of the circumference of the strand and leave room over small portions for excess material.

A forming sheave or roller 83 is mounted to be freely rotatable in a fixed position a little below sheave 43, with its periphery tangent to the path of the strand 19 from the sheave 43 to the sheave 45, and with its plane at right angles to the common plane of the sheaves 43 and 45. A coacting pressure sheave or roller 84 is mounted, on the other side of the strand 19, to be freely rotatable in a freely pivotable arm 85 supported in any suitable manner on the apparatus, and a tension spring 86. The peripheries of the sheaves 83 and 84 are grooved in the same manner as those of the sheaves 80 and 43 as the latter are shown in Fig. 13. Since the contact line of the sheaves 80 and 43 passes through the axis of the strand in a direction at right angles to that of the contact line of the sheaves 83 and 84, the strand is formed and compacted over the entire circumference of the applied coating by passing successively through the two pairs of coacting rollers.

If it be found desirable, a second set of forming rollers may be similarly associated with the sheaves 44 and 46.

A typical material heretofore in use contains about 20% of solids, largely cellulose acetate, in about 80% of solvent, largely acetone. Such a preparation is a sirupy but definitely fluid liquid, can be poured, and will flow through a pipe under gravity alone. Its viscosity will be around 2000 poises or less at 105° F.

As already pointed out it is the particular purpose of the present invention to create and deal with a strand having a coating of thick, pastily almost solid, viscous material ordinarily five or six times as thick as that when can be created on a strand in the case of the relatively thin, sirupy, raw coating materials heretofore used. This is highly advantageous, because the number of coating passes of the strand and therefore of the ensuing hardening passes is cut to one-fifth or one-sixth in number of those heretofore required to produce coats of like final thickness; also because the volume of solvent required to be evaporated off and either wasted or expensively recovered is very materially diminished, so much so that it may well be cheaper to waste the evaporated solvent than to maintain and operate the expensive recovery plant previously necessary.

In one instance a coating material was used, typical in physical characteristics of materials adapted for the present invention, which contained 58% by weight of solids (largely cellulose acetate) and 42% by weight of a liquid vehicle containing, in 42 parts, 40 parts of acetone and 2 parts of other liquids. The viscosity of this was about 25,000 poises at 75° F. and at the extrusion temperature of about 105° F. it was about 18,000 poises. It could not be poured or transferred in the manner of ordinary liquids except under pressure. In one instance in practice, it required a pressure of 150 lbs. per square inch to transfer the above mixture through a pipe.

The thick coating of raw cellulose acetate softened with acetone (by way of example), however, brings new problems to the procedure and apparatus required for hardening it, which arise directly out of the thickness and viscosity of the stuff from which the solvent is to be evaporated. If heat is supplied too intensely and rapidly to the surface of the raw, thick coat, as by passing the strand at once or too soon into a hot drying oven or chamber, the surface film of the thick coating may be hardened into an impervious film which prevents the escape of the solvent. Then when the superficially hardened strand is wound up and stored, the residual solvent softens the surface film, the coating is squeezed away where there is pressure, and the coils stick together. If heat be applied more gently but still too rapidly, so that the coating is heated through but too fast, the solvent will gather in bubbles in the thick, sticky substance and make pinholes in the coating where they burst out. Hence the necessity for the relatively long gentle extraction of the greater portion of the solvent by the preliminary pass or passes at room temperature before the strand enters the oven proper. Hence also the value, where extra thick coats are in view, of the compacting by the means shown in Figs. 10–13 between the cool passes and the hot passes, to prevent or cure these blowholes or pinholes. These difficulties do not arise in the prior art where the sirupy, liquid, raw materials are used, as the coat applied at each dipping pass is too thin to have sufficient body to cause these troubles.

Where acetate coatings are applied over textile sheaths on wire, especially cotton or silk or wool sheathings, fiber ends ("fuzz") on the textile may stick out through the acetate coating and become channels for the entry of water, deleterious gases or the like through the coating into the sheath. The compacting step serves to embed and seal such fiber ends within the body of the coating. In other cases the degree of adhesion of the coating to the sheath may be of importance. In some cases it may be necessary to ensure a high degree of adhesion. This is then effected by the step of compacting between the aging and the hardening. And this compacting may be far more severe and effective with the viscid paste coating material than with the liquid coatings of the prior art.

Substantially the same process and apparatus may also be used where the coating material is a preparation in the raw or more or less unpolymerized state of one of the polymerizable oils or artificial resins, e. g. comprising China-wood oil either raw or partly polymerized or one of the many forms of an aldehyde polymerized or condensed with a phenol type compound. In such a case the hardening of the material results primarily from an atomic or molecular re-arrangement of the substance of the material.

It is found, in some instances of such products, that what may be termed an aging step of allowing the material, after being applied and before being heated to induce hardening, to rest at room temperature in its finally desired physical conformation, may conduce materially to the satisfactorily uniform character of the finished product.

Hence it may be highly desirable, in some such cases, to employ substantially the same steps and to use apparatus analogous if not identically like that described, for such materials, wherein a heat hardenable coating material having no volatiliz-

able material is applied to a strand, is then aged for a predetermined time at room temperature, and is then hardened at an elevated temperature.

Many such materials in the raw state comprise ammonia or substance which gives off ammonia. In such cases the air circulating and supplying means of the apparatus as disclosed may be a practical necessity.

In some instances a satisfactory coating may be produced with a single applicator, the strand being brought out over the sheave **74** after its first drying instead of being brought out over the sheave **73** to the second applicator.

It may be noted here that it may be desirable in some instances to use an inert gas, e. g. nitrogen, carbon dioxide, helium or the like as a volatilizing agent. In such case the several chambers, modified as shown in Fig. 6, will be made substantially gas tight, and gas to replace that bleed off or carried off through the pipe **64** will be replaced by gas supplied from the solvent recovery means or any suitable source and introduced into the rear end of the chamber **40** and into the intake casing of the blower **62**.

In some instances it may be desired to leave a predetermined proportion of the vehicle in the sheath to provide a degree of residual plasticity for further manufacturing operations. The extent to which the removal of the vehicle approaches complete dryness may be controlled by the temperature in the chamber **50** produced by the heating elements **61** or by the total length of the path of the strand inside the chamber **50** or by both.

The embodiment of the invention disclosed may clearly be modified and departed from in various ways without departing from the scope and spirit of the invention as defined in and limited solely by the appended claims.

What is claimed is:

1. A process of coating strands which comprises the steps of applying to a strand raw coating material hardenable by time and heat and in a highly viscous plastic form, subjecting the raw coated strand to a predetermined aging period at room temperature to partially harden the coating, compacting the aged coating by pressure, and subjecting the aged coated strand to a gaseous heating medium at a raised temperature to finally harden the coating.

2. A process of coating strands which comprises the steps of applying to a strand raw coating material polymerizably hardenable by time and heat and in a highly viscous plastic form, subjecting the raw coated strand to a predetermined aging period at room temperature to partially harden the coating, compacting the aged coating by pressure, and subjecting the aged coated strand to a gaseous heating medium at a raised temperature to polymerize and thus finally harden the coating.

3. A process of coating strands which comprises the steps of applying to a strand raw coating material in a highly viscous form and containing a volatilizable vehicle, subjecting the raw coated strand to a gaseous vehicle volatilizing medium substantially at room temperature for an aging period sufficiently long to partially harden the coating by removing a major portion of the vehicle from the coating, compacting the aged coating by pressure, and subjecting the coated strand subsequently to a gaseous vehicle volatilizing medium at a raised temperature to finally harden the coating by removing the remainder of the vehicle therefrom.

4. A process of coating strands which comprises the steps of applying on a strand coating material hardenable by time and heat and of a highly viscous pasty consistency and comprising a solid and a solvent, subjecting the raw coated strand at room temperature to a gaseous treating medium for a sufficient length of time to evaporate a major portion of the solvent therefrom and thereby partially harden the same, compacting the partially hardened coating by pressure, and subjecting the partially hardened and compacted coating to a gaseous heating medium at an elevated temperature for a sufficient length of time to harden the coating fully.

5. A process of coating strands which comprises the steps of applying on a strand coating material polymerizably hardenable by time and heat and of a highly viscous pasty consistency and comprising a solid and a solvent, subjecting the raw coated strand at room temperature to a gaseous treating medium for a sufficient length of time to evaporate a major portion of the solvent therefrom and thereby partially harden the same, compacting the partially hardened coating by pressure, and subjecting the partially hardened and compacted coating to a gaseous heating medium at an elevated temperature for a sufficient length of time to polymerize and thus harden the coating fully.

6. A process of coating strands which comprises the steps of applying on a strand coating material hardenable by time and heat and of a highly viscous pasty consistency and comprising a solid and a volatilizable solvent, subjecting the raw coated strand at room temperature to a gaseous treating medium for a sufficient length of time to evaporate a major portion of the solvent therefrom and thereby partially harden the same, compacting the partially hardened coating by pressure, and subjecting the partially hardened and compacted coating to a gaseous heating medium at an elevated temperature for a sufficient length of time to volatilize the remaining solvent and thus harden the coating fully.

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