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J. C. LEE.

INSULATED CONDUCTOR AND PROCESS.

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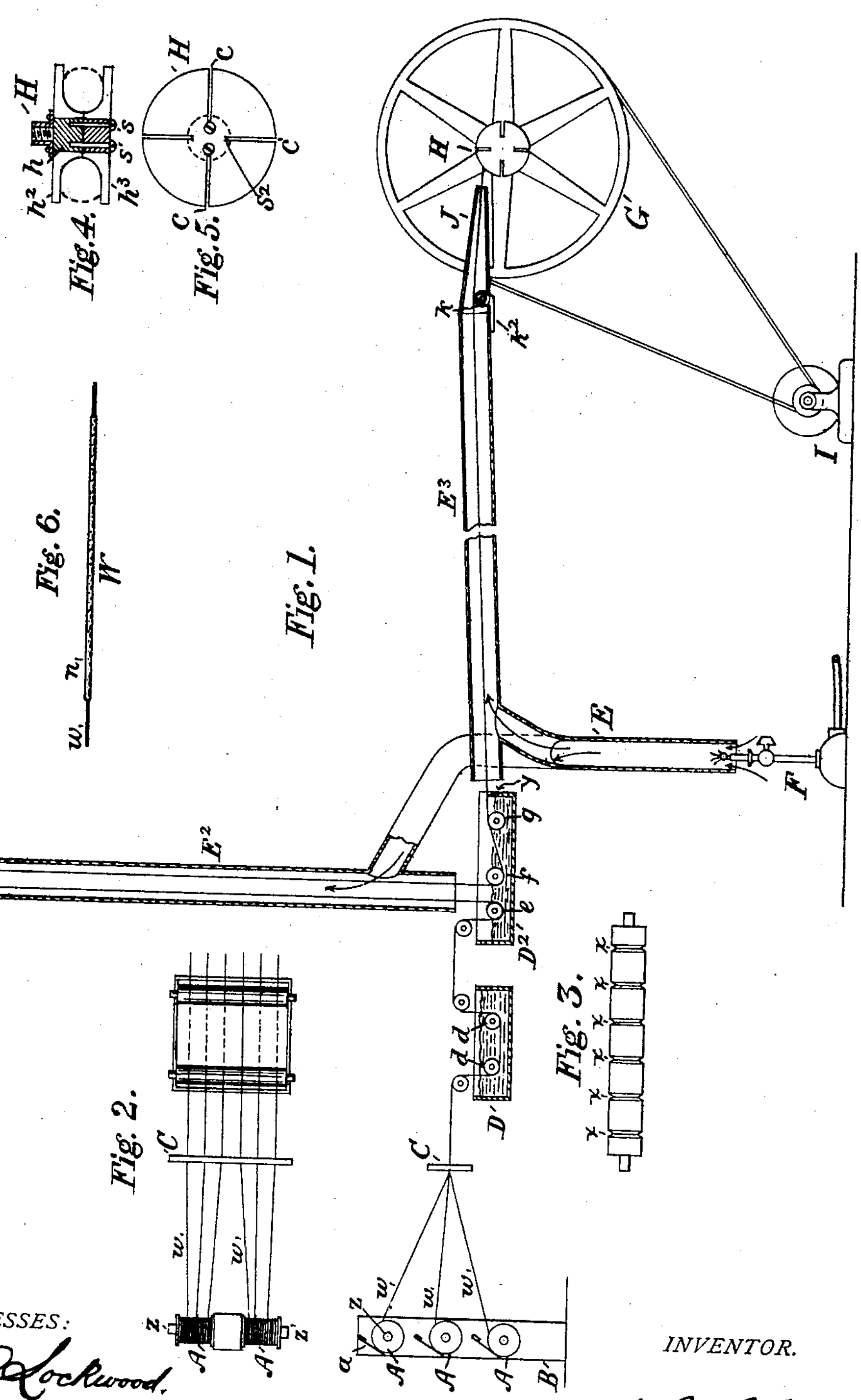
NO MODEL.



WITNESSES:

Frank C. Lockwood.

Joseph A. Gately

INVENTOR.

John C. Lee

By Thomas D. Lockwood

ATTORNEY.

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UNITED STATES PATENT OFFICE.

JOHN C. LEE, OF BROOKLINE, MASSACHUSETTS, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

INSULATED CONDUCTOR AND PROCESS.

SPECIFICATION forming part of Letters Patent No. 767,900, dated August 16, 1904.

Application filed April 10, 1902. Serial No. 102,299. (No model.)

To all whom it may concern:

Be it known that I, JOHN C. LEE, residing at Brookline, in the county of Norfolk and State of Massachusetts, have invented certain Improvements in Processes of Making Insulated Conductors, of which the following is a specification.

The present invention relates to the insulation of electric conductors, and particularly of fine wires used in the manufacture of electrical or electromagnetic apparatus. Its object is to provide for electric conductors a highly-effective insulating medium or material capable of being easily and economically applied to the conducting-wire and which when so applied shall cover the said wire with a satisfactory insulating-film, homogeneously enveloping the same and so thin that by its use a much greater length of wire can in the construction of electrical appliances be coiled within a given space than with insulation of fibrous or other ordinary character would be possible.

Electrical conductors employed in the manufacture of electrical apparatus have mainly or ordinarily been provided with an insulating-covering of silk, cotton, or like fibrous material or with solid albeit fusible substances—such as gutta-percha, okonite, mineral wax, &c.; but in many cases these materials are unsatisfactory, since those of the former type are liable to absorb moisture to the detriment of their insulating properties, while those of the latter class break down under a moderately abnormal rise of temperature, and since both classes add so seriously to the thickness of the conductor as to render impossible the employment of a sufficient number of turns of such conductor within an admissible space.

In the constitution of iron cores for inductance loading-coils for electric circuits through which rapidly-changing currents, such as telephone-currents, are transmitted the foregoing facts have especially emphasized themselves. The high frequency of alternation which characterizes such currents renders them peculiarly liable to losses accruing from the generation of eddy-currents and their circulation in the substance of the core, such currents being uniformly developed at the expense of the working current, which is of course correspondingly depreciated. Accordingly it has been found expedient to divide the iron of said cores and to increase their transverse resistance to the most radical extent, making each separate divided element as small as possible, and to insulate the several component members or divided elements of said cores with great care each from all others. Thus ring cores for loading-coils have been made by winding fine iron wire into the form of a torus, the size of said wire being No. 38 Brown & Sharpe gage, or .003965 of an inch, and for a variety of reasons it is not practicable to cover such wire with the ordinary fibrous and solid fusible forms of insulation hereinbefore mentioned. The insulation medium of the present invention is particularly well adapted for use as a non-conducting or insulating coating for the fine iron wire of which such cores are constituted to prevent the cross circulation of eddy-currents, and it has been employed in this connection with great advantage. A great many cores for loading-coils having been made up of a very large number of convolutions of iron wire, each turn being thoroughly insulated from its neighbors by an exceedingly thin coating of celluloid or celluloid and shellac.

In my invention celluloid preferably associated with a suitable adhesion-improving material, such as shellac, is dissolved in alcohol or like volatile solvent, and the conductors or wires to be covered are drawn or passed through a bath of the celluloid solution, thus receiving a complete liquid coating of the compound. The wires next pass through a drying-oven, where the coating thus received is fixed upon them by the evaporation or volatilization of the solvent of the coating-bath. The wires are then generally passed in the same way again through the insulating-bath or through a second coating-bath and then through a second drying-oven, thus repeating the initial process throughout, and are then wound tightly upon a reel or directly upon a form into a ring, core, or such other appliance as may be desired. To obtain the best results in drying the insulation, it is requisite to employ a higher temperature in drying the insulation compound than is necessary merely for the evaporation of the solvent. If the heat applied is merely sufficient to effect evaporation of the said solvent, as shown by the conductor issuing cold from the drying-oven, the insulation-coating adheres much less firmly to the said conductor than is the case when a greater amount of heat is applied and the wire issues hot. The coating of the wire is also much smoother in the latter case, the insulation having apparently experienced fusion or partial fusion much in the same way as occurs in the application of a japan. Nevertheless as decomposition of the celluloid is liable to occur when the insulation becomes superheated care must be taken in drying that the temperature of said insulation itself does not become unduly high. To obtain the best results, the temperature of the insulation should not exceed 180° Fahrenheit. The wire, however, may be and in practice is drawn through an atmosphere whose temperature is much higher than 180° Fahrenheit without injury to the insulation, and it is found satisfactory to maintain the drying atmosphere within the oven at a temperature of from 210° to 230° Fahrenheit and to draw the wire coated with the celluloid solution through said atmosphere at a speed of approximately thirty feet per minute.

The celluloid solution containing, as preferred, an admixture of shellac, which tends to enable the celluloid to more closely and firmly adhere to a wire when applied as a coating thereto, is conveniently and satisfactorily prepared as follows and in the following proportions: A preliminary celluloid solution is made by dissolving ten parts, by weight, of celluloid in two hundred and fifty parts, by weight, of wood-alcohol. A preliminary shellac solution is also made by dissolving fifty parts, by weight, of shellac in two hundred and fifty parts, by weight, of wood-alcohol. The final solution to be employed as the insulating-bath in the process applying the insulating-coating to electric conductors is then made by mixing fifty parts, by volume, of the preliminary celluloid solution and ten parts, by volume, of the preliminary shellac solution together and with forty parts, by volume, of wood-alcohol. A sufficient portion of anilin dye to impart a distinguishing color to conductors coated with this insulation material may be added to the above mixture.

In the accompanying drawings, Figure 1 is a diagram conventionally illustrating a means for and mode of insulating conductors in conformity with my improvements. Fig. 2 is a plan view of the uninsulated wire-spool support, an insulating-bath, and an intermediate guide-plate. Fig. 3 is a side view of the roller employed in apparatus adapted to simultaneously insulate several conductors at once. Figs. 4 and 5 are respectively a side view and cross-section of a reel or form on which said conductors are wound for the formation of loading-coil cores, and Fig. 6 represents a conductor coated with insulation according to my invention.

In the said drawings, A represents spools on which are wound the conductors to be insulated, the same being mounted on a suitable support B.

C is a guide-plate; D, a cleansing-vat; D^2, an insulating-bath; E^2 and E^3, drying-ovens, shown as hot-air tubes; E, an ingress-pipe for the heated atmosphere of said ovens, and F a suitable source of heat, shown as a Bunsen burner.

H is the reel upon which the wire is wound after it is covered with the celluloid insulation; G, a pulley on a shaft with said reel; I, any preferred motor mechanism for said reel and pulley, and J a blast-pipe continuation of the oven E^3, through which a stream of heated air may be directed on the wire while it is being wound on the reel H.

The bare wire w, which is to be insulated, is wound on the supply-spool A, of which one or more may be hung or supported in the frame B, fixed in suitable relation to the cleansing and insulating baths, the drying-ovens, and the reel to receive the conductor when coated. The spool A runs in bearings of the frame B and may be provided with a spring a, bearing upon its flange or journal to act as a brake. The said spring is arranged to exert sufficient pressure on the spool to bring it to rest should the wire break or the insulating process be from any cause interrupted.

The conductor w, drawn by the motor I or other suitable power exerted through the pulley G, is unwound from the spool A and passes, preferably, first into and through the cleansing-vat D, containing benzin or naphtha, whereby it is freed from all grease and dirt. Emerging from the vat D, it then passes successively through the insulating-bath D^2, which contains the celluloid mixture, and then through the drying-oven E^2, receiving a coating of liquid insulation in the former, which is dried and fixed in the latter. After passing through the said drying-oven it again enters the insulating-bath to receive a second coating of the celluloid mixture and is then drawn through the second drying-oven E^3 and issuing from thence is wound upon the reel H. If the conductor thus insulated is an iron wire and is to be employed in the formation of finely-divided iron ring cores for electromagnetic appliances, such as loading or other inductance or induction coils, a purpose for which, as hereinbefore stated, the said conductor being perfectly insulated by a very thin covering is especially adapted, the reel H may be constructed so that the floor of the wire space between its flanges shall have a curved contour, as indicated by Fig.

4. The said reel is then also a former adapted to determine the shape of the internal periphery of the core. In such a case the reel or former H may consist of a hub *h*, a fixed flanged side h^2, attached thereto, and a detachable side h^3, securable to the hub by any convenient device, as screws *s*. Radial slits *c* are then provided at corresponding points in the flanged sides h^2 h^3 at any desired number of points, and these are continued, as shown at s^2, for a short distance into and across the substance of the hub *h*. These slits provide means for attaching binding wires or cords round the cores as completed before taking them from the former. Such binding wires or cords are threaded through or previously placed in the grooves s^2, which cross the periphery of the hub, and may then be drawn round the core and secured at any point outside. The structure of the former or reel is therefore such that when the core is completely wound the reel can be taken apart and the completed core removed therefrom. If the insulated wire be required for other purposes, the reel H may of course be otherwise constructed, as desired, or may be of any preferred character. Moreover, when the coated wire is thus directly employed in the formation of insulated iron-wire cores the winding of such cores is greatly facilitated and accomplished much more expeditiously by applying the thin insulating-coating of celluloid and shellac to several wires simultaneously and by winding them together and all at the same time upon such a former as that which has been described or of any desired shape and size. As many as fifteen iron wires have thus been simultaneously insulated, and that this can be done is a material advantage in view of the great number of convolutions of fine iron wire (approximately ninety-three thousand) required in making up a single loading-coil core.

In the drawings the simultaneous insulation of six bare wires is indicated, three spools A of wire to be insulated, each having its own brake *a*, being mounted on suitable bearings *z* on each side of the support B. These wires pass through separate holes in the guide-plate C, which brings them all into the same horizontal plane, and then round the several rollers *d d* of the cleansing-vat *e f g* of the insulating-bath and *b* and *k* of the drying-ovens, the said rollers having all a plurality of grooves *x*, as particularly shown in Fig. 3. The last bath-roller *g* is so placed as to raise the conductors as they finally emerge from the bath to a level with the edge thereof, and any surplus insulation which may form, as a drop on the under side of the wires, is scraped or wiped off by a wiper *y* after the wires leave the said roller. The roller *k*, over which the wires pass when leaving the drying-ovens, may be mounted on a suitable bracket k^2, secured to the wall of said oven.

Obviously the drying-ovens may be constructed in a variety of ways. For instance, instead of an indraft of air to be heated in passing by a Bunsen burner there may be provided tubes or troughs to be heated by a series of gas or other flames directed against their lower sides, or the atmosphere of the said ovens may in a manner well understood be brought to the required temperature by electrical heating devices.

In directly winding cores of iron wire insulated as described herein it is desirable to direct a final hot blast upon the core itself while in the process of formation—that is, upon the wire which is being wound on the forming-reel—to prevent the absorption of moist air or the deposition of moisture from the air into the cores.

A jet or blast-pipe J, affixed to the end of the oven-pipe E^3 and directed against the reel H, is shown as being employed for this purpose.

In Fig. 6 is illustrated a portion of a conductor provided, as described herein, with a coating of celluloid insulation. W is the complete insulated conductor, *w* being the conductor proper, the ends of which are shown as being bare or uncoated, and *n* the insulation or celluloid coating.

A double coating of celluloid insulation applied to a wire of four one-thousandths of an inch in diameter is not more than two or three ten-thousandths of an inch in thickness, which is less even than ordinary variations in the thickness of the wire.

Having thus fully described the invention, I claim—

1. The process of insulating electric conductors which consists in applying to said conductors a liquid adherent coating thinned with a volatile solvent; in fixing the said coating by drying out the solvent; and of directing a hot-air blast upon said conductors while being wound directly upon a reel.

2. The method or process of insulating electric conductors which consists in applying to said conductors a liquid coating of celluloid and a suitable adherent dissolved in a volatile solvent, in fixing the said coating by volatilizing or drying out the solvent; in winding the said conductors on a reel; and in directing a hot-air blast upon said conductors while being wound upon said reel, substantially as and for the purposes described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 28th day of March, 1902.

JOHN C. LEE.

Witnesses:
GEO. WILLIS PIERCE,
FRANK C. LOCKWOOD.