

June 1, 1926.

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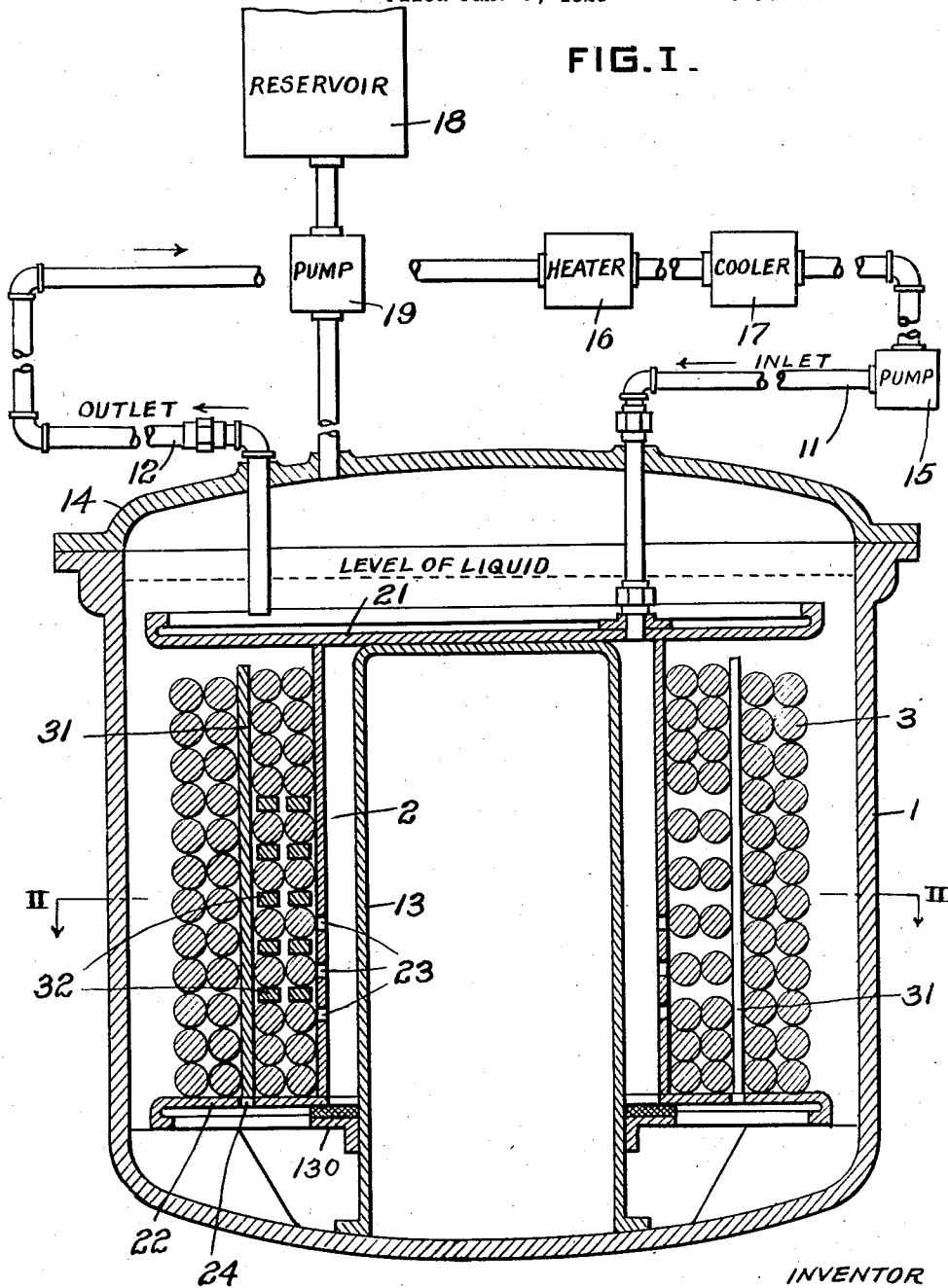
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METHOD AND APPARATUS FOR IMPREGNATING CABLES

Filed Jan. 5, 1925

2 Sheets-Sheet 1

FIG. I.



WITNESSES

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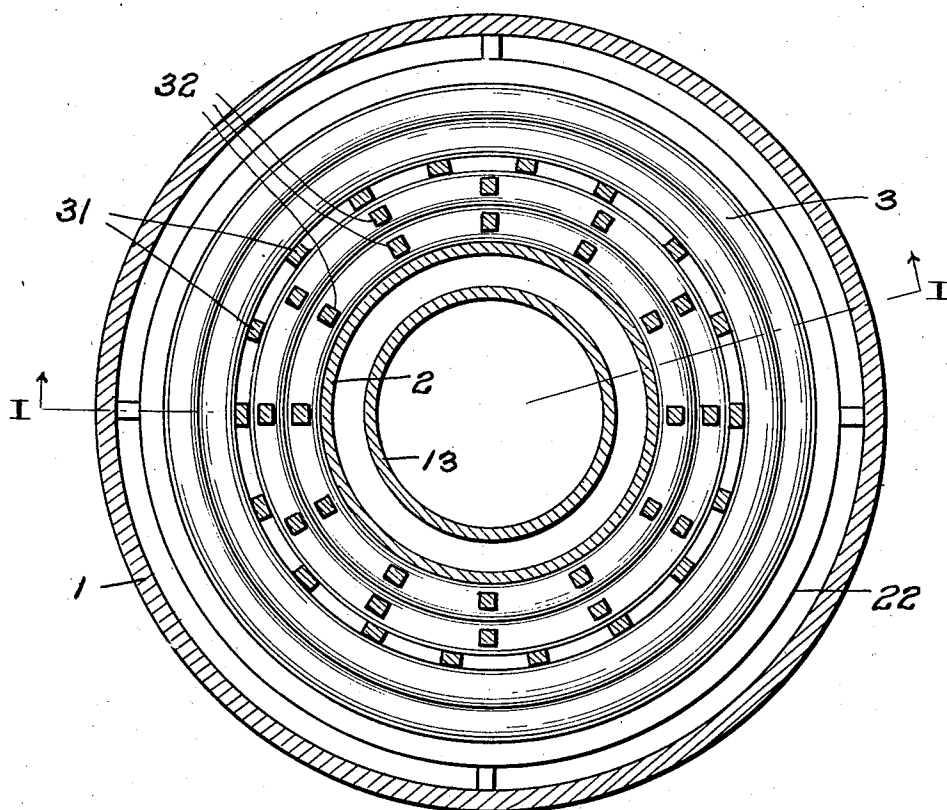
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METHOD AND APPARATUS FOR IMPREGNATING CABLES

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2 Sheets-Sheet 2

FIG. II.



WITNESSES

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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR IMPREGNATING CABLES.

Application filed January 5, 1925. Serial No. 495.

My invention relates to the building of electric cables and consists in an improvement in methods of and means for effecting the impregnation with an essentially liquid substance of the body of solid-insulating material with which a cable conductor is ordinarily enveloped.

In the accompanying drawings Fig. I is a view in vertical section of a kettle with its connections, in which impregnation is effected, and within the kettle a reel appears, carrying coiled upon it a length of insulated cable conductor. Fig. II is a view in horizontal section. The plane of section of Fig. II is in Fig. I indicated by the broken line II—II, and similarly the plane of section of Fig. I is in Fig. II indicated at I—I.

It is usual, after a cable conductor has been enveloped in a layer of wrapped-on paper insulation, to coil it upon a reel, and to immerse it, reel and all, in a bath of insulating compound, that the wrapped-on paper envelope may be impregnated. A special sort of a kettle is commonly provided for the purpose: a kettle which may be closed hermetically and a kettle which additionally is provided with connections and accessory appliances, by means of which air and moisture may be withdrawn from the paper envelope and compound be caused to fill all the interstices of the porous substance. The insulating compound employed (ordinarily a hydrocarbon oil) is advantageously one which at atmospheric temperatures is stiff and viscid, and which in order to enter the pores of the paper, must by heating be rendered fluid to a much greater degree than normally it is.

The operation of impregnation then involves immersion in hot compound. But, after impregnation has been effected, the bath of compound and the coil of insulated conductor within it, must be cooled again, before the conductor can advantageously be removed, for if the conductor were removed while still the bath of compound is hot and highly fluid, the compound would drain away, allowing air to penetrate in some degree the substance of the insulating envelope, and this with injurious results in the finished cable.

In the practice of my invention I bring it about that a coil of cable conductor enveloped in paper and wrapped upon a reel

shall in minimum time be wholly immersed in hot compound, of substantially uniform high temperature throughout all its depth, and in minimum time shall throughout all its depth be cooled again, and further I guard against premature removal of the coil from the kettle, with consequent injury to portions of the coil, which otherwise might not be cold enough for safe removal.

In the drawings, the kettle is indicated at 1, the reel at 2, and the conductor coiled upon the reel at 3.

The kettle may be provided with a lid, 14 applicable to and removable from position on the kettle, and adapted when in place to effect hermetically tight closure, and through the lid or through the sides of the kettle connections may be established, not shown, but well-known to the art, for removing air and moisture from an introduced coil of paper-enveloped conductor.

Inlet and outlet pipes 11 and 12 for insulating compound are diagrammatically shown passing through the lid. The inlet pipe entering the kettle opens to the hollow space at the center of a reel 2, brought to position within the kettle. The outlet pipe opens from the space within the kettle above reel 2, when the reel has been introduced. The inlet and outlet pipes might manifestly be caused to pass through the side walls rather than through the lid of the kettle, if that arrangement were preferred.

Any desired heating and cooling appliances may be provided for the kettle. I show to this end a central hollow column 13 rising from the bottom of the kettle, upon which and surrounding which the reel 2 is applied, and which filled with hot or cold fluid, expedites the heat-transference steps incident to the operation of impregnation.

The reel is formed of sheet metal and consists essentially of a central cylindrical drum to which the numeral 2 is immediately applied and terminal plates 21 and 22. The upper plate 21 constitutes a head for the drum-like body 2 of the reel and projects laterally to form flanges; the lower plate 22 does not close the central cylindrical space, but merely affords companion flanges to those above. On the outside of the drum 2 and between the opposite flanges the paper-enveloped conductor 3 is coiled. The upper

plate 21 is perforate, for the introduction of the inlet pipe 11. The lower plate 22 leaves the central cylindrical drum 2 open below, in order that the reel may be applied to and removed from the position in which it is shown, surrounding the column 13. The reel is additionally provided with orifices in its sheet-metal walls. These include orifices 23 near the lower end of the central drum 2, and orifices 24 through the lower flange 22, for purposes of circulation of the insulating compound, as presently will be described. Preferably the column 13 of the kettle is provided with an outstanding collar 130 faced with a suitable gasket upon which the introduced reel may rest, as shown in Fig. 1.

It will be understood that a closed system of circulation for a given body of insulating compound may be effected, by bringing the outlet lead 12 into continuity with the inlet lead 11, as is diagrammatically indicated in Fig. 1. In such a closed circuit a pump 15 may be introduced, to cause the compound to flow in a circulating stream. And in such return line of flow from outlet 12 to inlet 11 suitable apparatus, diagrammatically indicated at 16, 17, may be included, to effect either heating or cooling, or in proper sequence both heating and cooling, of the circulating stream of compound. A suitable reservoir 18 of insulating compound may be provided, in communication with the interior of kettle 1, and in the line of communication a pump 19 may be introduced, by means of which the body of insulating compound within the kettle may be maintained under pressure.

Within the kettle the connections and the apparatus arranged and operated as shown and described, bring it about that insulating compound flowing through inlet pipe 11 shall enter immediately the cylindrical space within the drumlike body of reel 2. From this space the compound will flow through orifices 23, and through the coiled-on body 3 of paper-wrapped insulation to the space within the tank and external of the loaded reel. Thence the flow will be through outlet pipe 12 and, in closed circuit back through inlet pipe 11. If the collar 130 be present, serving as described, all other lines of circulation are closed, and all the circulating stream of compound must pass through openings 23.

Factory conditions require that the paper-insulated conductor shall be coiled on the reel to the depth of a considerable number of layers of superposed wraps. The drawings show, diagrammatically, four such layers. That is an accurate indication of the actual condition of things, and will serve to illustrate my invention.

The problem has been, and is, to effect rapid and uniform heating and cooling throughout the entire extent of an intro-

duced coil, so that at every point, first the temperature necessary to accomplish proper impregnation shall be quickly attained, and then cooling shall be rapidly and uniformly accomplished. The difficulty has been that, not only do the superposed turns of the coil of material interfere with and disturb even circulation of compound to all the parts of the body, but the outer layers insulate the inner from heat communication. This condition, which obtains at all temperatures, becomes particularly aggravated and difficult to deal with as the compound in the progress of the operation is cooled and caused to become viscid.

The orifices in the sheet-metal body of the reel, indicated above, are provided to serve in cooperation with a particular arrangement of the coils of insulated conductor upon the reel, to bring about this particular condition: that channels of flow shall be established, for the circulation of the compound within the kettle, and that the length of insulated conductor shall at every point be exposed to compound flow, and indeed shall form part of the walls which define these circulation channels. The foregoing generalization is subject to one qualification: the innermost layer of the coil lying, as it does, immediately upon the drum 2, is in heat-exchanging relation to that body. It is not, therefore, requisite that the innermost layer form one wall of a channel for the circulation of insulating compound,—though, of course, it too may, by such arrangement as will be obvious, when once my invention has been explained, become a channel wall.

From what has already been said, it is manifest that with circulation established radially through the drum and the burden which it bears, there will be flow of compound through all the depth of the layers, but, without the further provision of definite channels, the distribution of flow will tend to be irregular (particularly as the compound cools), and I find it advantageous to provide, in addition to the perforate sheet-metal reel, precisely arranged channels of flow through the body of material coiled upon the reel.

The drawings show a coil four layers deep. The innermost layer is, as has just been said, promptly responsive to temperature change, by virtue of the fact that it lies immediately upon the metal drum 2. The outermost layer is likewise responsive to temperature change, for it is immediately exposed over all its surface to the body of liquid which constitutes the bath. The intermittent layers of the coil are, but for further features of my invention exposed only to an irregular and unevenly distributed temperature-changing influence, and in consequence they lag behind in the matter of

temperature change, and the operation of impregnation is prolonged, and the danger is imminent, of premature withdrawal of the impregnated coil from the bath.

5 The drawings show the second and third layers of the coiled insulated conductor 3 to be spaced apart, by means of slats 31, which may be formed of any suitable material,—wood, for instance. These slats are laid 10 while the conductor 3 is being coiled. They are laid longitudinally upon the second layer of the coil, and the third layer is wrapped upon them. Thus, in the assembly as it appears in Fig. 1, a vertically extending channel 15 is established between the second and third layers of this four-layer coil.

Additionally, between certain turns of the first two layers of coiled material, blocks 32 are, while coiling is in progress, interposed, 20 to afford in the body of the load upon the reel, passageways, through which the inflowing stream of insulating compound may gain access to the vertically extending channel formed by the interposition of slats 31, between 25 the second and third layers, as already described.

As a matter of convenience in practice, a proper number of blocks may be strung together in chain-like formation; and similarly 30 sets of slats may be made up for facility in application.

It will be understood that while in the immediately foregoing paragraphs I have been describing precisely what is shown in the 35 drawings, I do not mean to limit myself to a reel loaded with a specifically limited number of coiled-on layers, nor to spacing members of the particular form shown nor placed at particular places only. My invention involves such an opening of the coil, by the introduction of suitable spacing bodies, as shall 40 insure this condition: a stream of compound shall sweep an exposed surface of the insulated conductor at every point in the conductor's length.

The lower plate 22 of the reel 24 is perforate, to afford a lower opening for the vertical channel described, and at the upper 50 end, the load will of its own weight sink and leave a space as shown, through which there is escape from the vertical channel at its upper end. Preferably the openings 23 through the drum 2 are set toward the lower end of the drum, and through them the compound 55 has access through the spaces opened by blocks 32 to the vertical channel between the second and third layers.

Such a particular formation of the reel with its orifices, and associated with it, such 60 a particular building of the coil of insulated conductor upon the reel, brings it about that the stream of insulating compound circulating under the means described, will fill the central space within the drum 2, thence it 65 will pass freely to the vertical space between

the second and third layers of the coil, it will flow vertically, both upward and downward in this channel, and emerge to the space within the kettle, external of the loaded reel. It will be perceived that at every point 70 in its extent the coiled conductor 3 is immediately exposed and in heat-exchanging contact, either with the stream itself, or with the metal wall 2, on the opposite side of which the stream is flowing. 75

The temperature of the flowing stream is, as operation progresses, first hot, to effect impregnation, and then cold, to bring about a condition of viscosity. The arrangement 80 and method I have described bring about a uniform and rapid achievement of these temperature changes, throughout all the body material under treatment.

The reservoir 18 and the pump 19, with communication to the interior of the kettle 85 may be made effective, to maintain upon the body of insulating compound within the kettle, elevated pressure. Such high pressure exerted upon the body of compound while 90 cooling is in progress, is effective, to prevent the opening of voids in the hardening compound,—voids which, opening, might otherwise become flaws in the finished cable.

The apparatus operating in the manner described contains within itself a compensating 95 feature. To the extent that the hot compound tends to flow around the loaded reel, and not through the load (as it may if the collar 130 be omitted), it is by absorption of heat in the kettle walls cooled and reduced 100 in fluidity. As the outer regions of freer flow thus become relatively viscid, the warmer regions within the body of coiled material offer relatively less resistance to flow, and rate of flow increases there. 105

Suitable temperature indicating apparatus may be applied at proper points, by observation of which the operator may determine, how to control the operation, and 110 when to remove the impregnated material from the kettle.

The apparatus described with the material arranged in the manner described is adequate for the effective circulation of fluid, whatever its particular character may 115 be; and, while I have had liquid insulating compound primarily in mind, it will be understood that gaseous material may be circulated in similar course. In the building of electric cables it is of course of utmost 120 importance that water vapor be removed to the completest degree possible from the porous solid material, and all the spaces filled with insulating compound. And I have already remarked upon drying as a usual preliminary step in the operation of impregnation. It remains only to say that the channels 125 opened for circulation of liquid are available for the preliminary circulation of hot dry air, by which moisture to the last 130

possible trace may, before the insulating compound is admitted, be removed.

The usual procedure is this: The reel with its load of not yet impregnated material is introduced within the kettle and the kettle is closed. Hot dry air is caused to circulate through the kettle and through the load of material upon the reel, circulation being facilitated by the presence of channels, as already explained. Following upon this drying step, the last traces of moisture are best removed by exhausting the air from within the kettle. Following upon the drying of the material, the insulating compound, at suitable temperature, is caused to enter and fill and circulate through the kettle and the burden of material contained therein. The heating of the material incident to the drying step is of advantage in the ensuing step of impregnation, in that the impregnating liquid on entering the kettle meets an already heated body and its fluidity is not impaired, as otherwise it might be.

I claim as my invention:

1. The method herein described of effecting impregnation of insulated conductors, which consists in coiling a length of conductor into a layered coil, the superposed layers lying alternately in contact one upon another and spaced apart at an interval one from another, and causing insulating compound to circulate in a stream between the spaced apart layers.

2. The method herein described of effecting impregnation of insulated conductors which consists in coiling a length of conductor into a coil and upon spacers introduced between successive turns of the coil, immers-

ing the coiled conductor in a bath of insulating compound, and causing the compound to circulate in a stream through the space in the coil formed by such introduced spacers.

3. The method herein described of conducting the impregnation step in the manufacture of electric cables which consists in shaping a length of insulating conductor into a coil and upon spacers interposed between successive turns of the coil, immersing the coiled conductor in a bath of insulating compound, causing the compound to circulate in a stream through the space in the coil opened by such spacers, and as the stream flows lowering its temperature.

4. The method herein described of effecting impregnation of insulated conductors which consists in coiling a length of conductor into a coil and upon spacers introduced between successive turns of the coil, immersing the coiled conductor in a bath of insulating compound, placing the body of insulating compound under pressure, causing the compound to circulate in a stream through the space in the coil formed by such introduced spacers, and as the stream flows lowering its temperature.

5. In cable-impregnating apparatus, the combination of a kettle, means for circulating insulating compound through the kettle, means for maintaining upon the body of compound within the kettle elevated pressure, a reel adapted to be introduced within and removed from said kettle, said reel including in its structure a drum-like core with perforations in its walls and spacers.

In testimony whereof I have hereunto set my hand.

HENRY W. FISHER.