Dec. 18, 1945. L. I. KOMIVES ET AL 2,391,055

POLYMERIZED CABLE BLOCKS

Filed Feb. 23, 1938 2 Sheets-Sheet 1

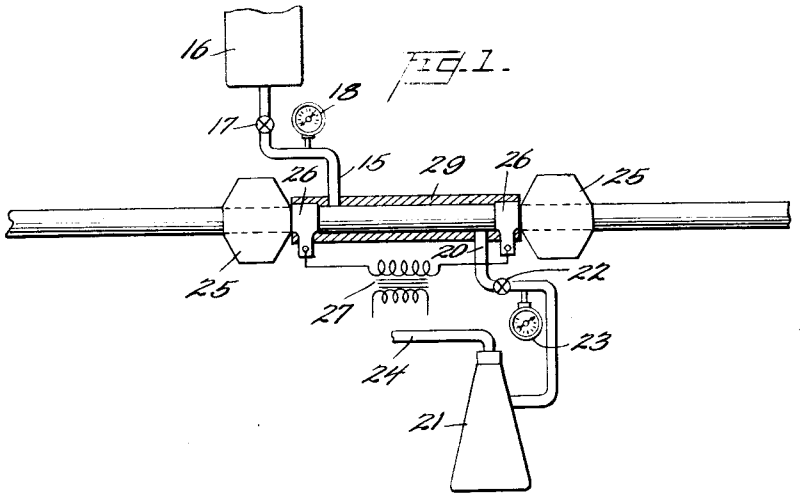


FIG. 1.

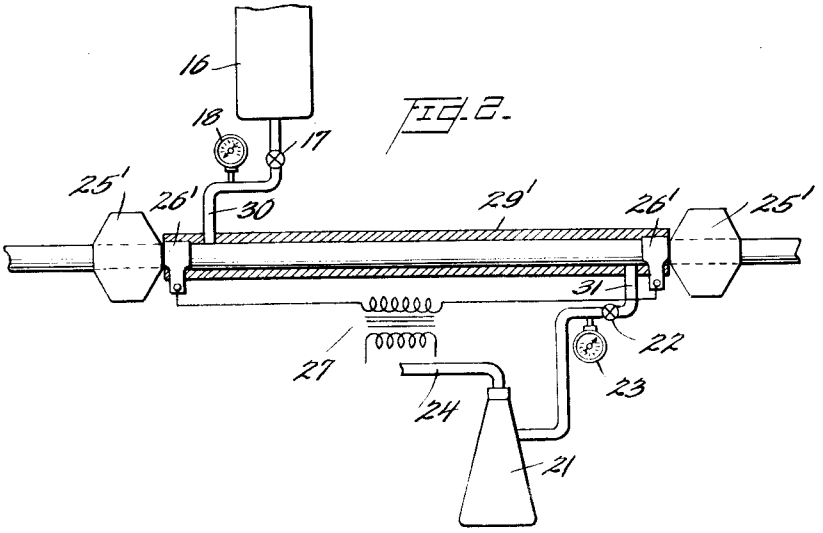


FIG. 2.

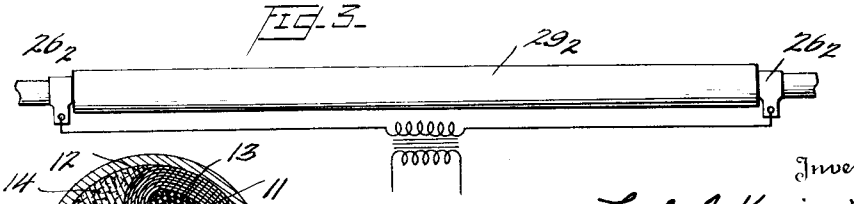


FIG. 3.

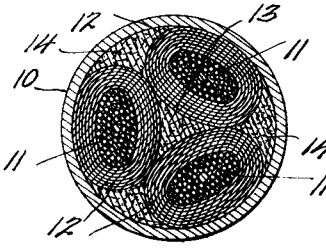


FIG. 4.

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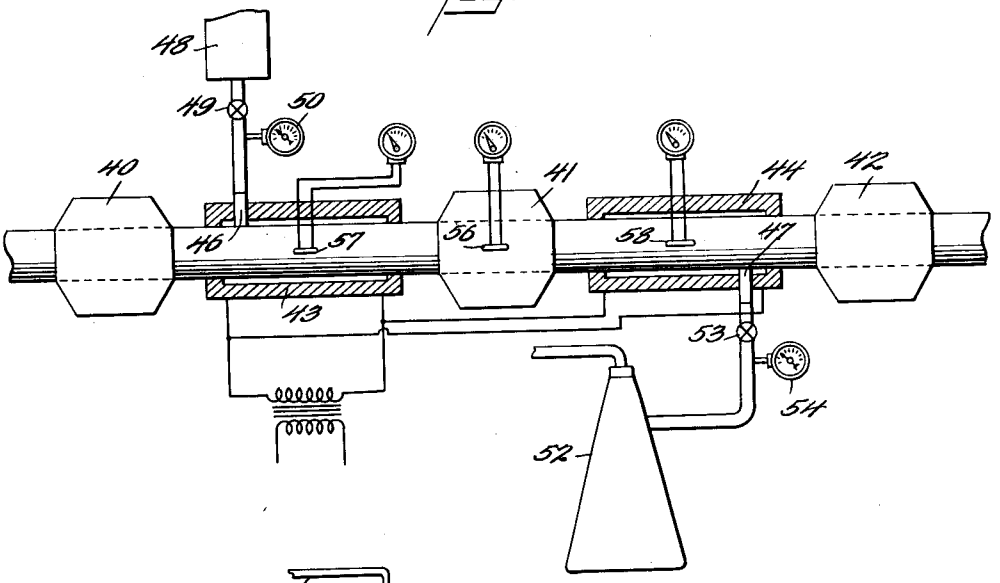
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FIG. 5.



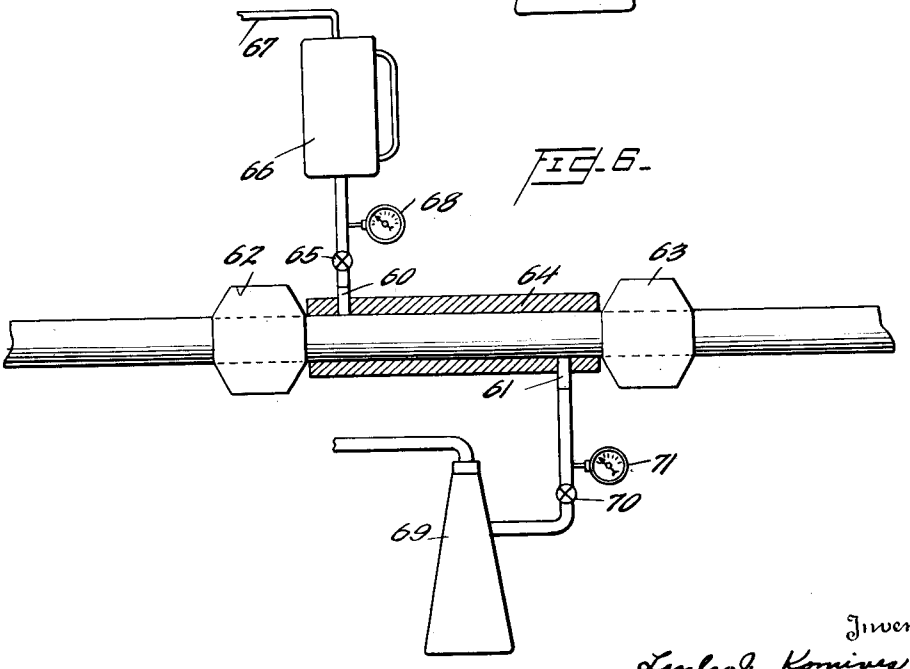


FIG. 6.

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UNITED STATES PATENT OFFICE

2,391,055

POLYMERIZED CABLE BLOCKS

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Application February 23, 1938, Serial No. 192,186

12 Claims. (Cl. 174—23)

This invention relates to electric power cables and more particularly to methods of and means for providing such cables with fluid stops or blocks to prevent the migration of insulating fluids along the cable and/or the invasion of oil or other liquids from external sources into the cable.

It is a general object of the present invention to provide novel and improved methods of and means for forming fluid blocks or stops in electric cables.

More particularly it is an object of the invention to provide methods of and means for forming fluid stops in new or existing cables intermediate the ends of the same without removing the sheath therefrom.

An important feature of the invention consists in the method of washing, dissolving or driving out existing insulating fluid or fluids from the laminated fibrous insulation, filler strips, belts and the like in the section of a cable where a fluid block is to be formed and in replacing said fluid or fluids with a relatively thin liquid capable of subsequent solidification into an excellent insulator which bonds during this solidification to the conductors, the insulating material, and the walls of the sheath.

A further feature of the invention resides in the provision of means to limit the flow of the fluid-block-forming liquid within the cable during impregnation, to confine it to desired portions thereof longitudinally so as to limit the amount of material used.

A further feature of the invention resides in the provision of means to limit the radial flow of the fluid-block-forming liquid within the confined longitudinal section of the cable so as to impregnate selectively the several types and portions of insulation within the sheath.

Still another important feature of the invention consists in the provision of means for use in belted-type cables for compressing the sheath against the belt insulation to limit the longitudinal flow of treating liquid and to prevent its escape between the belt insulation and the sheath where the resistance to flow is normally the least.

Another important feature of the invention resides in the conjoint and/or alternate use of: heat and cold, pressure and/or vacuum, to definitely confine the flow of treating liquid in both longitudinal and radial directions in various sections of the portion of the cable being treated, whereby selective control of the positioning of the block or block sections is had.

Other and further features and objects of the invention will be more apparent to those skilled in the art from a consideration of the accompanying drawings and following specification, wherein are illustrated the several methods and apparatus relating to the present invention.

In said drawings:

Figure 1 is a schematic elevation, partly in section, of the first stage in the treatment of a cable for the provision of a fliud stop therein;

Figure 2 is a view similar to Figure 1 but showing the second stage in the treatment;

Figure 3 illustrates a third stage in the treatment of the cable.

Figure 4 is a cross-section of a type of cable intended for treatment by the methods hereinafter described;

Figure 5 is a view similar to Figure 1 showing the arrangement of apparatus on a cable for the formation of a fluid block by what may be called a single-stage method; and

Figure 6 is a view of the apparatus set up for use in conducting a further method subsequently referred to as cyclic.

In many places in a cable system used for distributing power, it becomes essential to prevent or reduce migration of the impregnating, insulating fluids along the cable. Such migrations may result from differences in elevation of portions of the cable and are enhanced by temperature changes resulting from changes in the ambient air or from variations in the load on the cable.

Migration is particularly serious where long vertical runs are necessary as for instance in tall buildings. The elevated portions of the cable become starved for oil or other insulating fluid, voids are formed, and corona discharges may start, resulting in the ultimate destruction of the insulating material and requiring the scrapping of the cable.

It is also exceedingly important to prevent the invasion of oil from external sources as for instance from transformer and oil switch tanks, compound-filled joint boxes, pot-heads and the like, for these particular oils and fillers have different qualities, consistencies and insulating characteristics from the impregnating fluid, may be contaminated with dirt, moisture, or the like and can cause serious changes in the electrical characteristics of the cable which may result in its failure.

In communication cables it is often desirable to provide stops at intermediate points to sectionalize the cable so that gas pressure can be

applied within the sheath to exclude moisture. Alarms are actuated by loss of such pressure to indicate the faulty section.

In accordance with the present invention it is proposed to form fluid stops or blocks in cables wherever it is found essential to limit the travel of fluids therein. Such blocks are formed of insulating material which is normally liquid but which is solidified after introduction into the fibrous insulation of the cable.

The selection of such a material requires a careful consideration of its many characteristics. As a liquid it must be of sufficiently low viscosity to readily flow during the treatment, must be capable of dissolving and washing out the existing insulating fluids and replacing the same, must be capable of wetting all of the material within the cable and after solidification must not be soluble in insulating fluids nor seriously affected by temperatures commonly found in cables. It must be chemically stable, must possess good insulating qualities, should have a low coefficient of expansion and one quite similar to that of the lead sheath, should bond with the conductors, the insulating materials and the cable sheath to ensure fluid tightness, and should have a sufficiently low cost to make it economically feasible to use.

Complying with the above qualifications most fully are a number of liquid materials, the class of which may be generally described as readily polymerizable aromatic hydrocarbons of the vinyl type for which the general monomeric formula may be set down as follows:

$$(CH{=}CH_2)_N$$

wherein R is any aromatic hydrocarbon radical which contains less than four benzene rings and N is the number of vinyl groups attached to the aromatic radical.

These materials can be readily polymerized to change them from the liquid to the solid state either by the application of heat or by the use of chemical catalysts some of which may form copolymers therewith. In the polymerized form these materials have all the requirements enumerated for a suitable cable block.

Materials falling under the above broad definition are eminently satisfactory for carrying out the methods and producing the results of the present invention, but for the sake of simplicity these methods will be described as performed with one material from the class. The most readily available and probably the easiest handled material from this class is styrene, also known as styrol, styrolene, or in chemical terminology as phenyl-ethylene, ethylene benzene, vinyl benzene, or cinnamene.

Styrene is an unsaturated aromatic hydrocarbon which can be polymerized completely by heating to temperatures below 125° C. in a reasonable length of time, i. e. from twenty-four to seventy-two hours to a polymer having a molecular weight of over 100,000 or within the so-called eucolloidal range where the product is a tough-rigid, permanent solid, insoluble in insulating fluids, having a sufficiently high melting point for the present purpose and having electrical characteristics in all respects at least as good as the usual insulating fluids.

An important feature of styrene is its low viscosity permitting it to be introduced readily into the cable and passed through the more or less porous insulating materials forming the original solid insulation thereof. It blends well with residual insulating fluids which tend to act as plasticizers so that there are no abrupt junctions in the cable.

In accordance with the present invention the fluid block is preferably formed remote from the ends of the cable and may be applied with equal facility to new or installed cable. The methods of the present invention supplement those described in the copending application of Komives, Wyatt, et al., Serial No. 169,502, filed October 16, 1937, for Fluid stops for power cables, illustrating methods of providing fluid stops at or adjacent the ends of cables. This application has matured to Patent No. 2,222,748, dated November 26, 1940.

In the above identified application the treating liquid or styrene could readily be introduced in the spaces between the strands of the usual stranded conductors of the cable using these spaces as tubes to carry the processing material longitudinally from the end of the cable to the section chosen for the fluid stop or block, but where the block is to be formed intermediate the ends of the cable this simplified method of introducing the liquid is not available for in accordance with the present methods the solid insulation originally in the cable is maintained intact and only several small openings are made through the sheath alone.

Before considering the process of the present invention, it may be well to look into the construction of a power cable, a conventional cross-section of which is shown in Figure 4.

In that figure is shown a multi-conductor cable having the outer lead sheath 10 enclosing three conducors 11 of the stranded, sector type, each insulated with a laminated wrapping 12 of paper tape or similar material. The insulated conductors are twisted together and filler strips 13 and 14 are shown closing the voids between the insulation of the three conductors and between the insulation of each pair of conductors and the sheath so that fibrous, solid insulation completely fills the space within the sheath and no voids are present of sufficient size to present the opportunity for unusual potential gradients which might damage the insulation. All of the solid insulating material is fibrous and is impregnated in the customary manner with a viscous insulating fluid.

Belted cables differ only from that illustrated in Figure 4 by having the insulated conductors and filler strips covered with an additional wrapping or belt of insulation which fits closely within the sheath. It imposes additional insulation strength between the individual conductors and the grounded sheath. Such cables are even more difficult to equip with fluid stops than the more conventional type since the belt insulation offers a barrier difficult of penetration by the treating liquid.

In the first stage of the method illustrated in Figures 1 to 3, styrene is introduced through the lead sheath by means of a nipple 15 inserted therein and connected by suitable piping to a container 16 for the styrene where it may be maintained at atmospheric pressure and elevated to provide any desired static head or preferably under a slight positive pressure of say from five to twelve lbs. per square inch. A valve 17 permits control of the flow of the styrene and the pressure gauge 18 between the valve and the nipple is provided to determine existing pressures in different stages of the treatment.

Longitudinally displaced from the nipple 15 and at the opposite end of the section in which the fluid block is desired and 180° circumferentially thereof is the second or outlet nipple 20 connected by piping to the vacuum reservoir 21 under control of a valve 22. Between the valve and reservoir is a pressure gauge 23. The pipe 24 leading from the reservoir is connected to a suitable vacuum pump, aspirator or the like.

The removable chambers 25 are for the reception of refrigerating material which conveniently may be CO_2 ice. Hereafter such chambers are merely referred to as cold blocks and their purpose is to so congeal or even freeze the insulating fluids within the cable as to prevent the penetration thereof by the styrene.

To lower the viscosity of the insulating oil intermediate the cold blocks, resort may be had to any suitable heating means and there is shown in Figure 1 a pair of clamps 26 secured about the sheath at the ends of the treated section and connected to the secondary of the transformer 27, whereby the sheath may be heated by its own resistance. Coupled with this, heat may be introduced from the cable interior by suitably applying current to the conductors in the cable.

With the set-up shown in Figure 1, the first stage of the treatment takes place as follows. With valve 17 closed, valve 22 is opened until pressure gauge 18 indicates a sub-atmospheric pressure. This takes place a sufficient time after the application of the cold blocks and the heat from the transformer so that the insulating fluid in the to be treated section of the cable is there confined and thinned so that a certain portion of it due to expansion is withdrawn by the vacuum, being caught in the reservoir 21. When the gauge 18 shows a sufficient reduction in pressure, the valve 17 is opened and the processing material will flow into the cable through the nipple 15 and will follow along in the easily accessible places of the cable, such as the filler strips, spaces about them and the belt insulation, if any is provided, but very little will penetrate the more solid and tightly wrapped insulating tape about the individual conductors.

The styrene flowing into and about the insulation dissolves the insulating fluid therein and washes the same out through the nipple 20 and eventually replaces the liquid completely. When the liquid flowing into the reservoir 21, which is conveniently of glass, consists substantially of processing material only, which can readily be determined by its color, it indicates that the insulating oil in the easily accessible parts of the cable has been replaced and the valves 17 and 20 can now be closed and if desired the nipples 15 and 20 disconnected and capped.

Heating of the treated section is continued although the cold blocks 25 are removed. It is desirable to apply heat over a somewhat greater length of cable to now polymerize and solidify the treating liquid in the filler and other penetrated sections so the clamps 26 are moved to the position indicated at 26' in Figure 2. This ensures a uniform temperature in the treated section of the cable and upon solidification of the styrene the first stage of the method can be considered complete. It is preferred to carry out the polymerization at a temperature of approximately 120° C. for at least twenty-four hours, the temperature being indicated by an appropriate thermo-couple (not shown) mounted against the surface of the sheath which should be suitably encased, as shown at 29 in Figure 1 and 29' in Figure 2, with heat insulating material.

The completed first stage of this method provides a partially effective fluid stop which may be entirely satisfactory under certain conditions such as where only slight changes in elevation are made in cables having an especially viscous impregnator.

In the second stage of the process the cold blocks are replaced but at the positions indicated by 25' in Figure 2 with a much greater spacing than in Figure 1 and are filled with refrigerating material to solidify the insulating oil in the cable at the two new positions. New nipples 30 and 31 are now applied through the sheath at a much wider spacing than in Figure 1 to permit entry and exit of the fluids in untreated sections of the cable and the heating clips at 26' are maintained in circuit as already described. The nipples 30 and 31 are connected in the same manner as were the nipples 15 and 20 and when the pressure gauge 18 shows a vacuum the valve 17 is opened. Because the first stage of the process has formed a partial block within the sheath, it will be necessary for the processing material this time to penetrate the conductor insulation in order to travel from one nipple to the other since the solidified styrene in the filler spaces is not readily soluble in the liquid form under the conditions existing within the cable.

This penetration will of necessity be somewhat slow until the insulating fluids have been washed out of the tape surrounding the conductors. When this is apparent from the color of the issuing liquid the valves are closed, the nipples may be removed and the openings capped, and the heating maintained. After a short period the cold blocks 25' can be removed, for solidification of the styrene will have commenced and it may then be desirable to further extend the conductor clips to the position shown at 26_2 in Figure 3 so that the heating may be provided over a still longer portion of the cable to ensure uniform polymerization. Suitable heat insulation 29_2 is now arranged to cover the whole heated section. Following the heating necessary to obtain solidification of the processing material, the cable is allowed to cool gradually to air temperature.

During the solidification and cooling periods in both stages of the process, it may be desirable to have a static head of the processing material on the treated section of the cable to compensate for any contractions that may occur. This can be effected by removing only the lower nipple and maintaining the connection of the container 16 to the upper nipple during these stages. When the heating and cooling are completed the openings of the nipples may be soldered up to place the sheath in its original condition and the cable is ready for use. Any small quantity of styrene which may enter after polymerization will be polymerized in time by the working temperature of the cable.

When treating belted cables the conductor clamps 26 may conveniently be made much sturdier so that in addition to providing electrical contact for the heating current for the sheath they also serve to compress the sheath and clamp it tightly against the belt, thereby preventing flow of the treating liquid longitudinally of the cable between the belt and sheath beyond the treated region. By thus confining the treating liquid between the clamps it is forced to penetrate the belt and impregnate the other insulation confined within it. Obviously separate clamps for the

same purpose might be used having solely the mechanical function.

The form of the invention illustrated in Figure 5 shows a set-up of apparatus on a section of cable for forming an oil stop block in one stage. The arrangement of apparatus includes three cold blocks 40, 41 and 42 arranged alternately with heaters 43 and 44. The cold blocks may be of the form described in connection with the first method and the heaters are preferably of the resistance type adapted to be clamped about the cable sheath in any suitable manner. Each of the heaters is provided with an opening for the passage of one of the nipples 46, 47 disposed through the sheath of the cable at suitable longitudinal distances and 180° circumferentially as in the first embodiment.

The nipple 46 is connected by suitable piping to the styrene container 48 through the valve 49 with pressure gauge 50 connected thereto. The nipple 47 is connected to the vacuum bottle 52 by suitable piping through valve 53. The pressure gauge 54 is arranged between the vacuum bottle and the valve.

The purpose of this set-up is to direct the flow of the processing material (styrene) through the more inaccessible channels in the insulation by essentially "freezing" the oil in the easily accesible channels. In addition to the heaters 43 and 44, conductor heating may be resorted to.

To carry out the process after having set up the apparatus as shown in Figure 5, the cold blocks are charged with a suitable cooling material and the cable is heated by currents through its conductors and by the heating elements 43 and 44 connected to a transformer. A suitable thermocouple 56 is arranged beneath the central cold block 41 to indicate when the temperature there is sufficiently low to ensure freezing of the oil. If desired, additional thermo-couples 57 and 58 may be arranged beneath the heaters 43 and 44 to measure the temperature of the heated sections of the cable.

The valve 53 is opened and when the pressure gauge 50 indicates a suitable pressure below atmospheric showing that substantially all of the available insulating fluid has been withdrawn, the valve 49 is opened and styrene delivered through the nipple 46. The liquid flows longitudinally through the various cable insulations but is barred at 41 from passing through the filler spaces wherein the oil has been frozen. In order to pass this barrier the fluid must penetrate the insulating tapes of the individual conductors and even passes between the strands of the conductors where the channels must be closed.

When the liquid flowing into the vacuum bottle 52 consists substantially of styrene, indicating that the processing material has displaced the oil component of the insulation of the treated section, the valve 53 is closed, shutting off the vacuum, the central cold block is removed and the whole treated section heated until the processing material is partially solidified.

The end cold blocks may now be removed and by application of additional heaters, not shown, at least the whole treated section is brought to a uniform temperature and held there until complete solidification by polymerization is effected. During this solidifying and the following cooling period, it is desirable to maintain a static head of the styrene on the treated section of the cable to compensate for contraction. When the cable has reached the temperature of the surrounding air, the nipples are removed and the sheath repaired, putting the cable in condition for use.

In carrying out this process it may be advantageous to apply the central cold block 41 after the styrene has been flowing some time, but since the freezing point of styrene is lower than that of any oil used to impregnate the cables, the first variation is probably more practical. This single stage or freezing method of treating the cable eliminates one stage of impregnation and polymerization and materially cuts down the time for processing. The process depends for its effectiveness on the fact that cold blocks are quite efficient in stopping the flow of styrene near the periphery of the cable, i. e., in the lateral filler spaces.

The process just described in connection with Figure 5 of the drawings is intended to form two solid blocks of polystyrene, one beneath each heater 43 and 44, i. e., intermediate the end and central cold blocks. Under some conditions the oil which has been frozen by the cold block 41 and confined between these oil stops is undesirable. By suitable modification of the process just described, it is possible to produce one long block of polystyrene extending from 43 to 44.

To carry out this modification, the process just described is followed up to the point where the liquid flowing into the vacuum bottle is found to consist substantially of pure styrene, showing displacement of the oil impregnant beneath the heaters. When this happens, the central cold block 41 is removed and delivery of styrene is continued into the nipple 46 and withdrawn from the nipple 47. This styrene thaws the frozen oil and supplants it so that substantially all of the oil in the outer portions of the insulation, which was previously frozen, is removed, minimizing the chances of its diluting the adjacent insulating zones which are already impregnated with styrene before they are satisfactorily hardened.

The process is then continued by the removal of the end cold blocks and the application of additional heaters to the whole treated section so that the same is brought to uniform temperature and held there until solidification is effected.

A further form of the invention is illustrated by the set-up of apparatus shown in Figure 6. This may be referred to as the "cyclic" method and is based on the principle that the degree to which the styrene replaces the oil component of the insulation depends mainly upon the amount of styrene that has flowed through it. The idea behind the method is to produce a movement of the styrene in a radial direction within the insulation by heating and cooling cycles under non-polymerization conditions or by pressure and/or vacuum cycles, or a combination of both types. The pressure-vacuum cyclic system is believed to be preferable and will be described here, although it will be obvious from that description how the temperature cycle system may be applied.

The apparatus set-up as shown in Figure 6 includes the entrance nipple 60 and the exhaust nipple 61 arranged as previously described, the two cold blocks 62 and 63 spaced outwardly of these nipples and the heating element 64 of any conventional type arranged between the cold blocks and having openings for the nipples. The nipple 60 is connected through valve 65 to the styrene container 66. Pressure can be applied to the surface of the styrene through the pipe 67 and indicated by gauge 68 on the container side of the valve. The nipple 61 is connected to the vacuum bottle 69 through the valve 70

which in this case is between the bottle and the gauge 71.

With the apparatus set up and heat and cold applied at the indicated points, the treated section of the cable is evacuated by opening the valve 70 while the valve 65 remains closed. A considerable amount of the insulating oil will flow out of the cable into the vessel 69 under the vacuum and expansion by heating and when the rate of this flow decreases materially, processing material under pressure is admitted through nipple 60 by opening valve 65. Valve 70 is then closed and when the gauge 71 registers the full pressure applied to the processing material as indicated by gauge 68, the first cycle is considered complete.

The procedure of the first cycle is repeated a sufficient number of times until the liquid flowing into the reservoir 69 consists substantially of processing material only. Care must be exercised in all cycles following the first to insure against vaporizing the styrene already in the cable by high temperature and vacuum. If the vacuum is maintained after vaporization starts, styrene is wasted and lost from the cable. If vaporization starts, pressure must be increased or temperature reduced. Then the valve 70 is closed and a static head of processing material maintained on the treated section. The solidification of the processing material is now carried out by suitable heating as in the previous methods and after solidification the cable is allowed to gradually cool, when the static head of the processing material is removed, the nipples cut off and the openings sealed.

The length of time of each cycle or portion thereof can be adjusted to suit existing conditions and will naturally vary in accordance with the viscosity of the insulating oils, the tightness of the wrappings of insulating paper and the like.

The methods described above have been illustrated and disclosed specifically for operation on cables of the type shown in Figure 4 with multiconductors in a single sheath since this is the most common type of power cable. It will be appreciated that each of the methods is equally as applicable to cables containing but a single conductor within a sheath and no variations whatsoever in the methods are required in connection with this simpler form of cable.

Obviously, many variations and combinations of the above described processes can be effected but it has been found that the methods described are satisfactory under field conditions and show remarkable filling of all porous insulation and voids in the cable so that no penetration of the thus formed stops can be effected even by thin liquids.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. The method of forming in successive stages, radially of the cable section, a fluid stop intermediate the ends of a finished intact sheathed cable having conductors and fibrous insulation of different degrees of penetrability, said insulation being impregnated with an insulating fluid which also fills all voids in the sheath, comprising introducing a readily polymerizable liquid into the sheath to replace the insulating fluid in the easier penetrated insulation of a predetermined length of cable desired for the stop, polymerizing said liquid to thus block this portion of insulation, again introducing such liquid to now replace the insulating fluid in the remainder of the insulation and polymerizing said liquid to complete the stop.

2. The method according to claim 1 applied to a cable having filler strips in the channels between conductor insulation presenting a radial zone of insulating fluid easily penetrable by the polymerizable liquid introduced at one stage, wherein said one stage blocks said radial zone portion of the cable, and a succeeding stage blocks the cable portion containing the core and its insulation.

3. The method of forming a fluid stop intermediate the ends of a finished, sheathed, multiconductor cable having conductors initially insulated with laminated material impregnated with an insulating fluid and having filler strips in the channels between conductor insulation the whole sheath being filled with said fluid, comprising, introducing a readily polymerizable liquid into the sheath, causing a longitudinal flow of said liquid within limits, withdrawing washed out insulating fluid and treating liquid from a remote portion of the sheath within said limits, polymerizing the treating liquid, and repeating the process from introduction and exhaust points more widely spaced than and straddling the first used points.

4. The method according to claim 3, comprising the step of immobilizing the impregnating fluid at stations defining the approximate ends of the desired stop and wherein the repeating of the process includes spreading both of the immobilizing stations and of the introduction and exhaust points.

5. The method of forming a fluid stop intermediate the ends of a finished, sheathed cable having a conductor initially insulated with fibrous material impregnated with an insulating fluid which fills all of the otherwise unoccupied space in the sheath, comprising, freezing the impregnating fluid at stations defining the approximate ends of the desired stop, heating the cable between said stations, establishing inlet and exhaust passages through the sheath only, one near each station, introducing a readily polymerizable liquid through said inlet passage, withdrawing fluids from the exhaust passage until substantially pure treating liquid is obtained, closing the exhaust passage, continuing the heating with the treated section under static head of treating liquid, stopping the freezing after the treating liquid commences to harden, and extending the heating zone to include said stations and heating to complete the polymerization.

6. The method of forming a fluid stop intermediate the ends of a finished intact, sheathed cable having conductors insulated with fibrous material and having filler strips of fibrous material, said fibrous materials being impregnated with insulating fluid which also fills all voids in the sheath, comprising, immobilizing the fluid throughout the diameter of the cable at stations defining the ends of the desired stop, immobilizing the fluid in the outer portions only of the insulation at a station between the first stations, introducing a readily polymerizable liquid through the sheath between the intermediate and one end station, withdrawing fluid from between the intermediate and other end station until treating liquid issues therefrom and then polymerizing the liquid now filling the insulation.

7. The method of forming a fluid stop intermediate the ends of a finished intact, sheathed cable having conductors and fibrous insulation of two different degrees of penetrability, said insulation being impregnated with an insulating fluid

which also fills all voids in the sheath, comprising, immobilizing the fluid throughout substantially the full diameter of the cable at stations defining the ends of the desired stop, immobilizing the fluid only in the easier penetrated portions of the insulation at a station intermediate the first stations, introducing a readily polymerizable liquid through the sheath between the intermediate and one end station, withdrawing fluid from between the intermediate and other end station, continuing the operations until substantially pure treating liquid issues from the sheath and then polymerizing the liquid now filling the insulation.

8. The method of claim 7 wherein the treating liquid is less readily frozen than the insulating fluid.

9. The method of claim 7 where heat is applied between the stations before and during treatment to lower the viscosity of the insulating fluid.

10. The method of forming a fluid stop in a finished intact, sheathed cable having a conductor insulated with laminated material impregnated with an insulating fluid which fills all otherwise unoccupied space in said sheath, comprising, immobilizing the impregnating liquid at stations defining the ends of the desired stop, applying heat to the cable between said stations, applying a suction to the interior of the sheath between said stations until insulating fluid ceases to flow, stopping the suction and delivering a polymerizable, solvent liquid under pressure into the cable between said stations to dissolve the insulating fluid, shutting off the liquid, applying suction and repeating the cycles until substantially pure treating liquid issues from the cable, then heating the cable for a sufficient period to completely polymerize the liquid in the cable.

11. The method of claim 10 in which the heating during the cyclic treatment is non-polymerizing in the time elapsed for all cycles.

12. The method of forming a fluid stop in a finished, sheathed cable having a conductor insulated with laminated material impregnated with an insulating fluid, comprising, immobilizing the impregnating liquid at stations defining the ends of the desired stop, applying heat to the cable between said stations, venting the sheath between stations for the passage of displaced insulating fluid, closing the vent, cooling the cable between stations and there supplying polymerizable liquid under the cooling suction, shutting off the liquid entrance opening, heating the cable, venting the sheath and repeating the cycle, and finally applying prolonged heating to polymerize the liquid retained in the insulation.

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