

[54] **IMPREGNATION OF COMMUNICATION
CABLES WITH SOLID FILLING
COMPOUND**

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[56] **References Cited**
UNITED STATES PATENTS

3,672,974 6/1972 Tomlinson 117/115

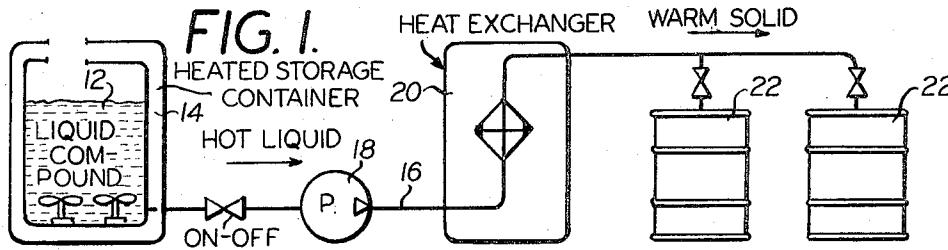
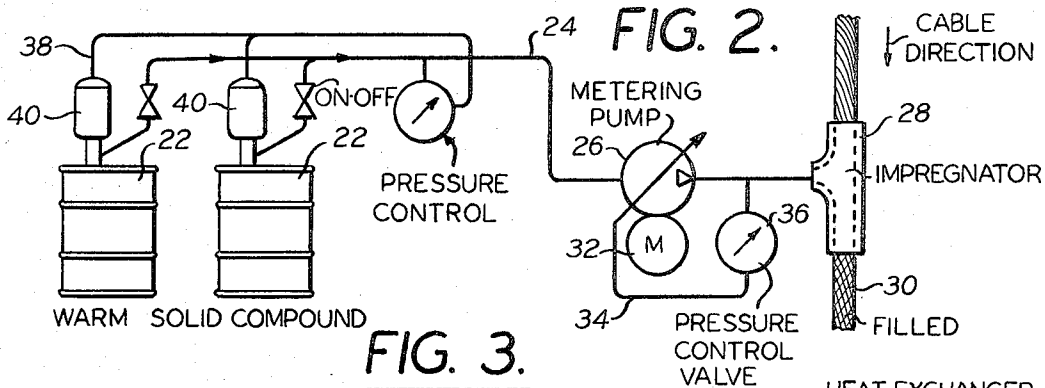
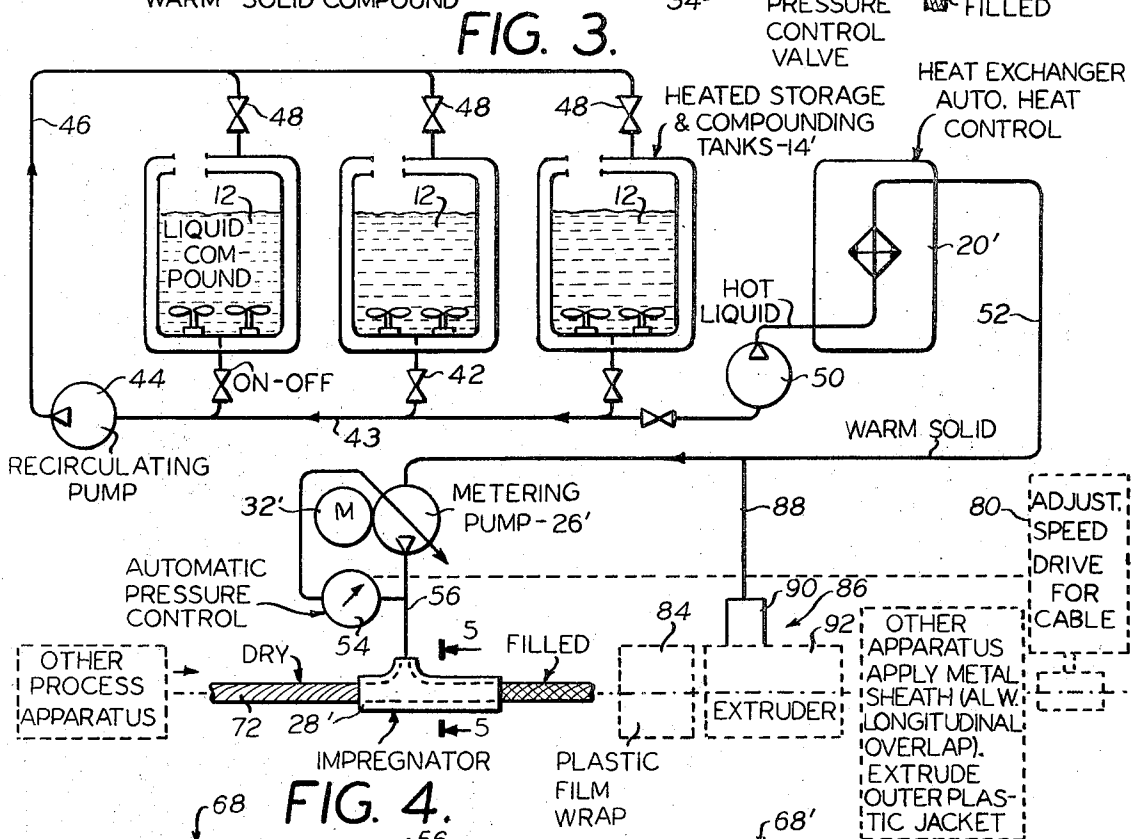
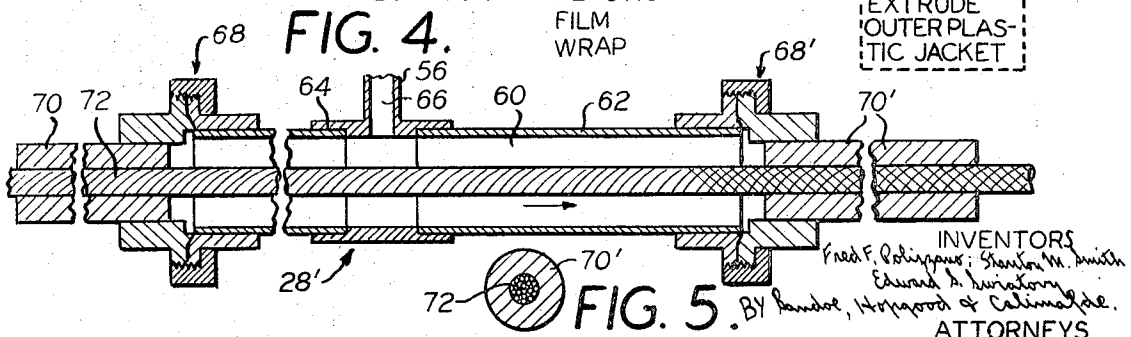
2,720,076 10/1955 Sachara 117/115 X

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[57] **ABSTRACT**

This invention fills communication cables with a filling compound of petrolatum mixed with some polyethylene to prevent dripping at temperatures of 80°C and below. A rapid cooling of certain compounds from above the melting point changes the characteristics of the compound so as to bring the drip temperature to this value. An impregnator apparatus is supplied with metered quantities of the compound at a rate coordinated with the speed of travel of a cable through the impregnator apparatus; and the cable is impregnated with the water repellent compound in a solid though soft condition (as opposed to liquid), and with uniform results lengthwise of the cable. The cable itself acts as the impeller for the compound in the impregnator; and the impregnator is kept full under pressure by a pump with a by-pass.

7 Claims, 5 Drawing Figures



IMPREGNATION OF COMMUNICATION CABLES WITH SOLID FILLING COMPOUND

BACKGROUND AND SUMMARY OF THE INVENTION

In recent years there has been a marked interest in the waterproofing of plastic insulated telephone cables to prevent moisture ingress to the cable which is as much as 47 percent air and the resulting instability effect on the electrical properties of the cable. An economical solution to the problem is described in a number of papers in recent years and involves the filling of these cables with a petrolatum jelly or compound. The filled cable then when penetrated due to a sheath break prevents water from entering the cable and flowing along the cable length, thereby stabilizing the transmission properties of the cable.

The processes for filling cables as described in the papers mentioned above fall into two categories: (1) liquid filling and (2) solid filling.

With respect to solid filling, the methods have been rather crude in that the solid petrolatum is not metered into the cable, but is simply pumped into a container through which the cable in the process of being assembled by stranding is pulled. Excess petrolatum is then pushed aside and must be collected to be returned into a central reservoir. Another disadvantage to solid filling is that if the viscosity of the material is very high the solid filling becomes almost impossible with respect to filling cables of diameters above $\frac{1}{2}$ inch.

Liquid filling lends itself somewhat to more precise control of the amounts used. It also allows for a comparatively simple storage and recirculating system for handling the material but its main disadvantages are associated with the high temperatures of the compound required to maintain it in liquid form and its affect on the insulated wires, also the safety hazards associated with the hot liquid material, and poor housekeeping resulting from splashing in the areas where the liquid filling is taking place. Another disadvantage to liquid filling has to do with the solidification and thermal shrinkage associated with the temperature change from liquid to the room temperature state. For example, if the petrolatum compound is applied at 240° F. and it is in liquid form at the time, approximately 10 percent shrinkage takes place due to the solidification of the material, an additional 3 percent or 4 percent due to the thermal shrinkage as the material cools so that at room temperature the cable may be only as much as 85 percent filled rather than "fully filled." Further, the liquid filled cable may be at elevated temperature for hours, while the massive amount of petrolatum which has been applied to the cable cools down to room temperature. It has been found that holding the cable at this elevated temperature swells the plastic insulation and creates a poor bond between the plastic and the conductor.

This invention provides an improved method and apparatus by which cables can be impregnated with metered quantities of petrolatum compounds with the compounds in a solid state but soft enough to flow into the spaces between the conductors of the cable under moderate pressure.

One advantage of the invention is that it can be used with prestranded communication cable. The compound is fed into the spaces between conductors in an impregnator which is a part of the metering apparatus and through which the prestranded cable passes. An-

other advantage which greatly simplifies the apparatus is that the cable itself serves as an impeller in the impregnator.

This invention includes a treatment of the petrolatum compound to make the compound suitable for use in the method and apparatus of the invention. A compound which has a drip point as low as 60°C can have this drip point raised to 80°C and above by cooling the compound rapidly from a temperature above its melting point to a lower temperature at which the compound is solid, though still soft.

The method and apparatus of this invention is adaptable to either batch operation or to continuous operation with automatic control.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

BRIEF DESCRIPTION OF DRAWING

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views:

FIG. 1 is a diagram illustrating the first step in the batch operation of this invention and in which the water repellent compound is treated to raise its drip point to a higher temperature;

FIG. 2 is a diagram showing the second step of the batch operation of this invention in which the compound is applied to a cable in the impregnator of this invention;

FIG. 3 is a diagram showing apparatus for impregnating cable in a continuous operation in accordance with this invention and with subsequent operations beyond impregnation to produce a completed cable;

FIG. 4 is a greatly enlarged, fragmentary, sectional view of the impregnator shown in the other views; and

FIG. 5 is a greatly enlarged sectional view taken on the line 5—5 of FIG. 3.

DESCRIPTION OF PREFERRED EMBODIMENT

In order to prevent water from entering multi-conductor communication cables, it has been the practice to impregnate such cables with petrolatum jelly and this jelly has been used extensively in England. It is also suitable for use in the United States except in some southern states where the temperature to which the communication cables are exposed sometimes rises high enough to cause the petrolatum jelly to soften to such an extent that it will drip out of the cable if there is any leak through which the jelly can drip. This makes the petrolatum jelly unsatisfactory as a water repellent agent in communication cables in warm climates.

Compounds having a petrolatum jelly base and containing some other plastic, such as polyethylene, can be made with higher drip temperatures. This invention can be used with petrolatum jelly, but the preferred water repellent compound used for this invention is a product of Western Electric Company designated as "filling compound PE-PJ." The compound is a mixture of 85 percent petrolatum with 15 percent low molecular weight polyethylene.

This material is supplied in barrels and it drips severely at 60° C. This makes it unsuitable for purposes of this invention in the state in which it comes from the barrels. However, if the material is melted to homogenize it by melting it above its liquefaction temperature,

and the material is then cooled quickly to room temperature, it undergoes a change of characteristics which raises its drip temperature above 80° C. This temperature of 80° C is high enough to qualify the communication cable filled with such compound for use in any of the southern states.

FIG. 1 shows the treatment of the PE-PJ compound to raise its drip temperature. The compound, designated by the reference character 12 is heated in a storage container 14 and then pumped through piping 16, by a pump 18, to a heater exchanger 20.

In the heat exchanger 20, the compound is chilled rapidly through its solidification temperature range and then discharged from the heat exchanger into drums 22 in which it is stored for subsequent use. If the compound is to be used in a continuous process, the heat exchanger can be connected directly with the apparatus for impregnating the cable as will be explained in connection with FIG. 3.

FIG. 2 shows the drums 22 connected with impregnating apparatus when using the invention for a batch process. With the compound in the drums 22 in a warm condition which makes it soft though still solid, the compound is moved through piping 24 by a metering pump 26 to an impregnator 28 through which a cable 30 passes.

The metering pump 26 is driven by a motor 32 at a speed which supplies compound to the impregnator at least as fast as the compound is used to impregnate the traveling cable 30. Any excess of compound from the metering pump 26 is discharged through a by-pass line 34 back to the inlet side of the pump 26 when the pressure of the compound delivered by the pump rises above the pressure for which a pressure control valve 36 is adjusted.

In the construction shown in FIG. 2, another pressure control valve bleeds off compound through a by-pass 38 which leads back to the drums 22. Motors 40 at the drums 22 drive portable pumps inserted in the drums 22 for supplying the compound from the drums into the piping 24.

Further description of the impregnator 28 and its operation, and further description of the operation of the motor 26 will be included in the explanation of FIG. 3.

FIG. 3 is a diagram showing the use of the invention for continuous operation when making long lengths of cable. The impregnating compound 12 is contained in a number of heated storage and compounding tanks 14' and compound is withdrawn from the lower ends of these tanks 14', through shutoff valves 42 connecting with a header 43 that leads to the inlet side of a recirculating pump 44 driven by a motor (not shown). The recirculating pump 44 delivers the compound back to the tanks 14' through piping 46 and the particular tanks to which compound is delivered can be selected by opening or closing shutoff valves 48.

Compound 12, which may be in a liquified condition and not treated for raising its drip temperature, is pumped by a pump 50 to a heat exchanger 20' which has automatic heat control set in accordance with the other conditions under which the continuous process is to operate. In the heat exchanger 20', the liquid compound is cooled quickly through its solidification range and it is discharged from the heat exchanger 20' through piping 52 which leads to a metering pump 26'.

If the compound cools too slowly from its liquid condition, the drip temperature is not raised; but if the cooling is rapid there is a substantial increase in the drip temperature, as previously explained. Experience has shown that this cooling should be at least 1° F. per minute with constant mixing during solidification.

The compound as it comes from the heat exchanger 20' is solid but it is warm enough so that it is soft and can be pumped through the piping 52 and into an impregnator 28' by the metering pump 26'.

Different kind of pumps can be used for the metering pump 26'. The pump 26' must be capable of pumping the soft compound against substantial pressure head and it must be correlated with the operating conditions required by the impregnator 28'.

Instead of having a pressure controlled by-pass as described in FIG. 2, the pump 26' has an automatic pressure control 54 which is responsive to the pressure of the compound in a pipe 56 leading from the pump 26' to the impregnator 28'. This pressure control 54 can control the pressure at which compound is delivered by pump 26' in various ways, as by changing the speed or torque of a motor 32' which drives the pump 26'. Such controls are well known and no further explanation of the control is necessary for a complete understanding of this invention. It will also be understood that pumps having adjustments for determining the output pressure can be used, such pumps being also well known.

The operation of the impregnator 28' will be better understood by reference to FIG. 4. A large diameter chamber 60 is formed by two pieces of pipe 62 screwed into opposite ends of a tee fitting 64 which has a reduced diameter side outlet 66 which is the supply passage for the entrance of compound into the impregnator.

At the opposite ends of the pipes 62 there are reducing unions 68 and 68' which connect the ends of the pipe 62 with smaller diameter pipes 70 and 70'. A cable 74 extends through the pipe 70 as an entrance guide into the impregnator and the cable 72 passes out of the other end of the impregnator through the pipe 70' which serves as the exit guide for the cable. The inside diameter of the pipes 70 and 70' is substantially the same as the outside diameter of the cable 74 with just enough difference to provide a running clearance for the cable to slide freely through the pipes 70 and 70' as guides. This clearance around the circumference of the cable 74, where it passes through the guides 70 and 70', is not enough to permit compound in the chamber 60 to escape from the chamber through the guides.

The pipes 62 are of substantially larger diameter than the cable and in the preferred construction are approximately at least three times as large in diameter as the cable 74 and the guides 70 and 70'. This gives the chamber 60 a substantial cross-section all around the circumference of the cable 74 for the circulation of compound which is forced into the impregnator from the pipe 56 through the supply passage 66 in the tee fitting 64. The compound circulates around all sides of the cable 72 and completely fills the space in the impregnator between the cable and the inside surfaces of the pipes 62 and tee fitting 64. As the compound fills the chamber 60, air in the chamber can escape through the clearance between the cable 72 and the inside surfaces of the guides 70 and 70'.

The pressure of the compound in the chamber 60 must be sufficient to force the compound into the

spaces between conductors so as to fill the cable with the water repellent compound. When the cable is not moving through the impregnator, a pressure of 20 pounds per square inch is sufficient to force the compound into the spaces between the cable conductors but this minimum pressure will vary depending upon the viscosity of the compound and to some extent upon the construction of the cable. In the preferred operation of the invention the minimum pressure imposed on the compound is 20 pounds per square inch.

The metering pump 26' (FIG. 3) will not supply any more compound to the impregnator after the impregnator is filled with compound and while the cable 72 is not moving. As soon as the cable 72 begins to move, it serves as an impeller for moving out of the impregnator the compound which has filled the spaces between the conductors of the cable and as this compound moves out of the impregnator, the metering pump 26' supplies additional compound to keep the impregnator full and under pressure. More compound is forced into the spaces to fill the dry cable which moves into the impregnator as the filled portion of the cable moves out and as long as the cable travels through the impregnator, the compound will be forced into the cable spaces to fill the cable progressively and the metering pump 26' continues to supply additional compound to keep the chamber of the impregnator filled and under pressure.

The operation of the metering pump 26' does have to be correlated with the speed of operation of the apparatus. As the cable 72 moves faster, each unit length of the cable is in the impregnator 28' for shorter lengths of time. Depending upon the length of the impregnator and the viscosity of the compound, there comes a time when the cable is moving through the impregnator too fast for the compound to have time to enter all of the spaces in the cable before the cable reaches the end of the impregnator unless the pressure on the compound is increased so that the impregnation is more rapid.

The automatic pressure control 54 is adjusted in correlation with the speed of the cable, which is determined by an adjustable speed cable drive 80. In practice, the pressure of the compound supplied to the impregnator is increased up to 200 pounds per square inch as the speed of the cable is increased up to 100 feet per minute. This gives satisfactory results with an impregnator chamber of approximately 16 inches in length and 2 inches in inside diameter when operating on a cable having a diameter of 0.590 inches with 25 pairs of conductors. These values are given merely by way of illustration.

From the description thus far it will be apparent that the pump 26' and the impregnator 28' are both part of the metering apparatus for determining the amount of compound supplied to the cable. The pump 26' supplies compound to maintain the chamber of the impregnator 28' full and to maintain a pressure on the material in the impregnator chamber. The cable 72 itself acts as an impeller for moving compound out of the impregnator and thus making way for additional compound to be supplied to the chamber of the impregnator, as already described.

Beyond the impregnator 28', the cable 72 passes through a taping head 84 which wraps plastic tape around the impregnated cable. In the preferred construction the cable is wrapped helically with overlap-

ping convolutions of tape made from polyethylene terephthalate (Mylar).

Beyond the taping head 84 there is an extruder 86 which is supplied with the same water repellent compound 12 by a supply line 88 leading from the piping 52 to the extruder 86. This extruder 86 has the conventional motor driven ram 90 which supplies the compound at extrusion pressure to the extrusion die, represented diagrammatically with the legend 92; and this extruder 86 extrudes a layer of compound over the film wrapping applied by the taping head 84.

Beyond the extruder 86 the tape passes through other apparatus which applies a metal sheath, preferably an aluminum sheath folded longitudinally with a seam overlap. This is a conventional operation in cable manufacture and no further explanation of it is necessary for a complete understanding of this invention. Similarly a final extruder applies an outer jacket, usually polyethylene and of considerable thickness, to the cable.

The cable 72 is pulled through the successive stations by the cable drive 80 and this cable drive is supplied with adjustable control means connected by a control signal line 94 with the automatic pressure control 54 so as to coordinate the pressure of the compound with the speed of the cable. Such interacting controls are well known and the particular control used forms no part of the present invention.

The preferred embodiment of the invention has been illustrated and described, but changes and modifications can be made and some features can be used in different combinations without departing from the invention as defined in the claims.

What is claimed is:

1. The method of filling a multi-conductor cable with water repellent compound including passing the cable in unfilled condition into a chamber, supplying to the chamber a water repellent filling compound in a viscous and flowable condition, surrounding the cable in the chamber with the filling compound in said solid but flowable condition, maintaining the compound under an impregnating pressure sufficient to force the solid compound to flow into the spaces of the cable that are to be impregnated, passing the filled cable out of the chamber at an end of the chamber downstream from that at which it passed into the chamber, obstructing the ends of the chamber around the cable against flow of compound from the chamber when the cable is not in motion, removing compound on the cable from the chamber as the compound fills the cable, and automatically maintaining the supply of compound in the chamber under full impregnating pressure for the cable speed as compound is carried out of the chamber by the cable.

2. The method described in claim 1 characterized by pumping the viscous compound toward the chamber in an amount sufficient to maintain the chamber full and to fill the cable at a predetermined speed of travel of the cable, and automatically by-passing excess compound back to the inlet side of the pumping cycle whenever the cable is travelling at a speed that does not require the full output of the pumping and the compound pumped toward the chamber rises in pressure above a predetermined value.

3. The method described in claim 1 characterized by pumping viscous compound toward the chamber and into the chamber at a predetermined pressure, advancing

ing the cable through the chamber at a predetermined speed automatically controlling the pressure of supply of the viscous compound to the chamber in accordance with changes in the speed of travel of the cable through the chamber, and withdrawing the cable from the chamber without cooling the filling compound below its temperature within the chamber.

4. The method described in claim 1 characterized by passing the cable through an impregnating chamber that is of substantially larger cross section than the cable with clearance on all sides of the cable, closing the ends of the chamber except for openings for entrance to and exit from the chamber for said cable, confining the clearance to prevent escape of the compound through the said clearances at the pressure and flow characteristics of the compound in the chamber, and using the cable as an impeller to move the viscous compound out of the chamber as the compound fills the cable.

5. The method of filling a multi-conductor cable with water repellent compound including passing the cable in unfilled condition into a chamber, supplying to the chamber a filling compound in a viscous and flowable condition, surrounding the cable in the chamber with the filling compound in said viscous and flowable condition, maintaining the compound under an impregnating pressure sufficient to force the viscous compound into the spaces of the cable that are to be impregnated,

passing the filled cable out of the chamber at an end of the chamber downstream from that at which the cable passed into the chamber, obstructing the ends of the chamber around the cable against flow of compound from the chamber when the cable is not in motion, removing compound on the cable from the chamber as the compound fills the cable, and automatically maintaining the supply of compound in the chamber under full impregnating pressure as compound is carried out of the chamber by the cable, characterized by treating the filling compound to raise the drip point temperature of the compound prior to supplying the compound to the chamber said treating including heating the compound above its melting point and then cooling the compound from a liquid condition through its solidification range with a rate of at least 1° F per minute with constant mixing during solidification and then supplying the viscous compound to the chamber.

6. The method described in claim 5 characterized by using as the filling compound a mixture of petroleum jelly and polyethylene, and then cooling the compound through its solidification range at a rate of cooling of not less than about 1° F. per minute with constant mixing during solidification.

7. The method described in claim 6 characterized by the amount of polyethylene in the compound being about 15 percent.

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