July 30, 1935. G. B. SHANKLIN 2,009,820

APPARATUS FOR IMPREGNATING CABLES

Filed March 15, 1934

Fig. 1.

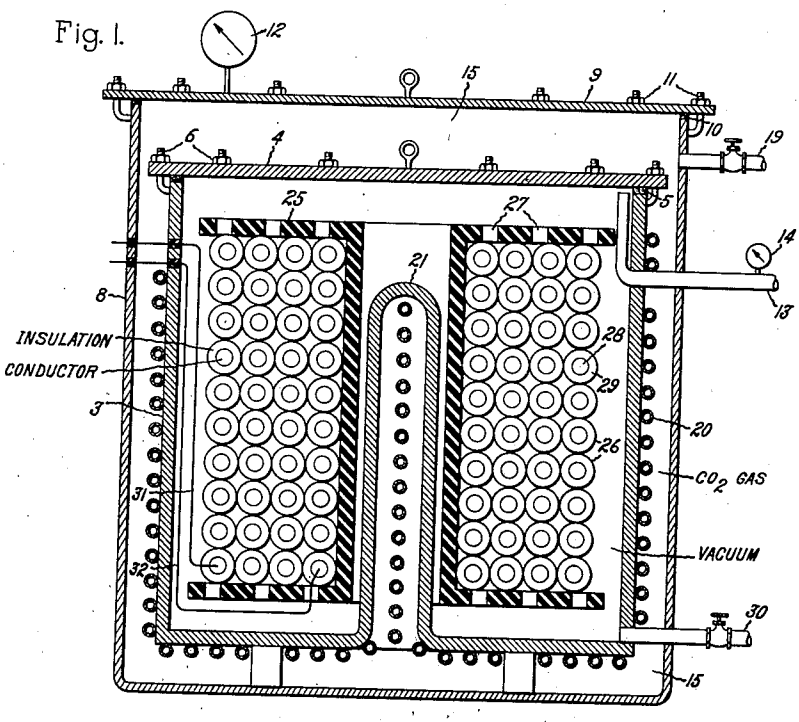


Fig. 2.

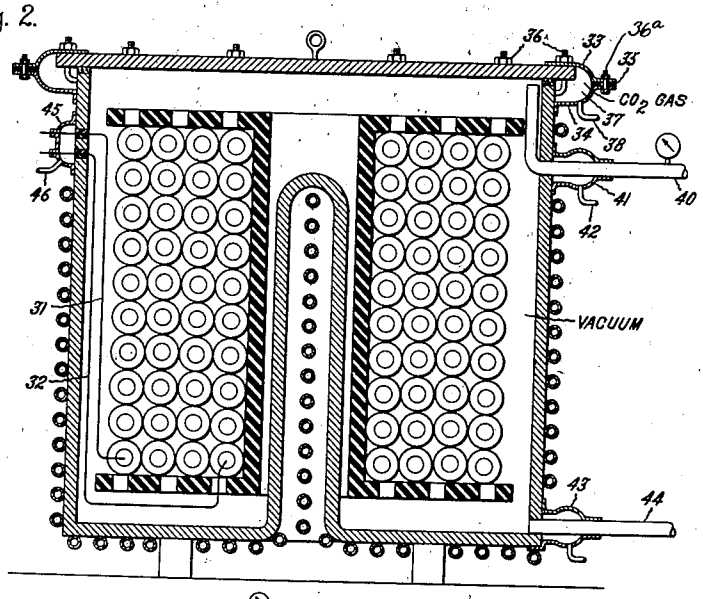
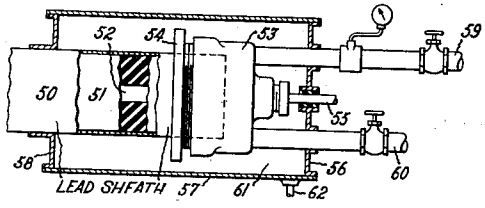


Fig. 3.



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APPARATUS FOR IMPREGNATING CABLES

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5 Claims. (Cl. 91—46)

In the manufacture of paper insulated cables intended for the transmission of electrical power, it is the practice to impregnate the paper with a heated liquid, such as oil or compound. The paper used as insulating material contains a certain amount of gas and moisture which must be largely removed if the best results are to be obtained both in the process of impregnation and during subsequent operation of the cable. In practice, this is done by winding the cable on a reel without the lead or other enclosing sheath and placing the reel and cable in a tank which is afterwards closed as by a cover. The tank is then evacuated to remove substantially all of the air and moisture from the tank and from the paper insulation. The vacuum is then broken by admitting CO_2 gas. Later, this gas content is evacuated and oil or other impregnating liquid admitted to the tank where it penetrates the paper and fills any voids which may exist in the cable. During the vacuum and subsequent treatments, the tank and cables are heated to facilitate the removal of gases and moisture from the paper, and especially the latter since the heat causes the moisture to form vapor of relatively large volume. For some types of cable, one complete cycle of operation as above outlined is sufficient. For other types of cable, the cycle is repeated a number of times. This depends chiefly on the thickness of the insulation and on the length of the cable. This cycle of treatment requires a good many hours to complete. In some instances from 10 hours for a relatively low voltage cable to 60 hours for a relatively high voltage cable having a correspondingly greater amount of insulation on the conductor. The total length of the cable is also a factor in the time required for treatment.

The treatment above mentioned is very valuable since it has the advantage of substantially increasing the ionization factor of the cable when it is in use and also its power factor temperature characteristics. These advantages are due wholly or chiefly to the fact that undesirable foreign matter is removed from the cable and the paper very thoroughly impregnated.

The tanks used in this impregnating process are of necessity very large and of heavy construction, particularly for the reason that the walls of the tank must withstand the difference of pressure between the atmosphere on the outside and vacuum on the inside tending to collapse them. This difference of pressure may result in a limited amount of leakage into the tank during the evacuation thereof with the final result that more than the permissible minimum amount of air is contained in the tank. If more than a very small amount of air remains in the tank, the primary purpose of the CO_2 treatment is largely defeated. Theoretically, there should be no trouble in packing the joint between the cover and the tank but as a practical matter it is a difficult thing to do. This difficulty is due to the necessarily large surfaces between the top of the casing and the cover which must be packed. It is in part due to warping of the parts due to temperature changes and to the fact that the cover being frequently used is liable to be somewhat distorted. There is also the human element to be considered, and the fact that points or regions of small leaks cannot be readily detected.

The object of my invention is the provision of an improved cable impregnating tank in which the leakage of air into the tank is prevented and in which any inward leakage at any joint is a gas which does not adversely affect the impregnating process.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and the claims appended thereto.

In the attached drawing which is illustrative of my invention, Fig. 1 is a sectional view of a cable impregnating tank, Fig. 2 is a similar view of a modified form of tank, and Fig. 3 shows my invention applied to a sheathed cable having an internal channel for liquid insulation.

3 indicates a vessel or tank which may be made in any suitable way provided it is strong enough to withstand the difference of pressure to which the walls thereof are subjected and which will not readily warp or change in shape due to alternate heating and cooling. 4 indicates the cover of the tank and between it and the main body thereof is a packing 5 having some yieldability to compensate for slight inequality of the adjacent metal surfaces of the main body and the cover. The cover may be hinged to the base or be capable of being lifted bodily by means of an eye-bolt. It is held in the closed position by a large number of suitably spaced bolts and nuts 6. The cover is located above the cable to afford a space or chamber between the two toward which the air and vapor from within the tank or casing tend to flow during the evacuating portion of the cycle.

Outside of the vessel or tank is a casing 8 made of relatively thin metal. It may be made with thin walls because the pressure to which it is sub-

jected is or may be of the order of one or two pounds. It is provided with a cover 9 and between it and the body of the casing is a suitable packing 10. The cover is held in place by spaced bolts and nuts 11. On the cover is a pressure gauge 12 of any suitable construction.

13 indicates a pipe which extends through the walls of the outer casing and the tank and extends upwardly inside the tank to substantially the highest point therein. It is connected by a flexible tube, as of rubber for example, to a vacuum pump (not shown) of any suitable construction. To the pipe is connected a vacuum gauge 14.

A neutral gas, such as CO_2 is admitted to the chamber 15 which completely encloses the tank by the valved pipe 19. In the chamber of the tank or vessel is located a steam heating coil 20, said coils also extending into the inset member 21 forming a part of the tank.

25 indicates a reel made of wood or metal as desired about which is wound the cable 26, the insulation of which is to be treated and impregnated. It is desirable to perforate the heads of the reel as at 27 to facilitate the removal of air and moisture, the admission of CO_2 gas and finally of the impregnating liquid. The cable may be of any suitable or well known construction, the details of which are immaterial to the present invention. In this cable, 28 indicates the conductor and 29 the insulation surrounding it. 30 indicates a valved pipe for admitting the impregnating liquid whatever be its nature after the cycle of evacuating and washing the tank and cable with CO_2 gas. It is desirable to preheat the liquid as by so doing it more readily penetrates the fibrous insulation on the conductor.

In addition to heating the tank and its contents by the steam coils 20, it is also desirable in some cases to heat the conductor 28 as well. This may be done by connecting the inner and outer ends of the cable through conductors 31 and 32 leading through the walls of the tank and enclosing casing to the outside of the latter. The leads where they extend through the metal walls are insulated and packed to prevent inward leakages. Any suitable source of current supply may be connected to the exposed ends of the leads.

In Fig. 2 is illustrated a modification of my invention in which the joints are sealed with a neutral gas such as CO_2 gas instead of enclosing the entire tank in a separate casing. In some instances, it will be found better to use the structure of Fig. 1 and for others that of Fig. 2. 33 and 34 indicate a pair of relatively thin members or pieces of metal which extend entirely around the tank and which are secured one to the tank and the other to the cover as by electric welding. Between the meeting faces of the members is a packing 35. The pressure which has to be resisted by this packing is low, being of the order of one or two pounds. The two members are united along their peripheral edges by spaced bolts and nuts 36^a and the cover is secured to the tank by bolts and nuts 36. CO_2 gas is admitted to the sealing chamber 37 by the small pipe 38 from a suitable source of supply.

The vacuum pipe 40 where it enters the tank is provided with an enclosure or housing 41 having the same function or purpose as the members 33 and 34 but because the housing does not have to be opened or otherwise disturbed is made in one piece and electrically welded both to the tank and to the pipe. It has a small sealing chamber to which CO_2 gas is admitted by the pipe 42 leading to a source of supply which conveniently may be the same one that supplies gas to the chamber 37. A similar housing 43 is provided for the pipe 44 which supplies impregnating fluid to the tank and its contents. The pipe 44 also acts as a drain when it is desired to free the tank of impregnating liquid. The terminals of the leads 31 and 32 are similarly provided with a housing 45 containing a small chamber to which CO_2 gas is supplied by the pipe 46.

The advantage of the construction shown in Fig. 2 over that shown in Fig. 1 is that it is simpler, can be applied to existing tanks without disturbing them, and does not require so much CO_2 gas to prevent inward leakage of air into the tank.

Both of the described constructions have the advantage that any leakage into the tank is CO_2 gas and not air or other substance or material which would be injurious to the cable. This is, of course, especially true when the vacuum within the tank is at its maximum. As the cycle of operation as previously mentioned takes many hours to complete, it is obvious that even a small leakage would in the course of time result in a considerable amount. Any inward leakage which does take place with my construction will be of the same gas that is used in the impregnating process, and since the impregnating liquid is capable of absorbing a considerable amount of such gas without injury, its effect is not objectionable. Stated briefly, the advantage of my improved impregnating tank resides in the fact that every joint where inward leakage of air could take place is protected or sealed with the same gas that is utilized in the impregnating process of the cable.

In treating cable having an internal oil channel and a lead sheath, the reel with the cable thereon is placed in a tank such as that illustrated in Fig. 2, for example. Instead of evacuating the tank, however, it is heated as before either by steam coils or by admitting low pressure steam to the interior. The purpose of heating the cable is to facilitate the impregnation of the insulation thereof. The ends of the cable are brought outside of the tank where they are accessible. 50 indicates the lead sheath, 51 paper or equivalent insulation and 52 a hollow conductor opening into a chamber in the head 53. Where the lead sheath enters the head, it is sealed by a packing gland 54. To the end of the conductor is secured a rod 55 by means of which electric current may be supplied to the conductor for heating it when desired. The rod passes through insulation in a head 56 which also serves as a packing. The head supports one end of a casing 57, the rear end of which is supported by a head 58 which is connected to the sheath as by a wipe soldered joint. The heads may also be soldered to the casing. Extending from the chambered head 53 is a valved tube 59 through which the cable is evacuated to remove air and moisture from the interior thereof. A valved tube 60 is similarly connected to the head and is utilized to fill the cable with a neutral gas. This tube or a similar one may also be used to supply heated impregnating fluid to the cable. After the undesirable contents are removed from the interior of the cable by one or more cycles of operation as above mentioned, the core is filled with thin oil which has previously been degasified to remove the gas and moisture contained therein. Admission of air to the cable, especially during the evacuation part of the cycle, is prevented by the casing 57, which completely en-

closes the head 53. The chamber 61 within the casing is maintained filled with a neutral gas, such as CO_2, for example, at a pressure slightly above the atmosphere by the pipe 62. By reason of the presence of the gas in the chamber 61, any inward leakage into the cable will be the neutral gas and not air or moisture.

I have illustrated my invention as applied to the principal points or regions in cable impregnating apparatus where inward leakage of air may take place to the detriment of the treating process. I may also apply the feature of sealing other joints in the system in the same manner.

To avoid making unnecessary openings in the walls of the vessel and in the outer casing when it is employed, it is evident that because the various operations do not take place simultaneously, I may use the same conduit means for admitting and removing gas from the vessel that is used in evacuating it, or I may use the same conduit means for admitting and removing gas from the vessel that is used to admit and remove impregnating liquid from it. To this end, an arrangement similar to that shown in Fig. 3 may, as an example, be employed in which case the head 53 will be secured to the outer end of one of the selected pipes instead of to the cable sheath and the valved pipes 59 and 60 used, for example, one for evacuating the vessel and the other for admitting and removing gas, or one for the gas and the other for impregnating liquid, whichever is the more convenient. To prevent the entrance of air, the head and pipes are desirably enclosed in a casing such as 57 containing CO_2 gas.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A cable impregnating apparatus comprising a vessel in which the cable to be treated is located, means for heating the vessel and cable, conduit means through which the insulation of the cable is evacuated, conduit means for admitting a neutral gas to the cable after it is evacuated and for subsequently admitting impregnating liquid to the cable, sealing means for the conduit means, and a conduit for supplying the sealing means with the said neutral gas so that any inward leakage into the cable will be said gas and not air.

2. A cable impregnating apparatus comprising a vessel in which the cable to be treated is located, a removable cover therefor, a packing located between the adjacent surfaces of the vessel and cover, conduit means entering the vessel for evacuating it and a means for admitting gas to the vessel after it has been evacuated for treating the cable, sealing means for the joint between the vessel and its cover, means supplying gas to the sealing means under a pressure greater than atmospheric to prevent the admission of air into the vessel and sealing means, and means for admitting impregnating liquid to the vessel.

3. A cable impregnating apparatus comprising a vessel in which the cable to be treated is located, a removable cover therefor, a packing located between the adjacent surfaces of the vessel and cover, a conduit entering the vessel for evacuating it, conduit means for admitting a neutral gas to the vessel after it has been evacuated for treating the cable and subsequently for admitting liquid thereto, a chambered sealing means for the joint between the vessel and its cover, and means for supplying the same kind of gas to the sealing means that is used in filling the vessel under a pressure greater than atmospheric to prevent the admission of air to the vessel and sealing means when the vessel is under vacuum.

4. A cable impregnating apparatus comprising a vessel in which the cable to be treated is located, a removable cover therefor, a packing for the joint between the vessel and its cover, a seal for the packing comprising a gas chamber, a means for evacuating the vessel, means supplying gas to the chamber of the packing during the period of evacuation of the vessel at a pressure greater than that of the atmosphere, and means for admitting impregnating liquid to the vessel after its gas content has been removed.

5. A cable impregnating apparatus comprising a sealed vessel in which the insulated cable to be treated is located, a removable cover therefor, means for heating the vessel and the cable contained therein to facilitate the removal of moisture from the insulation of the cable and its subsequent impregnation with liquid, conduit means through which the insulation of the cable is subjected to the effects of a vacuum and subsequently to the effects of a neutral gas, a conduit means through which impregnating liquid is introduced into the circulation of the cable, a chambered seal for the conduit means, and a means for maintaining a supply of neutral gas in the chambered seal to prevent the entrance of air into the cable.

GEORGE B. SHANKLIN.