March 24, 1942. G. B. SHANKLIN 2,277,460

GAS FILLED CABLE INSTALLATION

Filed June 6, 1940

Fig. 1.

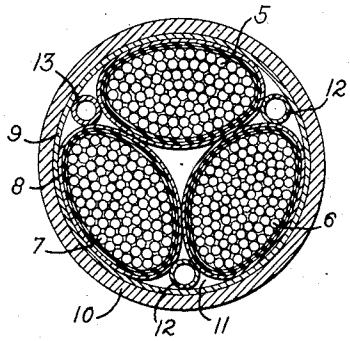


Fig. 2.

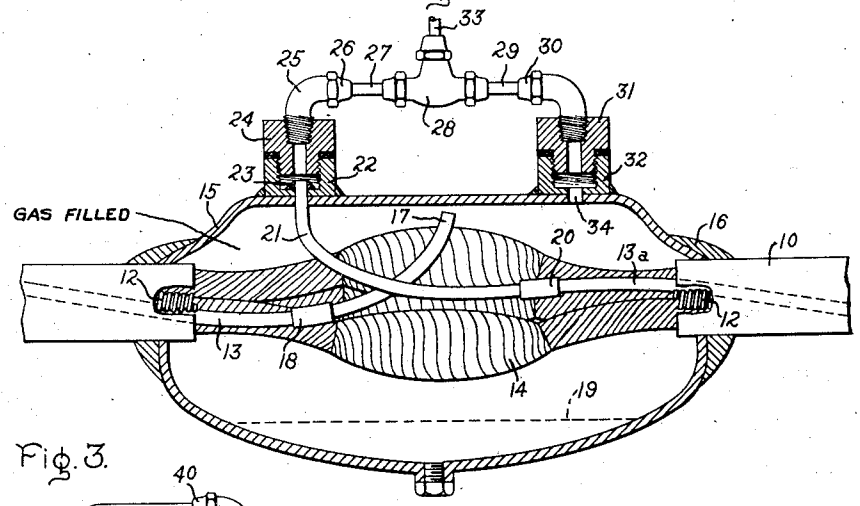
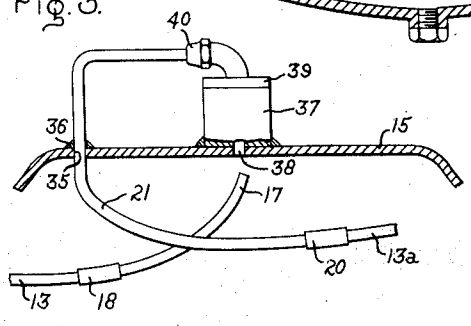


Fig. 3.



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GAS FILLED CABLE INSTALLATION

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4 Claims. (Cl. 174—21)

The present invention relates to gas filled cables of the type in which the insulation, such as paper, on the conductors is impregnated with a compound that is retained therein by capillary action and which has little tendency to ooze from the insulation even under load cycles. At suitably disposed places within the cross-section of the cable are located free feed gas conveying channels which in addition to conveying gas to the insulation also serve as conduits for receiving and conveying any compound oozing out of the paper to selected points such as the joint casings. It frequently happens that there are low spots or areas of the cable occasioned by dips therein to avoid obstructions in the path of the cable such as water, illuminating gas and other pipes, or the dips may be due to the rugged profile of the ground in which the cable is laid. Such a dip or low spot may cause compound to collect in the free feed gas channels in amount sufficient to form slugs which interfere with the free movements of the insulating gas. To prevent the effects of such slugs on the free flow of gas, a small solid wall tube extending from end to end of the cable is located at some convenient place in the cross-section of each cable length and through which gas may flow from suitable tanks from end to end of a cable section if stop joints are employed to sectionalize the cable, or from end to end of the cable if stop joints are not employed.

It is important to provide means whereby access may be had to these tubes without opening or removing the joint casings or injuring them in any way. Such access is necessary for various purposes, including testing for gas leaks in the cable enclosures, as will be described later. It is also important to arrange the portions of the tubes entering the joint casing from connected lengths of cable in such manner that any compound within the joint casing is prevented from entering the tubes where its presence would cause stoppage thereof and thus defeat the purpose of the tube which is to by-pass any slugs of compound located in low areas and ensure free flow of gas between widely separated points, as terminals for example.

One object of my invention is the provision of improved simplified means or arrangement of parts whereby access may be had to the solid wall gas conveying tubes located within the cable proper and in the casings enclosing the joints between conductor lengths, and whereby insulating gas under positive pressure may readily be supplied to the tubes as well as to the free feed channels and the joint casings.

A further object of my invention is the provision of an improved method of testing the cable installation to ascertain the approximate location of a leak in the cable sheath.

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 drawing, Fig. 1 is a cross-section of a gas filled cable; Fig. 2 is a longitudinal sectional view of a joint between adjacent cable lengths; and Fig. 3 illustrates a modification.

In the drawing, 5, 6 and 7 indicate conductors and 8 the paper or other porous insulation thereon. Surrounding the conductors is a binding band 9 and an enclosing impervious sheath 10 made for example of suitable metal such as lead. In the so-called filler spaces between peripheral parts of adjacent conductors are free feed channels 11 which extend from end to end of each cable length. In two of the three channels are located tubular members 12 desirably made in the form of coiled spiral springs, the spaces between turns thereof permitting free access of gas from the members into the insulation and the entrance of compound thereto from the insulation. The members 12 in addition to acting as conduits or channels for gas and any compound oozing from the insulation serve as internal supports for the sheath. The ends of the channels 11 terminate at the cut ends of the cable sheaths and open directly into the chambers of the joint casings as shown in Fig. 2 so that compound, if and when it accumulates, may pass into the casing chamber. This action is facilitated if one or both cables are downwardly inclined toward the joint. If there are dips or low areas in a cable length between joints, the oozing compound may collect in the channels at the dips and form slugs.

In order to by-pass any slugs which may form in the normally free feed channels, a solid wall tube as of copper for example is located in one of the filler spaces defining a channel. For convenience of description, the tube 13 located in the left hand cable length is designated as the first tube and the tube 13^a located in the right hand cable is designated as the second tube. Since each tube does not entirely fill the channel, a certain amount of gas and compound may flow alongside of the outer wall thereof. The conductors are twisted or arranged to form long pitch spirals and on that account, the channels

and the members 12, and tubes 13 and 13a are similarly arranged. This means that the channels and tubes alternately appear at the top of the cable and then at the bottom.

Referring to Fig. 2, 14 indicates the joints between the ends of adjacent conductors. In accordance with the usual practice, each comprises a metal connector for each pair of conductor ends and an applied wrapping of suitable insulation. The joints are enclosed in a chambered casing 15 which is wipe soldered at 16 to the sheaths of the cables. The sheaths are broken away to show the ends of the spiral members 12 and the channels. Because the solid wall tubes 13 and 13a are co-extensive in length with the cable lengths, and because it is desirable to cut back as little as possible of the cable ends, each tube is provided with a short length of tubing forming an extension thereof so that the total required length may be obtained and also to provide the necessary flexibility to permit training of the tubes to their proper respective positions. To the first gas tube 13 is connected a short length of flexible tubing 17, such as copper, by means of a coupling 18. The outer end of the tubing terminates with an open end just under the upper wall of the casing 15. The end should be well above the level of any compound collecting in the chamber of the casing as well as above the channels in the cable. The dotted line 19 indicates a normal level of compound, and it will be noted that the ends of the coiled channel members 12 are well above the level shown. In service, the compound level may be above or below that shown.

To the right hand or second gas tube 13a is connected by a coupling 20, a piece of tubing 21 made of copper which is longer than the tubing 17 because it is terminated outside of the joint casing. To carry out this feature, a small opening is made in the wall of the casing and covering it is a chambered fitting 22 that is soldered or otherwise secured to the casing. The fitting has a central opening or chamber of a diameter substantially greater than that of the tube. The tube 21 is bent upwardly and passes through the opening after which it is secured in place by a soldered joint 23. Fig. 2 shows the end of tube 21 soldered in place at 23, as described. It is understood, however, that the invention is not limited to this particular method of sealing the tube end in place. Any effective method will do. For example, a gas tight compressed gasket assembly can be used instead. The chamber of the fitting is closed by a screw threaded cap 24 and located between the metal parts is a gasket for ensuring a gas tight joint or seal. In assembling the joint the tube 21 is pulled into the fitting by any suitable means.

It will be noted that the tubing 21 forming an extension of the second tube 13a passes through the upper wall of the casing as distinguished from passing through an end of the casing and the wiped soldered joint. This is important for several reasons. It is very difficult to pass a tube through a wiped joint and have it fluid tight; also it is more difficult to wipe a joint where a tube projects through it and hence is in the way of the wiping operation; also such pipes would have to be substantially longer. By the arrangement shown, the thin wall and rather delicate tube 21 is fully protected from injury due to external causes.

It is important to arrange the solid wall tubes 13 and 13a in series as regards the flow of gas, also to fill the chamber of the casing with gas under pressure, also to provide means whereby one of the tubes 13a, for example the right hand or second tube, may be directly supplied with gas under pressure independently of the other or left hand tube. This has the advantage that the tube 13a may be blown out by higher pressure without affecting tube 13. Tube 13 may be blown out through gas admitted under suitable pressure from a joint casing at the left without affecting tube 13a. These features are important to the user of the cable in case of trouble or in testing. To accomplish this a screw threaded elbow 25 is mounted in the cap 24 of the fitting and to this is connected by suitable compression type fittings 26, a short length of pipe 27. The pipe enters a T 28 which has a pipe 29 secured therein by a compression type fitting 30. The other end of the pipe is suitably connected to the cap 31 of fitting 32 which is generally similar to the fitting 22 except that no tube enters it. The portion of the casing under the second fitting 32 is provided with a port or opening 34 through which gas may enter or be discharged from the joint casing. The T 28, when desired, may have a pipe 33 entering it for supplying the solid wall tubes 13 and 13a with gas under pressure. In the case of the second tube 13a, the filling is direct, and in the case of the first tube 13 the filling takes place through the joint casing. If this additional feature of supplying gas is not necessary or desired, the T may be omitted and a length of pipe connecting both of the fittings substituted. The parts above described which are external to the joint casing are and can readily be made heavier than the tubes and are therefore much better adapted to withstand possible injury. Because of the small cross-sectional area of the filler spaces between conductors, the tubes are necessarily small. Only one joint casing is shown but it is to be understood that each joint casing between lengths of cable are similarly constructed and arranged.

From what has been said, it will be seen that each solid wall tube has one of its ends secured to and supported by a chambered fitting and that its other and open end terminates in another joint casing remote from the first and above the level of any compound contained therein and requires no fitting. Such an arrangement not only avoids passing each solid wall tube through a wiped soldered joint but it rigidly supports one end of the tube and permits of the use of relatively heavy external fittings and pipe connections which are not easily damaged. In making a wipe soldered joint between the casing and sheath ends, hot solder is first poured over the parts to be united to heat them, then solder at a lower temperature while in a semi-plastic state is by suitable pads wiped by a circular movement around the parts. Whereas it has been proposed to extend the solid wall gas tubes through the wipe, difficulty is encountered in the wiping operation by reason of the presence of the tube. In particular, difficulty is experienced in getting the solder to completely fill the small space on the under side of the tube adjacent the sheath. Stated another way, the projecting tube forms a bump which interferes with the smooth application of the solder entirely around the tube and the joint between the casing and sheath. Even the smallest leak around the tube will cause a loss of gas from the installation. Because the tubes of necessity have thin walls there is also danger of pinching the tube or even breaking it in the region of the solder when the tubes outside

of the casing are trained to their proper positions or during the various jointing operations. It is also to be borne in mind that all of the work of jointing has to be carried out in manholes where space is at a premium and where conditions are generally unfavorable to fine work.

The arrangement has the advantage that access may always be had to the second tube from the outside of the casing by merely removing the cap on the fitting, or it may be done by opening one of the compression fittings. Since only one tube need be accessible from the outside of the casing, the structure as a whole is thereby simplified. It also has the advantage that external control of the gas conditions is obtained by simple and reliable means and this with a minimum danger of gas leaks. Leakage of gas from the interior of the cable installation is prevented due principally to the fact that the soldered joint **23** in the fitting **22** is small and hence easily made gas tight and to the use of the well packed caps on the fittings. Also, the surfaces of the two fittings which engage and are supported by the casing are small and for that reason may easily be made tight by soldering.

Because the ends of the conductors occupy angular positions determined by the lay of the conductors and are relatively stiff and for that reason cannot readily be moved angularly from their respective positions, because in many instances the joints and their wrapping very largely fill the joint casing leaving little room for the gas tubes and because it is important to have the tube fitting located at the top of the joint casing where it is readily accessible, the arrangement shown in Fig. 3 may be employed. In this figure, the end of the solid wall tube **17** is terminated close to the inner wall of the casing as before, the tube being long enough so that it can be bent around one or more of the joint coverings if necessary. The other tube **21** is longer and instead of terminating directly in a fitting, as in Fig. 2, passes through an opening **35** in the casing which may be angularly located at any convenient place, for example, in alignment with a triangular space between adjacent cable joint coverings where more room is afforded. This opening should be in spaced relation to the joints between the casing ends and the cable sheaths. The tube is soldered at **36** directly to the casing, and its outer end which is sufficiently long is suitably bent to align it with a fitting **37** which may be similar to fitting **32** and is soldered to the upper side of the casing and covers a port **38** opening into the casing. Desirably the tube **21**, particularly the portion located outside of the joint casing, is made sufficiently strong to minimize injury due to external causes. The portion or tube located outside the casing may be regarded as a conduit connecting the tube with the chamber of the fitting. As stated above, the conduit may be stronger than the tube within the casing. The cap **39** of the fitting may be united with the extended end of the tube **21** in my suitable gas tight manner, as by soldering. When it is desired to make the connection between parts readily removable, a compression type fitting **40** may be employed. For convenience of illustration, the tube opening **35** and the fitting **37** are shown as located in the same axial plane but this may or may not be the case in an actual cable installation. The tube **35** may be located wherever it is the most convenient having due regard to the respective positions of the cable ends. The opening will commonly be made by the splicer when assembling the joint. The lengths of solid wall tube in the cable, with access to the tube ends as described, furnish a convenient means of locating accidental gas leakage along the cable line. The test locating method used depends upon whether or not compound slugs, such as previously described, exist at low points or dips in the cable run. If such slugs exist, gas flow past these points in the regular free feed channels **12** is stopped, but the compound free tube for example **13** readily by-passes these slugs and gas flow towards the point of leakage continues only in the tube lengths and the joint casings connecting the tube ends. To locate the leak, it is first necessary to shut off the tube lengths from the joint casings and temporarily stop the flow of gas through the tubes. This can be conveniently done by disconnecting any one of the external fittings, such as **26** or **40**, and temporarily plugging the disconnected ends. The slugs on each side of the point of leakage then limit the gas supplied to the leak to a relatively short section of the cable line and the gas pressure in this isolated section falls below that in the rest of the line. The leaky section can be readily located by pressure readings at each joint along the line until the low pressure point is reached.

To accomplish the above, it is obviously necessary to shut off only one end of each tube length. That explains why tube end **17** is not also brought outside the joint casing, and the necessary control fittings thereby simplified at reduced cost.

Where no complete compound slug stoppages exist at low points or dips in the cable run, the by-pass tube **13** still furnished a useful purpose in locating leaks. A gas flow meter can temporarily be inserted at a convenient external fitting, such as **26** and **40**, and the direction of gas flow, the amount of gas flow, and the pressure drop read. The point of leakage can be readily traced down in this way. Large leaks can be more quickly located by merely reading the gas flow and pressure drop at two or three selected joints along the line and calculating flow resistance as a function of cable length. The tube **13**, being of uniform bore and entirely free of compound furnishes a uniform flow resistance for this purpose, not offered by the channels **12**, which usually have non-uniform and uncertain flow resistance because of the heavy compound clinging at random to the channel walls.

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

1. A gas filled cable installation comprising lengths of insulated conductors, joint means for uniting them, compound impregnating the installation which is liquid at cable operating temperatures, impervious sheaths for the conductors, a chambered casing for each joint means forming a sump and provided with openings located in its wall between the ends thereof, the ends of the casing being sealed to adjacent sheaths, a free feed channel within each sheath opening into a casing for feeding gas to the insulation and also receiving compound oozing from the surface thereof and conveying it to the sump, first and second solid wall gas conveying tubes, one in each cable length, for by-passing slugs of compound contained in the channels thereof, the first tube having an open end terminating in the casing above the level of the channels, a first chambered fitting covering one of the openings in the casing wall, a second chambered fitting also mounted on the casing and covering another of its openings

and in which an open end of the second tube terminates, and an external means establishing communication for gas between the tubes through the chambers of the fittings and that of the casing, the said tubes being wholly within and protected by the casing and one of the fittings.

2. A gas filled cable installation comprising lengths of insulated conductors, joint means for uniting them, compound impregnating the insulation which is liquid at operating temperatures of the cable, impervious sheaths for the conductors, a chambered casing for the joint sealed at its ends to the sheaths and provided with an opening located between its ends, free feed channels within the sheaths opening into the casing chamber for feeding gas under positive pressure to the insulation and receiving liquid oozing from the insulation and conveying it to the casing chamber, a chambered fitting closing the opening in the casing with its chamber in communication with the opening, and first and second solid wall gas conveying tubes located within the sheath for by-passing slugs of liquid contained in the channels, the first tube having an open end terminating within the casing chamber above the level of the channels, the second tube conveying gas to and terminating in the chamber of the fitting so that gas may flow between the tubes through the intermediary of the casing chamber.

3. A gas filled cable installation comprising jointed lengths of insulated conductors, compound impregnating the insulation which is liquid under operating temperatures of the cable, impervious sheaths for the conductors, chambered casings for the joints, each secured to and connecting adjacent sheath ends and having an opening in its wall in spaced relation to the ends thereof, a chambered fitting secured to the wall of each casing for closing the opening therein, a free feed channel within each of the sheaths for supplying gas under pressure to the conductor insulation and receiving compound oozing from the surface thereof, the channels opening at one end into a joint casing, a solid wall gas conveying tube located within each of the cable lengths for by-passing slugs of compound contained in the feed channel thereof, one end of each tube extending outside the casing and being provided with conduit means connecting it to a fitting, the other end opening into the casing of another joint at a point above the level of any compound contained therein, said conduit means being located outside of each casing and conveying gas between the end of the tube extending outside the casing and the open end of another tube located in the same casing through the intermediary of the casing chamber.

4. A gas filled cable installation comprising lengths of insulated conductors, joint means for uniting them, compound impregnating the insulation which is liquid at operating temperatures of the cable, impervious sheaths for the conductors, a chambered casing for the joint sealed at its ends to the sheath and provided with an opening located between its ends, free feed channels within the sheaths opening into the casing chamber for feeding gas of positive pressure to the insulation and receiving liquid oozing from the insulation and conveying it to the casing chamber, a chambered fitting closing the opening in the casing with its chamber in communication with the opening, first and second solid wall gas conveying tubes located within the sheaths of the respective conductors for by-passing slugs of liquid contained in the channels, the first tube having an open end terminating within the casing chamber above the level of the channels and the second tube terminating outside the casing, and conduit means connecting the end of the second tube terminating outside the casing with the chamber of the fitting and conveying gas so that the gas may flow between the tubes through the intermediary of the casing chamber.

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