June 14, 1938. L. EMANUELI 2,120,889

STOP JOINT FOR FLUID FILLED CABLES

Filed Feb. 17, 1938

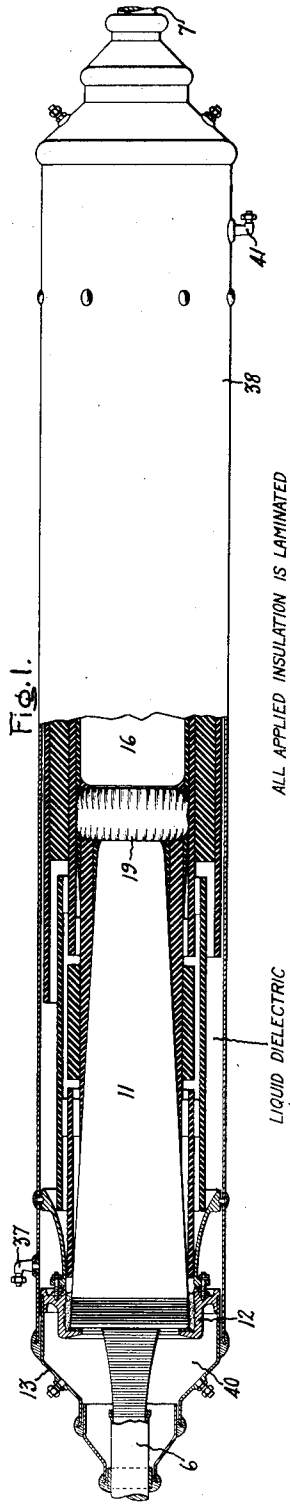


Fig. 1.

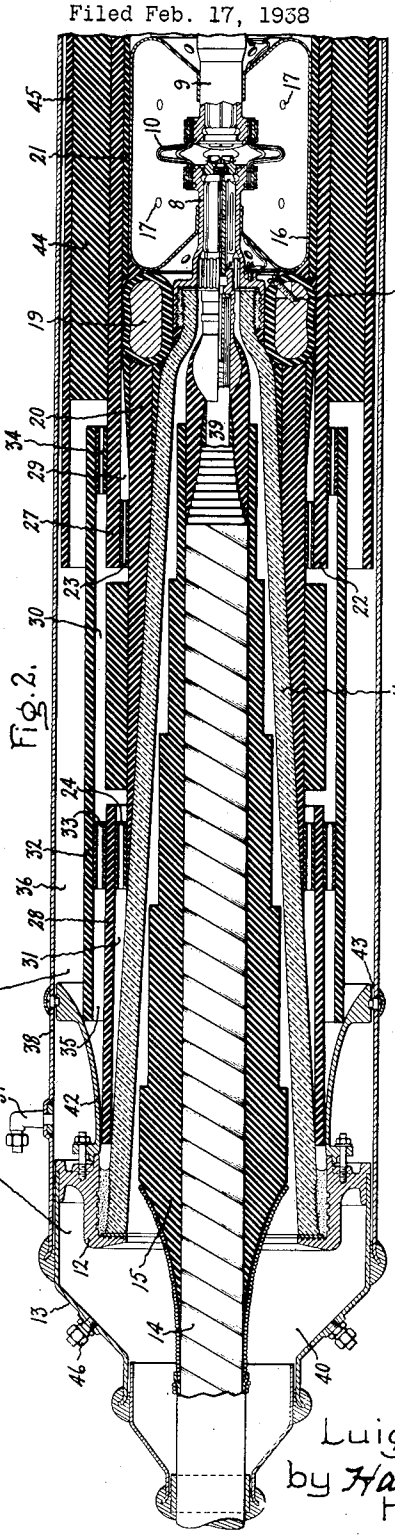


Fig. 2.

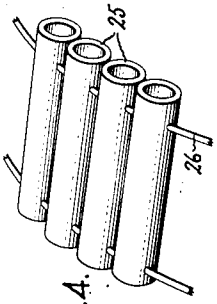


Fig. 4.

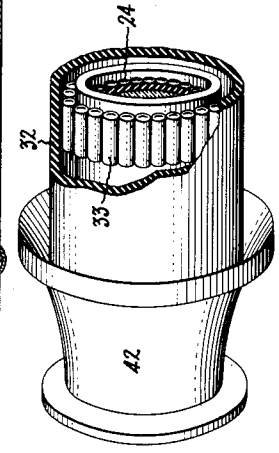


Fig. 3.

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STOP JOINT FOR FLUID FILLED CABLES

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7 Claims. (Cl. 173—268)

Stop-joints are employed in fluid filled cable systems for the purpose of subdividing the cables into sections so as to limit the hydrostatic head of the impregnating liquid on the enclosures or sheaths of the connected cable lengths, and for the purpose of permitting the impregnating dielectric or liquid to flow between the hollow core of the cable conductor and an external source of supply, such as a variable capacity reservoir sealed against the admission of air. They are also employed to segregate one section from another as regards the liquid dielectric so that in the event of a leak in one section, the liquid will not be drained from the connected section or sections.

On account of the fact that there is a great difference of potential between the conductor and the surrounding metal parts, the problem of effectively insulating them one from the other presents many difficulties. The greater the difference of potential, the greater are the difficulties of manufacture and greater care must be exercised in making an installation. Prior to my present invention, numerous installations of fluid filled cable had been made in the United States and in countries foreign thereto operating at 132,000 volts, and in most or all cases the cables were provided with stop-joints, for example of the type shown in my Patent 1,698,051 dated January 8, 1929 or that shown in the Eby Patent 1,819,882 dated August 18, 1931.

The present invention is directed to a stop-joint for underground cable systems and is especially designed to operate under very high voltages. Joints made in accordance with my invention are in successful operation at the present time, and, with the connected cables, are operating at the highest voltage ever used in a commercial underground cable system. As an illustration, but not as a limitation of my invention, the joint illustrated herein is designed to operate at 220,000 volts. In order that some idea may be had of the size of such joints as are here illustrated, it may be stated that the joint casing is approximately 10½ feet long with an approximate maximum diameter of 15½ inches. It is to be understood, however, that the dimensions given are not limitations since a change in operating voltage or a change in the insulating materials used, or both, may and in most cases would result in a change of dimensions.

In such a stop-joint, a great mass of fibrous insulation is applied to the joint parts in order that they may withstand the tremendous voltage to which they are subjected. The value of such material as an insulating medium depends to a very great degree upon how thoroughly gas is removed and how completely the material is impregnated with liquid dielectric, as degasified oil, for example, and how completely all voids are filled with the liquid, or both. My invention is directed more specifically to the ways and means for ensuring complete filling of the voids or spaces within the joint and the proper impregnation of the fibrous insulation.

The object of my invention is the provision of an improved cable joint, and specifically one that is capable of withstanding high voltages.

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 which illustrates one of the embodiments of my invention, Fig. 1 is a view partly in section of a high potential stop-joint; Fig. 2 is an axial sectional view of approximately one-half of the joint; Fig. 3 is a perspective view of a portion of one end of the joint, and Fig. 4 is a perspective view of a portion of a belt comprising parallel tubes of insulating material.

6 and 7 indicate the cables, the conductors of which are hollow and united by the two-part connectors 8 and 9 and the flexible member 10. As both halves of the joint are alike, a description of one of them will be sufficient. The connector 8 supports the small end of a cone-shaped insulator 11, its outer end being supported by the head 12, the latter being secured to the end member 13 of the joint casing. 14 indicates the factory applied insulation on the conductor and surrounding it are layers of fibrous insulation 15 arranged in step formation and all located within the cone insulator.

Surrounding the connector is a thin sheet metal cylindrical screen 16 of relatively large diameter for controlling the electric field and providing a lower gradient of potential on its surface, which is supported at its ends by the connector parts 8 and 9 and is therefore at line potential. It is provided with openings 17 to permit of evacuation and subsequent filling by the liquid dielectric of which degasified oil may be taken as an example. The casing is made in halves to permit of assembly after the parts of the connector are united by the flexible member 10, the plane of division of the casing being axial. The parts of the casing are soldered or otherwise secured together. Adjacent the ends of the screen 16 are metal rings 19 of which one is shown. Each of these is connected to a conductor as by a lead and screw 19a and hence is at the same potential. The

function of these rings is to increase the perforation tension in the regions near the two ends of the connector which are particularly subject to electrical discharges. Each of the rings is separately insulated before application to the joint structure and is supported internally by the enlarged end of a connector part such as 8.

Over the cone insulator is applied bands of fibrous insulating material 20, either in the form of layers or laminations of tape or sheet material, a small amount of fibrous tape being first applied over the portion of the cone insulator adjacent the ring 19 to enlarge the diameter and make the outer surface more nearly cylindrical. An additional wrapping or band of fibrous insulating material 21 is applied over the screen 16 and over a part of the insulator 20. Another reinforcing insulation, indicated at 22, is applied over the insulation 20. Surrounding the insulation 20 on the cone are belts 23 and 24, each comprising small tubes 25 made of insulating material, all strung together or held in place to form an annulus by cords 26 which pass completely through them. By passing the cords through the tubes and permitting the tubes to make contact along their sides, the necessity of individually anchoring each tube is avoided. After the belt is applied, the ends of the cord or other fastening means are tied or otherwise united. It is desirable to use two such cords located near the ends of the tubes to prevent relative displacement thereof. By making the tubes relatively small in diameter and so numerous that they contact with each other along their peripheral surfaces in axial planes, they form an annulus which presents relatively smooth internal and external surfaces and because of that fact, they snugly fit the supporting surface and also form or define an outer surface over which relatively thin insulation may smoothly and evenly be wound or applied in layers to form a cylinder as contrasted to an irregular surface composed of high and low spots as would be the case if the tubes were widely spaced. It is advantageous to slightly bevel the internal ends of the tubes so as to ensure smooth surfaces and free passage of the liquid therethrough. The right hand belt 23 serves as a support for one end of the overlying cylindrical body of fibrous insulation 27 and also as a means to permit the passage of liquid dielectric axially therethrough. The left hand belt 24 supports the right hand end of a tubular body of insulation 28, the opposite end of which is supported by the rigid cone insulator. It will be observed that there are liquid containing spaces or chambers such as 29, 30 and 31. If it were not for the belts of tubes, they would be wholly or largely shut off from the liquid dielectric within the joint casing and as a result the effective insulation would be greatly decreased.

32 indicates a relatively long cylinder of insulating material which is supported in concentric relation with the axis of the joint by spaced belts 33 and 34, each comprising parallel tubes of insulating material as best shown in Fig. 4 and previously described. The tubes of belt 33 serve to convey liquid dielectric between the space or chamber 35 and space or chamber 30. The tubes of the right hand belt 34 serve to convey liquid dielectric between the annular space or chamber 30 and the outermost annular space or chamber 36. From Fig. 3, it will be seen that the belts 24 and 33 are located in the same plane with the cylindrical body of insulation 28 between them. The tubes of the inner belt 24 are desirably slightly smaller in diameter than those of the outer belt and fewer in number because the diameter of the joint in this plane is less. The belts by reason of their construction are flexible so that they may easily be wrapped around the parts of the joint and because the tubes are united by flexible means such as cords, it becomes a simple matter to secure them in place. Liquid dielectric is supplied to and received from the outer chamber 36 of the joint casing by the fitting 37 carried by the outer main casing 38 of the joint. Liquid dielectric is admitted to and received from the hollow core cable by the fitting 46 mounted on the end cap of the joint casing. This fitting when the cable is in service is connected to a variable capacity reservoir to compensate for variations in volume of the liquid in the core of the conductor. The liquid dielectric flows into and out of the hollow conductor 39 through the connector and through the space between the insulation on the conductor and the cone into the end chamber 40 of the joint casing. The joint casing is also provided with a fitting 41 whereby the filling and draining thereof is facilitated.

As previously indicated, the belts act as supports for masses of insulation and also serve as channels to convey liquid dielectric from one more or less isolated space or chamber to another or others and in so doing prevent the formation of dry spaces which otherwise would be only imperfectly filled with liquid.

It is a characteristic feature of my improved construction that the solid or mass insulation outside of the cone insulators is arranged in the form of tubular elements and that between certain of the elements are arranged flexible belts which serve the double purpose of supporting the outer or surrounding elements and affording definite passages for the liquid. The belts form a unit assembly and being flexible conform to the shape of the body encircled thereby and are easily secured in place. Due to the numerous tubes of which each belt is composed, there is no danger of a stoppage of the free circulation of the liquid dielectric. The tubes being assembled and united to each other as they are, there is no danger of a workman making an error in the application of the belts.

Attached to the end head 12 is an end bell 42 which flares outwardly to the wall of the casing 38 and is secured thereto. The purpose of this bell is to provide voltage gradients both radial and lateral which are within the safe working values of the several insulating materials employed. The end bell is provided with a number of grooves or notches 43 which establish connection between the chamber supplied by the fitting 37 and the central part of the joint casing.

The center of the joint is provided with a thick covering of fibrous insulation 44 over which is applied a relatively thin tubular body of insulation 45, the latter being separated from the metallic casing of the joint by an annular space to which the liquid has free access.

The use of flexible belts has been described in connection with stop-joints as they have great utility in connection therewith but they may also be used with advantage in other types of joints where it is important to keep the solid insulation fully exposed to the action of the liquid dielectric.

The wrappings of fibrous insulating tape and sheets are referred to herein as solid insulation to distinguish them from the liquid dielectric. In

some instances, the sheets or tapes are wound in layers directly on some interior part and are immovable when once applied, while in other instances, as the cylinder **28**, for example, the cylinders are wound and then slipped endwise into place in the end bells **42**. It will be apparent that flexible belts of the character described are not limited in their use to cable joints since they may be used wherever desirable in electrical apparatus as a means for insulating one conductor means from another and where it is important to maintain complete filling and circulation of liquid dielectric. It will also be apparent that while the greater part of the liquid dielectric will flow back and forth through the tubes as it expands and contracts, a certain amount will flow through the small spaces defined by the peripheral surfaces of the tubes and the solid insulation upon which the belt is supported or between said surfaces and the wrapped-on insulation covering and supported by the tubes.

The belts are so constructed as to have sufficiently good dielectric strength in a radial direction, that is toward the joint casing, having at the same time passages or channels for the liquid which greatly facilitate the impregnation of the internal parts of the joint casing.

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

1. An electrical conductor means, a metallic enclosure therefor, a filling of liquid dielectric for the enclosure, and a flexible belt comprising insulating tubes arranged side by side and surrounding the conductor means and located between it and the enclosure and through which the dielectric is free to flow.

2. An electrical conductor means, a metallic enclosure therefor, a filling of liquid dielectric for the enclosure, insulating tubes surrounding the conductor means and located between it and the enclosure and through which the liquid dielectric is free to flow, and flexible means located near the ends of the tubes for holding them in side by side relationship to form a flexible belt and for securing the belt around the conductor means.

3. A cable joint comprising electrically connected conductors, bodies of liquid impregnated insulation of cylindrical form enclosing the conductors, the ends of certain of the bodies being in spaced relation, a flexible belt arranged between one of the bodies and that immediately thereunder to support the former, the belt comprising a relatively large number of small diameter tubes arranged in close side by side axial arrangement and united to prevent relative displacement, a sealed casing enclosing the parts of the joint, and a filling of liquid dielectric for the casing which permeates the bodies and flows freely through the tubes as the liquid expands and contracts with temperature changes.

4. A cable joint comprising electrically connected conductors, a body of insulation surrounding one of the conductors, a flexible belt surrounding and supported by the body, the belt comprising a relatively large number of small insulating tubes arranged side by side and extending parallel to the axis of the conductor, a cylindrical body of solid insulation, one end of which is supported by the belt, a second belt of similar construction concentric with the first and supported by the cylindrical body, a second cylindrical body of solid insulation surrounding the second belt and supported thereby, the bodies being in radially spaced relation with liquid containing chambers between, a sealed casing for the joint parts, and a filling of liquid dielectric for the casing which flows into and from the chambers through the tubes as the liquid expands and contracts due to temperature changes.

5. A cable joint comprising electrical conductors arranged end to end, a connector for uniting them electrically, a body of solid insulation surrounding one of the conductors, a flexible belt comprising a plurality of insulating tubes arranged side by side, means for flexibly uniting the tubes and securing them over the body of solid insulation, a body of solid insulation surrounding the belt and supported thereby, a casing for the joint, and a filling of liquid dielectric for the casing which circulates through the tubes and prevents the formation of voids.

6. A belt for the purposes described comprising a plurality of relatively small tubes of insulating material having perforations near their ends, and means for uniting the tubes to form an annulus comprising cords of insulating material which extend through the perforations, the ends of the cords being united to secure the belt in place.

7. A cable joint comprising conductor means, a metallic enclosure therefor, a filling of liquid dielectric for the enclosure, and a flexible belt comprising insulating elements disposed side by side in axial relation and surrounding the conductor and flexible insulating means for securing the belt as a unit assembly in position around the conductor.

LUIGI EMANUELI.