Oct. 30, 1934. L. EMANUELI 1,979,150

FEEDING JOINT

Filed Oct. 5, 1931 2 Sheets-Sheet 1

Fig. 1.

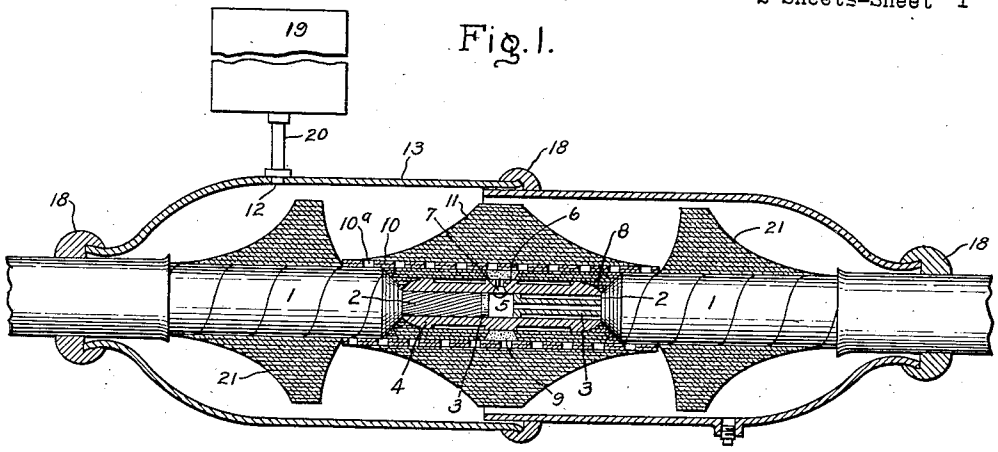


Fig. 2.

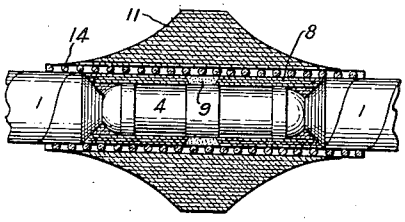


Fig. 3.

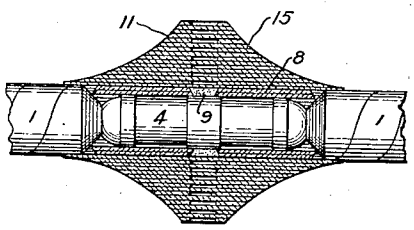


Fig. 4.

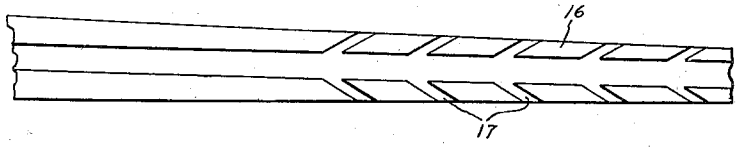
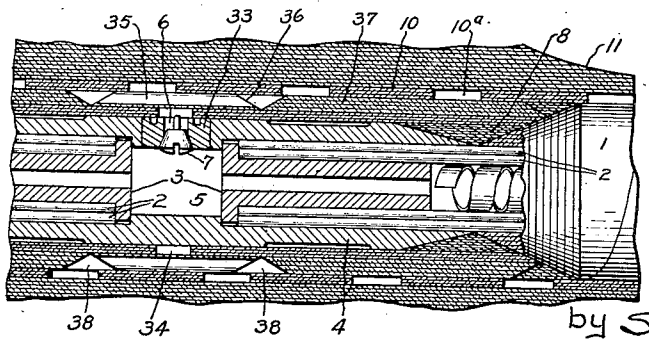


Fig. 5.



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Fig. 6.

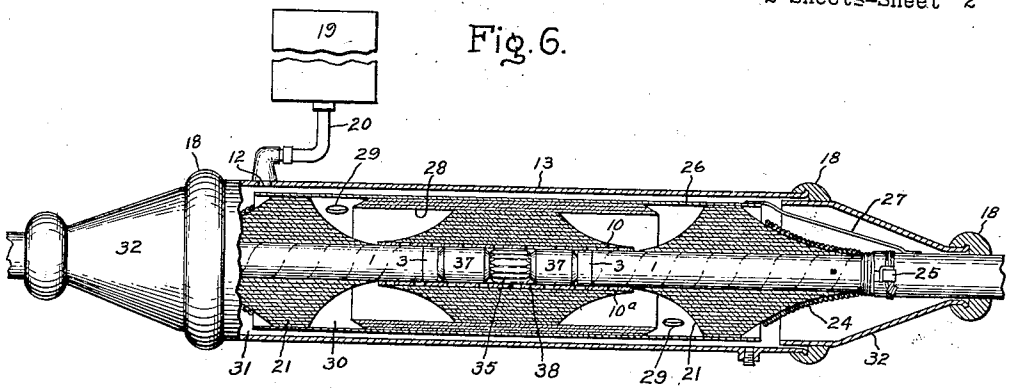


Fig. 7.

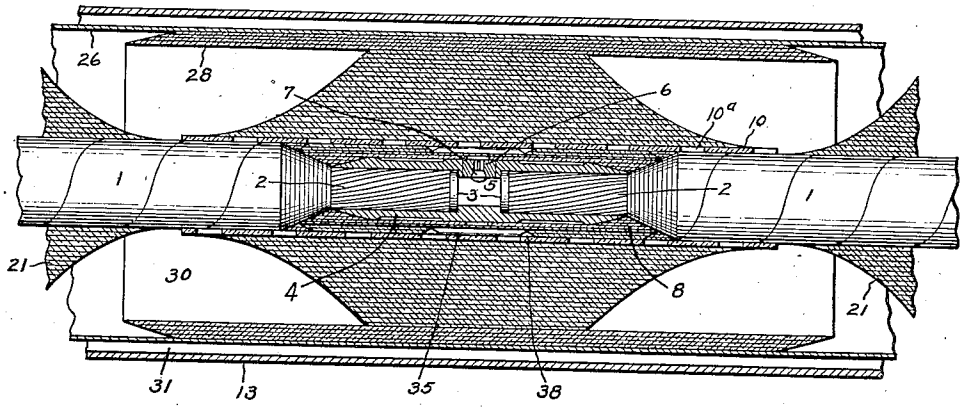
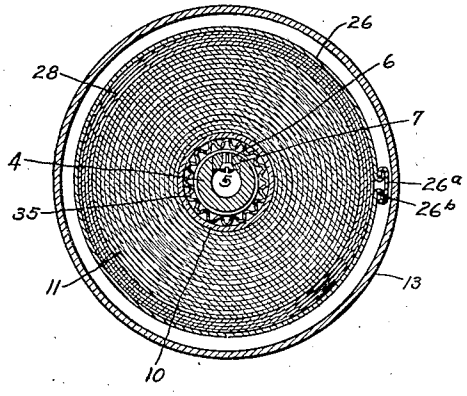


Fig. 8.



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1,979,150

UNITED STATES PATENT OFFICE

1,979,150

FEEDING JOINT

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Application October 5, 1931, Serial No. 567,089
In Italy May 2, 1931

19 Claims. (Cl. 173—268)

The present invention relates to high tension cables of the type having a conductor comprising one or more layers of metallic wires supported by a hollow metallic core in the center which forms a longitudinal channel for insulating fluid, such as oil which impregnates the layers of insulating material, such as paper wrapped around the conductor, the whole being enclosed in a metallic sheath.

The core or interior of the conductor is connected at convenient intervals to special feeding reservoirs, as for example, those described in my English Patent No. 255,034, which have for their purpose automatically maintaining the pressure of the oil in the cable within predetermined limits.

The single or reel lengths of cable are connected by means of convenient joints constructed by a tubular socket which electrically unites the two adjacent conductors and through which the oil can freely pass.

When the line is of considerable length or is laid over a hilly area it must be divided into separate sections in order to limit the pressure of the oil in the cable. In such cases two consecutive sections are connected by means of so-called stop joints, which while they establish the electrical continuity between the two sections, interrupt the passage of the oil from one section to another. Such stop joints are, for example, described in my United States Patent No. 1,698,051.

In cable installations of the type mentioned above, these stop joints have heretofore been used, not only at the ends of each section as described above, but also where it was necessary to connect the cable with feeding reservoirs placed at intermediate points along the length of a section, in which case the passage of the oil from one part to the other of the joint had to be established by means of an external connection between the two end chambers which normally must be kept separate, thus nullifying the principal feature of a stop joint. Stop joints are inherently expensive and because of their size and particularly their considerable length require the use of large and expensive manholes along the line. The use of such joints when acting merely as devices to feed oil to and receive it from the interior channel of a fluid filled cable at spaced intervals has been recognized as uneconomical but prior to my invention they have been the only means of accomplishing the desired result. In this connection it is to be borne in mind that the voltages to which these cables are subjected are very high, at the present time 132,000 volts being a standard. Because of this high voltage every care has to be exercised to prevent leakage of current, to prevent excessive stressing of the insulation, and particularly of the fluid, and to prevent breakdowns due to various phenomena peculiar to high tension electric cables. While the problem of getting fluid into and from power cable may at first seem a simple thing, as a matter of fact it is a very difficult one because of the many factors which enter into cable construction and operation. The outstanding problem is how to reduce the electrical stress on the fluid insulation while at the same time permitting it to freely flow from a reservoir into and from the core of the cable.

My invention has for its object the provision of an improved simple form of joint for feeding insulating fluid to and receiving it from the interior channel of an electric cable, and especially to provide in such joint a means whereby the electrical stresses to which the fluid is subjected may be reduced to a small safe value, to the end that the use of expensive stop-joints as fluid feeding devices may be avoided except in those cases where it is necessary to prevent a flow of fluid from one cable section of a system to another.

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 drawings, some examples of execution of these feeding joints are represented. Fig. 1 represents a longitudinal section of a joint; Figs. 2 and 3 show other examples of execution; Fig. 4 shows a special tape; Fig. 5 is an enlarged view of the central part of the joint; Fig. 6 is a sectional view of a modified form of joint; Fig. 7 is an enlarged view of the central part of said joint, and Fig. 8 is a cross-sectional view of the joints shown in Figs. 6 and 7.

In the example shown in Fig. 1, the feeding joint is made by first removing the insulation 1, such as paper, from the end of each of the two conductors 2 to be jointed, and then introducing into the internal channels of the conductors two tubular steel pieces 3 of which one is shown in section. The ends of the conductors are in turn introduced into a tubular connector or socket 4, made of copper for instance, and having such a length as to form between the ends of the conductors a small central chamber 5

which can be put in communication with the exterior by means of a laterally opening port 6 closed by a small valve 7. The connector is pressed on the conductors at several points by means of a vise operated by a small hydraulic press for instance, so as to ensure a perfect electrical connection with both conductors without soldering. A similar procedure for making a joint without solder is described for example in my English Patent No. 304,912.

The connector is then covered with some layers 8 of paper tape or equivalent insulation until the initial diameter of the insulated conductors is reached, leaving however, the central part of the connector free, this part being covered with a winding 9 made of very porous paper or cotton. On the connector so covered and on the adjacent parts of the insulated conductors a paper tape 10 of considerable thickness, formed by several tapes cemented together, is then wound helically with a long lay with suitable spaces 10^a between the edges of adjacent turns. The spiral formed by this paper tape is then covered with a winding 11 of normal paper tape. A helical channel or conduit constituted by the spaces 10^a between the turns of the spirally wound paper tape 10 is thus formed, and has open outer ends, so that when the joint is connected with a feeding reservoir through a screw hole 12 in the casing 13, oil can pass into and along said helical channel or conduit and can penetrate into the internal channels of the conductors through the porous paper 9 and the port 6 in the socket.

To state the matter another way, the opposed connected ends of the conductors are covered by a wrapped on body of insulation, composed in this figure of tapes 8 to 11 and within the body so formed and between certain of the layers is a channel or conduit so constructed and arranged that at one point it communicates with the channels of both conductors and extends left and right to the outer ends which terminate at or about the surface of the body and are open so as to communicate with a chamber in the joint casing. Such a channel effectively reduces the stress on the oil to a small safe value. The tendency for an electrical discharge in this region is longitudinal but, due to the helical arrangement of the turns forming barriers, this is prevented.

Instead of the paper tape 10, a rope 14, Fig. 2, made of paper tape or other fibrous material may be used to form the helical channel, duct or conduit which permits the flow of oil to and from the socket; the rope is also wound helically. This arrangement has the advantage that a greater number of turns may be used for a given length of joint.

Another procedure to obtain the same result is represented in Fig. 3. This consists in winding on the first or second coverings applied on the connector and on the adjacent parts of the insulated conductors, a long paper tape the width of which gradually decreases in such a way as to form a winding 15. This tape has cemented along one surface at its edges two narrow paper strips 16, as indicated in Fig. 4, so that the tape in section is as represented in Fig. 3. On the narrower half end of the paper tape the paper strips are discontinued at various intervals as shown in Fig. 4 to form fluid passages or channels 17. When the tape is wound on the socket the single layers of the central part form a kind of spiral channel or conduit which is in communication with the exterior through the open lateral channels 17 which are left between two layers of the tape by the discontinuity of the paper strips 16. In other words, there is a main channel formed between each two layers of paper and numerous small or auxiliary channels extending laterally therefrom.

After the joint has been made, according to one of the procedures described above, it is protected by means of a chambered casing 13, as shown in Fig. 1. In the present instance it is made in two parts and joined at the center by a wiped soldered joint 18. The ends are similarly connected to the lead sheaths of the cable sections or lengths.

The joint is then evacuated and subsequently impregnated with oil, it being first connected to a vacuum pump through the screw hole 12 and then to an oil reservoir 19 which establishes the necessary pressure. There is no danger that the oil contained in the cable will flow out or be absorbed by the pump during the evacuation process because the small valve 7 situated in the tubular socket is pressed against its seat by the pressure of the oil within the cable core, so closing the port 6, said pressure being of course superior to that in the casing at this time and above atmospheric pressure.

The various steps involved in joining the conductor ends and evacuating may and generally will be those commonly employed. By preference the cable is filled with fluid at the factory and delivered in that condition to the point of installation. To ensure the proper seating of the valve 7 in the jointing operation, the outer or small end may be attached to a light string by means of which the valve may be positively moved to its proper position. When once properly seated, it will remain so due to the difference of pressure between the fluid in the internal channel or core and the atmosphere. The string or other valve seating means should be removed before the first layer of insulation is applied to permit automatic opening of the valve, as referred to later on.

When the impregnation of the joint is finished a pressure, slightly greater than that existing in the inside of the cable, is applied to the oil contained in the casing by means of a pump. This greater pressure propagating to the socket through the spiral channel 10^a predisposed in the inside of the body of insulation, as described above, causes the small valve 7 to drop into the chamber 5, so putting the oil in the cable in communication with the exterior.

The joint can then be permanently connected to the feeding reservoir 19 by means of a conduit 20 entering the screw hole 12 of the casing, the second of said holes being closed by a screw plug. The oil can in this way penetrate into the cable through the spiral channel or conduit 10^a in the inside of the body of insulation and the hole 6 in the tubular socket.

On each side of the joint formed as previously described is located an annular body of insulation 21, forming a barrier, the purpose of which is to prevent longitudinal discharges due to the high potential. They may be made of relatively narrow tape or they may be made of a tapered sheet of impregnated paper wound on the conductor covering wide end first as set forth in my United States Patent No. 1,799,158, issued April 7, 1931. The outer end surfaces of this insulation are provided with a wrapping of wire or braid 24, Fig. 6, to distribute the

electrical stresses, one end of the wire being soldered to the sheath as indicated at 25. The bodies 21 also serve as a centralizing support for a metal cylinder 26, said cylinder being grounded to the sheaths by wires or equivalent devices 27. The cylinder is split lengthwise, Fig. 8, so that it may easily be applied over the insulation. It is held in place by a clamp 26^a which engages the out-turned edge members 26^b. Surrounding the center body of insulation is a cylindrical barrier 28 made of suitable insulating material, the peripheral surface of which is in engagement with the metal cylinder 26. In the metal cylinder are openings or perforations 29 which permit the insulating fluid to pass freely between the chambers or spaces 30 defined by the metal cylinder and the chamber 31 defined by the wall of the outer casing.

In addition to forming a barrier, the cylinder 28 and casing 26 form a rigid member and, being supported as they are by the end bodies, very greatly strengthen the joint as a whole from a mechanical standpoint. By reason of this arrangement, the outer casing and its joints are practically relieved of all mechanical strains. In Fig. 6 the outer casing 13 surrounding the inner casing is made in the form of a long tube which is sealed at its ends to conical members 32, and the latter in turn are secured to the sheaths. In all cases the joints are soldered.

In Fig. 5 the central parts of the joint are shown on an enlarged scale. The connector 4 is bored and threaded to receive the plug 33 which contains the seat for the valve 7. The layers of insulation 8 are so applied to the peripheral surface of the connector as to leave an annular groove or channel 34 so that oil passing through the port in the plug 33 will have a free passage. Surrounding the connector and resting on the adjacent ends of the insulations 8 is a fluted ring 35, Figs. 5 and 8, made of some stiff insulating material which will not collapse when the outer turns of the insulation are applied. This ring takes the place of the part 9 of the previous figures but has certain advantages over it in that it affords a better path for the oil, is not so liable to clog and forms a mechanical support for the outer windings. The ends of the ring are beveled as at 36 as are also the adjacent ends of the layers of insulation 37, thereby forming annular grooves 38 which form a part of the oil passage or channel. As has been previously described the insulation 10 is spirally wrapped around the connector in such manner as to form a spiral channel 10^a. Because the flutes of the ring 35 extend axially of the connector and the channels 10^a spirally or at an angle to the flutes, there is bound to be some place or places where the oil can freely flow between the inner channel 34 and the outer channel or conduit 10^a. Since the channel 10^a is continuous from end to end, some of the oil will flow to the left and some to the right of the port in the connector.

Feeding joints, of the character herein described, are only approximately one-half the length of a properly constructed stop joint, and their cost is only approximately one-fourth of that of said joints. From this it follows that a greater number can be used per unit length of cable without undue expense, and because of the greater number the fluid in the channel does not have to travel so great a distance to and from a reservoir. This means that a smaller internal core may be used which results in a cable of smaller diameter for the same service with a consequent decrease in initial cost.

A further and substantial advantage arises from the fact that the passage or channel extending through the body of insulation from the region of the conductor ends to the outside of said body being relatively long and tortuous acts as a restrictor to prevent too free a flow of oil or other insulating fluid from the core of the cable in the event of a leak in the joint casing or cable sheath.

One form of connector for the conductor ends has been described as this has been found in practice to be satisfactory, but other forms may be employed without departing from the spirit of my invention, and in particular modifications may be made in the port or passage which permit the passage of fluid to and from the core. The construction shown possesses, however, the advantages of being simple to construct and reliable in operation. Also my invention is not limited to the specific type of channel within the body of insulation. Such arrangements have, however, proved satisfactory in practice.

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

1. In a fluid filled cable system, the combination of a pair of insulated conductors, each having an internal channel containing insulating fluid, a tubular connector for uniting the adjacent ends of the conductors and the channels, a normally open lateral port in the connector, a body comprising wrapped layers of insulation surrounding the connector and containing a relatively long, narrow, tortuous restricted channel between the layers which is in communication with the port at one end and opens outwardly from the body at the other end, and a chambered casing for the aforesaid parts.

2. In a fluid filled cable system, the combination of a pair of insulated conductors, each having an internal channel containing insulating fluid, a connector means for uniting the adjacent ends of the conductors and also the channels and through which fluid is free to flow from one channel to another and also laterally, a body surrounding the connecting means comprising insulation applied directly over the means, other insulation tightly wrapped around the first and defining a restricted channel in communication at one end with the fluid within the conductors and open at its outer end, and an outer wrapping of insulation applied directly to the second named insulation, a chambered casing for the aforesaid parts sealed to the cables, and a fluid containing feeding reservoir connected to the casing.

3. In a fluid filled cable system, the combination of a pair of insulated conductors, each having an internal channel containing insulating fluid, a connector means uniting the adjacent ends of the conductors and channels and through which fluid may also flow laterally, a body of insulation immediately surrounding the connector means, a channel within the body of helical form extending from the region of the connector means to the outside surface of the body, a chambered casing for the aforesaid parts, and a fluid containing feeding reservoir connected to the casing, said helical channel establishing communication between said casing and said internal channels.

4. In a high tension fluid filled cable system, the combination of a chambered casing normally

connected to ground, a pair of insulated conductors, each having an internal channel containing insulating fluid, a connector means uniting the adjacent ends of the conductors and channels, a laterally extending normally open port in the connector means through which fluid is free to flow, and a body of insulation covering the port and comprising an inner wrapped portion defining a helical channel of restricted area, one end thereof receiving fluid from and delivering it to the port at full-line potential, the other end being open to the chamber in the casing at a substantially lower potential.

5. In a high tension fluid filled cable system, the combination of a pair of insulated conductors, each having an internal channel containing insulating fluid, a connector means uniting the adjacent ends of the conductors and channels, a body of insulation wrapped directly around the connector means having an inner layer comprising numerous turns with definitely formed spaces between the sides of the turns to form a helical channel extending from the connector to the outer surface of the body, and a casing for the aforesaid parts having a chamber containing fluid for supplying it to and receiving it from the outer end of the helical channel.

6. In a fluid filled cable system, the combination of a pair of insulated conductors, each having a metal sheath and an internal channel containing insulating fluid, a connector means uniting the conductors and internal channels, a body of insulation around the connector comprising an inner portion, a spiral wrapping of insulation applied over the inner portion having numerous spaced turns defining a channel of restricted area and a third wrapping of insulation overlying the spiral wrapping, and a chambered casing containing fluid and enclosing the aforesaid parts.

7. A joint for fluid filled cables comprising a chambered casing containing fluid, a pair of sheathed insulated conductors sealed to the casing, each conductor having an internal channel, a connector means uniting the conductors and channels and through which fluid is free to flow laterally, a wrapping of spaced cord around the connector means and defining a helical passage of restricted cross section extending from said connector means to the chamber of said casing, and a second wrapping of insulation surrounding the first.

8. A joint for fluid filled cable comprising a chambered casing containing insulating fluid, a pair of insulated conductors entering the casing, each having an internal channel, a connector uniting the ends of the conductors and through which fluid is free to flow from one channel to the other and also laterally, the diameter of the connector being less than that of the insulation on the conductors, a body of insulation comprising porous insulation covering the connector and filling the annular spaces between it and the conductor coverings to the level of the latter, spirally wrapped insulation with spaces between the turns applied over the porous insulation to define a long restricted fluid channel, and an external wrapped on cover for said spirally wrapped insulation.

9. A joint for fluid filled cables comprising a chambered casing containing insulating fluid, a pair of insulated conductors entering the casing, a connector for electrically and mechanically uniting the conductor ends and through which fluid is free to flow longitudinally and laterally, a body of insulation wrapped around the connector and adjacent parts of the conductors, and spacing means located between the turns of the body and extending in the direction of its length to form a main spiral channel of restricted area, said means being interrupted at intervals to form numerous small lateral channels leading outwardly from the main channel.

10. In a fluid filled cable system, the combination of a pair of insulated conductors, each having an internal channel containing insulating fluid, a connector means uniting the adjacent ends of the conductors and channels and having a lateral port through which fluid may also flow, a helical duct of restricted cross-section surrounding said connector means, and a wrapping of insulation enclosing said duct, said helical duct establishing communication between said port and a region outside of said insulation at a point longitudinally beyond said connector means.

11. A joint for fluid filled cables comprising a chambered casing containing insulating fluid, a pair of metal sheathed, insulated conductors, each conductor having a central channel, a metal connector uniting the conductor ends and affording a free lateral passage for fluid from the channels, a centrally located body of insulation enclosing the connector and containing therein a relatively long channel of restricted cross section through which fluid is free to flow to and from the conductor channels to the chamber, a pair of other bodies of insulation located one on each side of the central body, ground shields applied to the outer ends of said pair of bodies, a perforated metal cylinder supported by the pair of bodies, a ground connection for the cylinder, and a cylindrical barrier carried by the cylinder and enclosing the central body.

12. A joint for cables comprising a chambered casing containing fluid, metal sheathed insulated conductors entering the casing at its ends, each conductor having an internal fluid filled channel, connecting means uniting the conductors and channels, and a body of insulation closely surrounding the connecting means, said body containing a continuous duct of restricted area which makes a turn around the connecting means and is in communication at one point with the channels of the conductors and at another point opens into the chamber of the casing.

13. A joint for fluid filled cable comprising a chambered casing containing fluid, a pair of sheathed insulated conductors entering the casing, each conductor having an internal channel, a connector uniting the conductor ends, normally open port means in the connector through which fluid is free to flow from the channels, a body of insulation covering the connector and comprising spaced turns of insulation defining a channel extending axially in two directions from the port means to convey fluid to and from the casing, and a wrapping of insulation tightly applied over the spaced turns, the inner layer of which forms a part of the last named channel.

14. A joint for fluid filled cable comprising a chambered casing containing fluid, a pair of sheathed insulated conductors entering the casing, each conductor having an internal channel, means uniting the conductors and through which fluid is free to flow laterally from a chan-

nel, a member surrounding the said means and defining channels which extend in an axial direction, and a body of insulation surrounding said member and defining a channel, one part of which channel communicates with channels of the member and at its ends opens into the chambered casing.

15. A joint for fluid filled cable comprising a chambered casing containing fluid, a pair of sheathed insulated conductors entering the casing, each conductor having an internal channel, a tubular connector uniting the conductors having a laterally opening port, insulation on the connector defining an annular channel, a fluted ring surrounding the channel, the spaces between the flutes communicating with the channel, and a body of insulation surrounding the ring and containing therein a channel of restricted cross-sectional area, the outer end of which is open to the interior of the casing.

16. A joint for fluid-filled cable comprising a chambered casing containing fluid, a pair of sheathed insulated conductors entering the casing, each conductor having an internal channel, longitudinally spaced annular bodies of insulation mounted on the conductors, and a rigid tubular means extending over and tightly clamped around all of the said bodies and carried thereby to form a mechanical support for the interior parts of the joint, said tubular means being electrically connected with the conductor sheaths.

17. The combination of an electric conductor having an internal channel, insulating fluid in the channel, a casing enclosing a part of the conductor and normally grounded, a body of insulation surrounding the part of the conductor located within the casing, and a narrow tortuous conduit having walls of insulating material located within the said body for conveying fluid between the channel and a point in said casing outside of said body, the conduit being of such restricted cross sectional area and length as to prevent electrical discharge through the fluid contained therein from the conductor to ground.

18. A joint for electric cables comprising insulated conductors, one of which has a channel filled with insulating fluid, a connector electrically uniting adjacent conductor ends, a body of insulation enclosing the connector and parts of the conductor ends, a tubular fluid conveying conduit of relatively small cross-section located within said body and spirally arranged about the axis of the connector, whereby a conduit of relatively great length is provided, said conduit communicating with the conductor channel at its inner end and terminating at its outer end in a region outside of the body, and a casing enclosing said body and conduit.

19. A joint for electric cables comprising insulated conductors, one of which has a channel filled with insulating fluid, a connector electrically uniting adjacent conductor ends, a body of insulation wrapped around the connector and parts of the conductor insulations in concentric layers, a narrow, continuous conduit within the body having side walls defined by the material of said body, said conduit making a plurality of turns about a conductor end to increase the length of the conduit and thereby form a high resistance path to electrical discharges, the inner end of the conduit communicating with the conductor channel and its other end with a region outside of the body, and a casing enclosing said body and conduit.

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