Sept. 16, 1930. K. W. MILLER 1,776,127

JOINT FOR OIL FILLED CABLES AND METHOD OF BUILDING IT

Filed Sept. 10, 1927 2 Sheets-Sheet 1

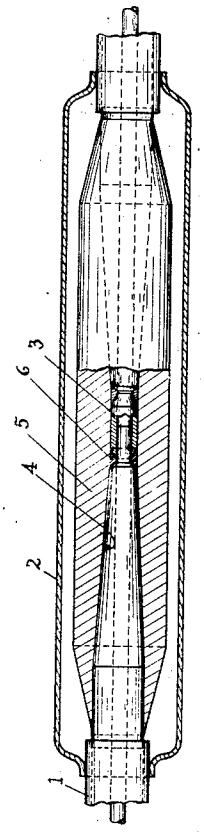


FIG. 1

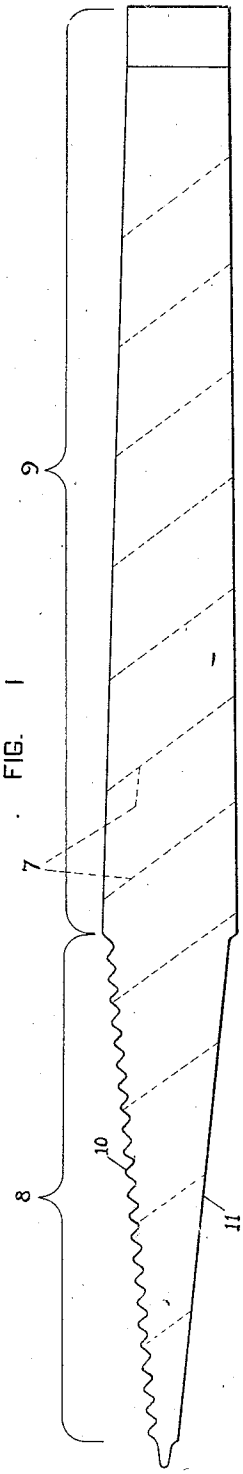
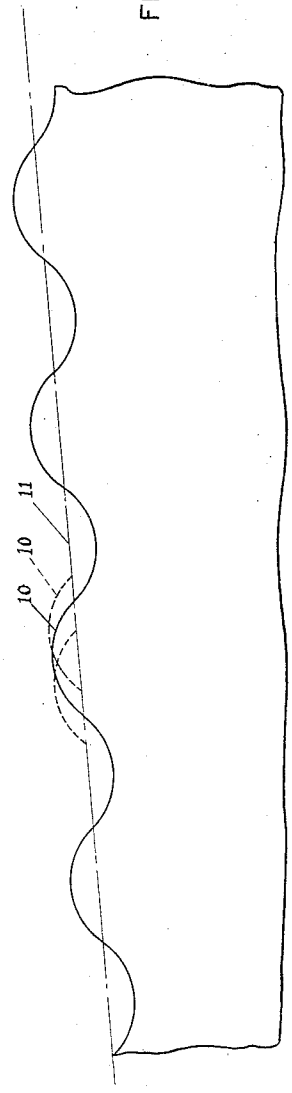


FIG. 2

FIG. 3



INVENTOR

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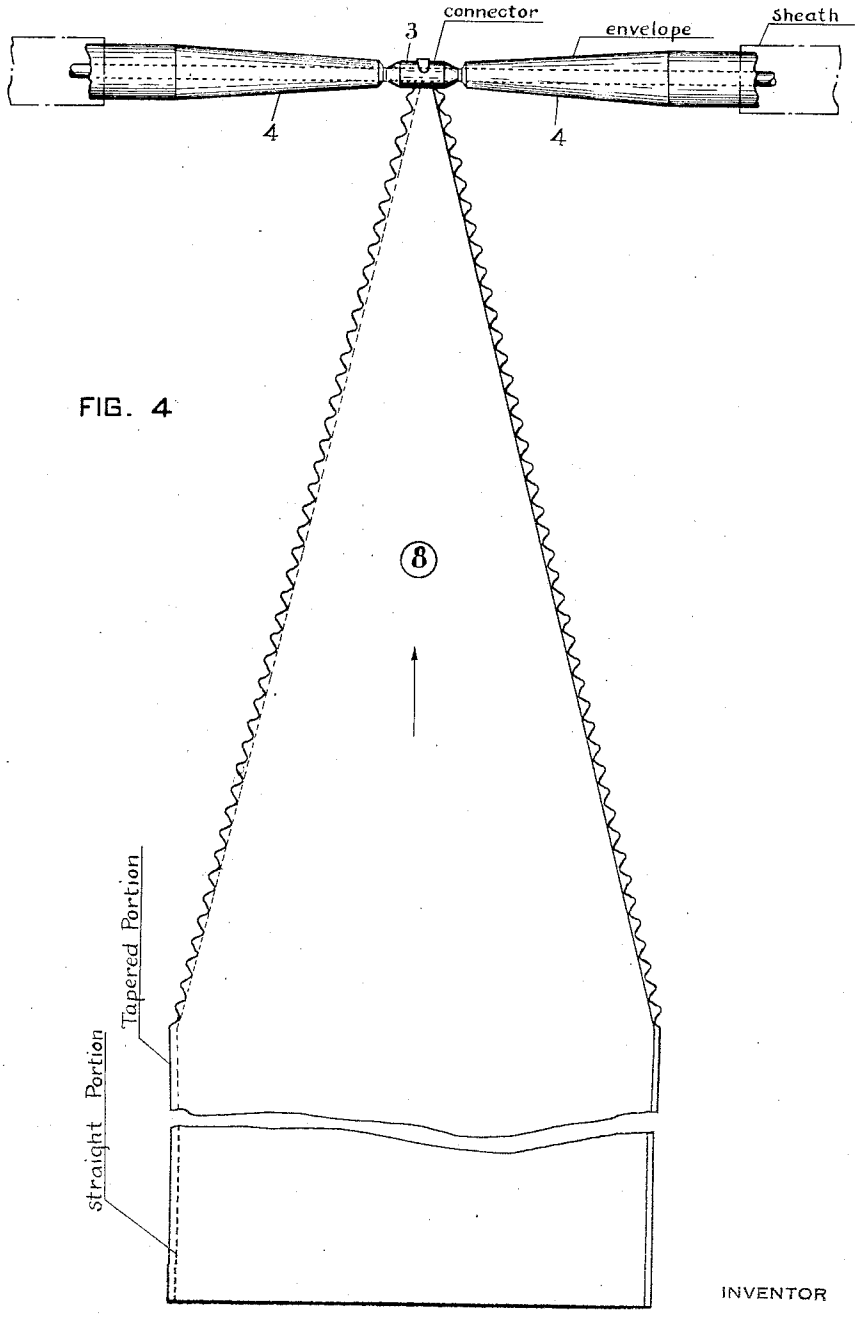


FIG. 4

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UNITED STATES PATENT OFFICE

KENNETH W. MILLER, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO GENERAL CABLE CORPORATION, A CORPORATION OF NEW JERSEY

JOINT FOR OIL-FILLED CABLES AND METHOD OF BUILDING IT

Application filed September 10, 1927. Serial No. 218,793.

My invention relates to the building of joints for oil-filled, high-tension electric cables, and consists in improvements in the apparatus, method, and product disclosed in Letters Patent of the United States No. 1,585,127, granted May 18, 1926, on the application of Donald M. Simons and Frank D. Barbour; No. 1,613,911, granted January 11, 1927, on the application of the said Simons; No. 1,642,514, granted September 13, 1927, on the application of the said Simons, and No. 1,642,515, granted September 13, 1927, on the application of the said Simons.

My invention is illustrated in the accompanying drawings. Fig. 1 is a diagrammatic view in longitudinal and axial section of the finished joint, built according to and embodying my present invention. Fig. 2 is a view in plan of a preformed web of flexible insulating material, in its shape embodying features of my invention, which in the building of the joint is wrapped to place around the electrically connected conductor ends. Fig. 3 is a view to larger scale, illustrating diagrammatically and in detail, a certain feature of construction achieved in the use of the web of Fig. 2. Figure 4 is a diagrammatic view illustrating the application of the webs of flexible insulating material in the building of a joint.

According to the disclosure of the Simons Patent No. 1,613,911 mentioned above, a tank is provided with opposite end-walls adapted to receive and engage in liquid tight closure upon them two cable ends to be united. These cable ends are by the engagement of the end walls of the tank held to axial alignment. The patent describes the preliminary exposure of the conductor ends, before the cable ends are introduced within the tank; it describes the electrical connecting of the conductor ends within the tank, the cutting back of the ends of the envelopes of machine-laid insulation, and the wrapping upon connecter and between the ends of the envelopes of machine-laid insulation, and under oil, a web of flexible sheet insulation. The tank contains a rotary cage, rotatable upon the axis of the cable structure under treatment, and the cage carries the sheet insulation in a roll and in the progress of operation this sheet insulation is unwound from the roll and wound upon the cable structure. It is with the joint so built and with the machinery for and the method of building that my invention has to do.

According to the teaching of Patents 1,585,127 and 1,613,911 mentioned above, the ends of machine-laid insulation are prepared for the wrapping on of a web of sheet insulation between them by cutting them either into successions of receding steps or into tapering conical or "penciled" form and the web of sheet insulation is correspondingly cut, to fit the space between the opposed ends of the two envelopes of machine-laid insulation and in a single wrap to fill all the space. The penciled formation is preferable to the stepped formation; the "riser" of the step is of no electrical consequence nor advantage; it is the "tread" of the step, the surface which extends in parallelism with the cable axis upon which electrically secure union is made; and I find that a web wrapped under oil upon a penciled end of the envelope of machine-laid insulation, particularly if the penciling be done and the web of wrapped-on material be shaped as herein described, will be electrically and mechanically secure, and capable of practical and economical production.

In the diagrammatic showing of Fig. 1, illustrative of the finished joint of my invention, the sheath of the cable end is indicated at 1, and the joint casing which at its ends is mechanically united to the ends of the cable sheath, is indicated at 2. Within the sheath the bared conductor ends have been electrically joined within the connecter 3. The ends of the envelopes of machine-laid insulation have been laid back in the tapered or penciled configuration 4, and upon the connecter 3 and the penciled ends 4 of the envelopes of insulation has been wrapped the body 5 of sheet insulation. This body 5 in a single wrap fills all the space between the bodies of machine-laid insulation, and at its edge makes electrically secure union upon the penciled ends 4. At their innermost ends and adjacent connecter 3, the bodies of machine-laid insulation form with the connecter small recesses which may be filled with bodies

6 of hand-wrapped tape, building out a surface to afford continuous gradient from pencil 4 to the essentially cylindrical surface of connecter 3. There is in this hand-wrapping 6 (and in the first few turns in the building of body 5 as well, under practical conditions) the chance that small bubbles of air or of moisture may occur. But, as compared with hand-taping, that chance, which in hand-taping attends the whole operation, is in the practice of my invention limited to a relatively small region. Furthermore, the volume of air or of moisture which may possibly be so included, is so small that with good, dry de-aerated (or even plain) oil, any bubble will soon diffuse and be absorbed into the whole body of insulation, and practically cease to exist. It is in the surface 4 where my invention centers: both in the penciling of the envelope of machine-laid insulation, and in the shaping of the body 5 to it.

In the oil-filled cable the body of machine-laid insulation is formed of paper wrapped helically to place, and saturated with oil of high dielectric strength. All the space within the sheath not occupied by conductor and by paper, is flushed with oil. The material which in the operation of joint building is wrapped under oil to form body 5 is preferably varnished cambric.

The web of varnished cambric for building the body 5 of Fig. 1 is shown diagrammatically in plan in Fig. 2. Its overall dimensions are 50½ feet x 36 inches. The cambric is cut on the bias, and the seams 7 extend obliquely to the length. The portion 8 is that which, when wrapping has been effected, immediately surrounds the connecter and fills the space between the penciled ends of the insulating envelopes. The portion 9 forms the enlargement of the body 5 beyond the diameter of the bodies of machine-laid insulation, and, for the purpose of limiting dielectric stresses, the edges of the portion 9 and the outer end of the portion 9 may be metallized. It is with the portion 8 that my present invention has more particularly to do.

The web is cut throughout the extent of portion 8 a little too wide, a little over-size. In consequence, when the web is wrapped to place, its medial portion will lie in parallelism with the surface of the conductor, but the edges of portion 8 will "spool up" slightly on the penciled surfaces 4. This, however, is advantageous. It affords the best bearing of surface upon surface, where such bearing is needed, and while accomplishing this it does not cause voids to occur in medial portions of the wrap.

The cutting of the penciled surface 4 is advantageously effected by instrumentalities which take their position by bearing upon connecter 3. The surface 4 accordingly may under practical conditions deviate minutely from a perfect cone, precisely coaxial with the cable structure. But such small irregularities will have no serious nor appreciable disturbing effect upon the dielectric field, for the web of varnished cambric as it is wrapped will adjust itself perfectly to them. And when the great saving of time which may be realized in cutting the pencil is taken into account, and when it is remembered that the longitudinal slope of the pencil is uniform and that the cutting is accomplished without any trapping of air under the edges of the paper, the very slight occasional eccentricity of the pencil is a matter of no appreciable moment. The only electrical effect of such slight eccentricity will be a very small but "smooth" shift of voltage stresses. The location and accuracy of the pencil will be much more perfect than the circumstances require.

The varnished cambric may be about 0.011 of an inch thick; the gradient of the penciled slope 4 may be 1:18. Each edge of body 5 then should widen about 0.2 of an inch for every added layer. I preferably form the body 5 of two webs wrapped together and accordingly each web should widen at a rate of about 0.4 of an inch on each side for every turn. When two webs are wrapped together to form a body 5, they are laid down at diametrically opposite points.

To avoid trouble due to errors of a fraction of a turn in starting the two rolls of cambric in the wrapping operation, the gaining of one roll upon the other because of inequality in tension, and to afford correction for any slight shifting of the rolls of cambric longitudinally upon the cage which carries them,—but chiefly to get widened surfaces of bearing in planes parallel to the axis of the cable structure—I adopt the minute shaping of the edge of the wrap, particularly in the portion 8, which is shown in Fig. 2. The edge is cut on a sinuous line to form scallops. The scallops are cut by a template at the factory, and the wave length is incommensurate with the circumference to which the web is wrapped, with the consequence and effect indicated diagrammatically in Fig. 3; the successively superposed scallops do not register one with another, and each presents an extended surface for contact upon the penciled surface 4. The depth of the scallop may increase in correspondence with the enlargement of the circumference of the wrap, but should average, approximately, from a half to three quarters of an inch on the main line of increase of width. I have said that I preferably build the body 5 of two webs of cambric and when two webs are employed, one edge only of the portion 8 of each web need be scalloped. The opposite edge may, as shown in Fig. 2, be straight. In application, the scalloped edges of the two webs comes to place one on each of the two opposite penciled surfaces 4, and, considering either

edge alone, the assembly will be that diagrammatically indicated in Fig. 3. The scalloped edge 10 and the straight edge 11 will overlie one another, in alternation. When the two webs are wrapped (considering one side only), the scalloped edge of one web will alternately extend beyond and not up to the straight edge of the other web. The overlap will average out over a succession of turns, and the scallops will lap one over another, like the feathers of a bird, or like the shingles on a roof. And since the webs have intentionally been cut slightly over-size, the bearing upon the underlying penciled surface 4 will be perfect. The elasticity of the cambric will give intimate contact across the width of the wrap, and the oil in which at the time of wrapping the work is submerged, will afford perfect filling. Such an application of two webs in the building of a joint is diagrammatically illustrated in Figure 4 of the drawings. The two webs are here shown to be superposed, each has one edge scalloped. One web is scalloped along one edge, the other web is scalloped along the opposite edge, so that the assembly shows a line of scallops along each of the two edges. The webs at their ends are applied to the connector 3 and then they are wrapped upon the connector 3 and upon and between the penciled ends 4 of the bodies of insulation of the two cable ends whose conductors are united in the connector 3.

While I have in Figure 4 diagrammatically shown the two webs as brought together and applied together, and while this particular arrangement is entirely possible, I prefer to build the body 5 of two webs of cambric applied at diametrically opposite points, first, because, in consequence, the overall diameter of the joint-building machine may be reduced; second, because the oppositely applied tensions of the two wraps counterbalance one another; third, the twists on the two tension brakes, which conveniently are mounted both on one cage head, tend to balance one another, and accordingly the cage head may be built of lighter material; and, fourth, the individual webs are each but half as long as a single web must be, and the wrapping may be done at double speed.

I claim as my invention:

1. The method herein described of building a body of insulation in electrically secure abutment upon an inclined surface, which consists in superposing under oil layers of sheet insulation with scalloped edge, the so successively superposed scallops of the layers being out of register one upon another and overlapping lengthwise of the sheet upon such inclined surface.

2. The method herein described of building a body of insulation in electrically secure abutment upon an inclined surface, which consists in superposing layers of sheet insulation with edges alternately straight and scalloped, the so successively superposed scallops of the edges of the sheet insulation being out of register one upon another, the edges of the layers lapping lengthwise of the sheet upon such inclined surface.

3. The method herein described of building a wrapped-on body of insulation around a conductor and in electrically secure abutment upon an envelope of machine-laid insulation with which the conductor is adjacently surrounded, which consists in penciling the end of the body of machine-laid insulation and wrapping upon the conductor a scalloped-edged web of sheet insulation, such scalloped edge of the web overlapping lengthwise of the web as the successive layers are wrapped upon the penciled surface of the envelope.

4. The method herein described of building a wrapped-on body of insulation around a conductor and in electrically secure abutment upon an envelope of machine-laid insulation with which the conductor is adjacently surrounded, which consists in penciling in a rippled surface the end of the body of machine-laid insulation and in wrapping upon the conductor a scalloped-edged web of sheet insulation, such scalloped edge of the web overlapping lengthwise of the web as the successive layers are wrapped upon the penciled surface of the envelope.

5. The step in joint building herein described which consists in penciling oppositely and at predetermined spacing the ends of machine-laid insulation of the cable on either side of the electrically connected conductor ends, and wrapping upon the connected conductor ends and between the penciled envelope ends a scalloped-edged web of flexible sheet insulation, with scallops overlapping lengthwise of the web as the successive layers are wrapped upon the penciled envelope ends.

6. In an electrical installation two bodies of insulation overlying a conductor and meeting on a surface oblique with respect to the surface overlaid, one of said bodies being built of laminate scalloped-edged sheet insulation, the sheets throughout their medial portions extending in parallelism to the surface of the conductor, and the scallops of the edge overlapping lengthwise of the web as the successive layers are wrapped upon the other body in the oblique surface of meeting.

7. In an electrical installation two bodies of insulation overlying a conductor and meeting on a surface oblique with respect to the surface overlaid, one of said bodies being minutely rippled over the surface of meeting and the other body being built of laminate scalloped-edged sheet insulation, the sheets throughout their medial portions extending in parallelism to the surface of the conductor, and the scallops of the edge overlapping upon the rippled surface of the other body.

8. In a cable joint and in combination with connected conductor ends, envelopes of machine-laid insulation oppositely penciled at predetermined spacing one from the other on either side of the connected conductor ends, and a wrap of flexible scalloped-edge sheet insulation encircling the connected conductor ends and filling the space between the penciled envelope ends and over-lapping marginally upon the pencilled envelope ends.

9. The method herein described of building a body of insulation in electrically secure abutment upon an inclined surface, which consists in superposing layers of sheet insulation with scalloped edge, the so successively superposed scallops of the successive layers being out of register one upon another and overlapping lengthwise of the sheet upon such inclined surface.

10. A wrapping for a cable joint comprising a sheet of insulating material, the sheet being tapered towards one end and one of the edges extending in sinuous line.

11. A wrapping for a cable joint comprising a sheet of insulating material tapering with scalloped edge towards one end.

12. A wrapping for a cable joint comprising two tapering sheets of insulating material one edge of each extending in sinuous course, the two sheets being assembled to form a double wrap and in assembled position presenting their sinuous edges one along one side the other along the other side of the assembly.

13. A wrapping for a cable joint comprising a sheet of insulating material, the sheet being tapered towards one end and one edge of the tapered portion, by departure from a straight line, being formed with alternate extensions and recessions.

In testimony whereof I have hereunto set my hand.

KENNETH W. MILLER.