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(54) METHOD OF MANUFACTURING ELECTRIC CABLES

(71) We, THE FUJIKURA CABLE WORKS, LIMITED, a Japanese corporate body, of 5-1, 1-chome, Kiba, Koto-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of manufacturing electric cables.

In order to prevent penetration of moisture, corrosive liquid or gas and to provide an electromagnetic shield as well as adequate flexibility, an electric cable, particularly a telephone cable, has been proposed which is provided with a laminated or composite tape consisting of a metal tape and a plastics tape such as polyethylene, vinyl chloride and the like. The composite tape extends in the longitudinal direction of the cable and its longitudinal side edges are overlapped and bonded together by means of an adhesive such as a copolymer resin. Then, an outer sheath of a plastics material is extruded to surround the composite tape. With this construction, it is inevitable to form a longitudinal air gap between the inner surface of the outer sheath and the seam between overlapped side edges of the composite tape, that is at the portion where the upper side edge is bonded to the lower side edge of the composite tape. Such air gap causes separation of the overlapped edges when the cable is installed in cold districts because the metal tape of the composite tape is not directly bonded to the outer sheath.

It is an object of this invention to provide a method of manufacturing an electric cable having a composite tape of metal and plastics material which is longitudinally applied to a cable core and is formed about the cable core so that the opposite side edges of the composite tape are overlapped, and a plastics outer sheath is extruded about

the formed composite tape without forming an air gap between the composite tape and the outer sheath.

Another object of this invention is to provide an electric cable having a core, a composite tape of metal and plastics surrounding the core, and an outer sheath of plastics material, wherein the side edges of the composite tape are overlapped and firmly bonded each other and to the outer sheath without forming any air gap therebetween, the arrangement of which is impact-resistant and thus prevents peeling off of these overlapped edges when the cable is used in cold districts. Furthermore, a cable formed according to this method provides a good barrier against moisture.

According to this invention, these and other objects can be accomplished by providing a method of manufacturing an electric cable, said method comprising the steps of fabricating a composite tape by bonding together a metal tape and a plastics tape having a width larger than that of the metal tape with at least one side edge portion of the plastics tape remaining exposed and with the exposed side edge portion or portions of the plastics tape folded back over the adjacent edge or edges of the metal tape, longitudinally forming the composite tape about a cable core so that the opposite side edges of the composite tape overlap and so that a folded back side edge portion of the plastics tape is interposed between the overlapped side edges of the composite tape, and extruding an outer sheath of plastics material about the formed composite tape so as to bond the outer sheath to the composite tape.

By means of the method of the invention, rolled metal tapes can be added one after another by sequentially effecting a spot welding operation when the terminal end thereof is caused to be exposed during the unwinding operation. This permits con-

tinuous steps of operation and therefore is economical as compared with those conventional methods using intermittent tapes.

In order that the invention may be well understood there will now be described some embodiments thereof, given by way of example only, reference being had to the accompanying drawings, in which:

Fig. 1 shows successive steps of manufacturing a telephone cable according to the invention;

Fig. 2 shows a schematic view similar to Fig. 1 illustrating a modified embodiment of this invention;

Figs. 3A to 3D show successive steps of manufacturing a composite tape;

Fig. 4 is a cross-sectional view of a telephone cable utilizing the composite tape fabricated by the steps of Figs. 3A to 3D the seam formed by overlapping longitudinal side edges of the composite tape being shown magnified;

Figs. 5A to 5D show successive steps of fabricating a modified composite tape; and

Fig. 6 shows a cross-section of a telephone cable utilizing the modified composite tape fabricated by the steps of Figs. 5A to 5D.

Referring now to Fig. 1, a metal tape 1, of aluminium or copper, is wound about a reel 2. A strip of the metal is slit to form metal tapes of given width. After annealing the tape is wound into a coil. A plastics tape 3 having a width greater than that of the metal tape 1 is wound about a reel 4. The plastics tape 3 is advantageously made of ionomer, ethylene-ethylacrylate copolymer, ethylene-methacrylate copolymer, ethylene-acrylic acid copolymer, ethylene-vinyl acetate copolymer, polyethylene or vinyl acetate which manifests excellent adhesive property to the metal tape 1 and to the plastics material of an outer sheath to be described later.

Metal tape 1 payed out from the reel 2 is passed through a tension adjuster 6 which adjusts the tension of the tape to a suitable value and is then passed through a heating device which is used to heat the surface of the metal tape to a temperature sufficient to heat bond the metal tape to the plastics tape 3. The heating device may take the form of a heated plate upon which the metal tape slides, a heated roller 7 around which the metal tape passes as shown in Fig. 1, or a heating furnace 7a as shown in Fig. 2.

In the arrangement shown in Fig. 1, only the metal tape 1 is passed through the heating device but in the arrangement shown in Fig. 2, both the metal tape 1 and plastics tape 3 are passed through the furnace 7a. Heated metal tape 1 and plastics tape 3 are then passed through the nip between rolls 8 which apply pressure to

bond them together to form a laminated composite tape 9. When metal tape 1 on the reel 2 has not been annealed, a suitable annealing device, not shown, may be added between the reel 2 and the rolls 8.

The composite tape 9 is fabricated by the steps shown in Figs. 3A to 3D or Figs. 5A to 5D. In the case shown in Figs. 3A to 3D, a metal tape 1 is placed on a plastics tape 3 having a larger width than that of the tape 1 so that the tapes are aligned along one side edge thereof. Alternatively, as shown in Fig. 5A the metal tape 1 is placed on the plastics tape 3 with their transversal centers aligned thus leaving exposed side edge portions 3a and 3b of equal width on the opposite sides. The composite tape 9 is then passed through a heated edge folding device 10 to fold back the exposed portion 3a of the plastics tape on the back of the metal tape. The edge folding device has a section which gradually converges in the direction of movement of the composite tape. Thus, in the case of Fig. 3, the edge folding device 12 has a cross-section of a segment of an arc at the entrance thereof as shown in Fig. 3B and finally assumes a cross-section of a letter U having legs of unequal length at the exit as shown in Fig. 3D. In the case of Fig. 5, the cross-section of the folding devices 12a and 12b at the exit ends takes the form of a letter U. Alternatively, such folding back operation may be performed by a blast of pressurized heated fluid. Further, it is clear that the edge folding device 10 may be combined with the rolls 8.

Bonding of the folded back edges 3a or 3a and 3b to the metal tape 1 may be effected by utilizing the heat imparted to the edge folding device. The composite tape 9 with its edge portion or edge portions folded back is then passed through a cooling device 15 which may comprise a nozzle 18 for ejecting cold fluid as shown in Fig. 1 or cold rollers 15 as shown in Fig. 2.

The cooled composite tape 9 is then entered into a former 16 together with a continuously advancing cable core 11 in which the composite tape 9 is wrapped about the cable core in the longitudinal direction to overlap the opposite side edges of the composite tape with the metal tape 1 positioned inside and the plastics tape outside, and with the folded back edge portion or portions of the plastics tape 3 (14 in the case of Fig. 3; 14a and 14b in the case of Fig. 5) interposed between overlapped side edges of the composite tape.

The cable core 11 applied with the composite tape 9 is then passed through an extruder 17 of any known type which extrudes an outer sheath of plastic 5 about

the formed composite tape. By the heat and pressure applied by the extruder, the overlapped side edges of the composite tape are firmly bonded together against peel off and since the inner side of the plastics sheath is urged against the outer surface of the plastics tape 3 having high bonding power, there is no fear of forming an air gap at the right hand side of the overlapped side edges of the composite tape 9 as viewed in Fig. 4.

Fig. 4 shows a cross-section of a completed cable utilizing the composite tape with only one side edge portion 3a of the plastics tape folded back as shown in Fig. 3D whereas Fig. 6 shows a cross-section of a completed cable utilizing the composite tape with both side edge portions 14a and 14b folded back as shown in Fig. 5D. With the latter embodiment, either one or both of folded edge portions 14a and 14b of the plastics tape are always interposed between overlapped side edges of the composite tape irrespective of which one of the side edges lies above the other. Moreover, either one of the folded side edge portions 14a and 14b is always in contact with the plastics sheath. In other words, the direction of wrapping of the composite tape is not essential thus increasing the flexibility of manufacturing. Bonding of the overlapped side edges may be effected by the heat and pressure applied by the extruder or by heating them with an independent heating device, such as a high frequency heating device for example. Alternatively, the heat for bonding the overlapped side edges may be applied by the composite tape former and thereafter the outer sheath 5 may be applied by the extruder 17.

By increasing the travelling speed of the cable core 11 above the extrusion speed of the plastics sheath 5 by the extruder 17, the applied plastics sheath 5 is orientated to increase the bonding strength or clamping force applied to the overlapped side edges.

It should be noted that the composite tape may be fabricated beforehand, wound into a coil and such coil of the composite tape may be used.

The cable applied with the outer sheath by means of the extruder is then suitably cooled.

WHAT WE CLAIM IS:—

1. A method of manufacturing an electric cable, comprising the steps of fabricating a composite tape by bonding together a metal tape and a plastics tape having a width larger than that of said metal tape with at least one side edge portion of said plastics tape remaining exposed and with said exposed side edge portion or portions of said plastics tape folded back

over the adjacent edge or edges respectively of said metal tape, longitudinally forming said composite tape about a cable core so that the opposite side edges of said composite tape overlap and so that a folded back side edge portion of said plastics tape is interposed between the overlapped side edges of said composite tape, and extruding an outer sheath of plastics material about said formed composite tape so as to bond said outer sheath to said composite tape.

2. A method of manufacturing an electric cable as claimed in claim 1, wherein said plastics tape is made of at least one material selected from the group consisting of ionomer, ethylene-ethylacrylate copolymer, ethylene-methylacrylate copolymer, ethylene-acrylic acid copolymer, ethylene-vinyl acetate copolymer, polyethylene and vinyl chloride.

3. A method of manufacturing an electric cable as claimed in claim 1 or claim 2, wherein said metal tape is laminated on said plastics tape so that said tapes are aligned along one side edge thereof thus leaving exposed one side edge portion of said plastic tape.

4. A method of manufacturing an electric cable as claimed in claim 1 or claim 2, wherein said metal tape is laminated on said plastics tape so that their lateral centers are aligned thus leaving exposed both side edge portions of said plastics tape.

5. A method of manufacturing an electric cable as claimed in claim 1 or claim 2, wherein said metal tape and plastics tape are heat bonded together, said composite tape is thereafter cooled, and said exposed side edge portion or portions of said plastics tape prior to said composite tape being so cooled is or are respectively folded back on to said metal tape by means of a mechanical folding device.

6. A method of manufacturing an electric cable, comprising the steps of feeding an annealed metal tape of a predetermined width, adjusting the tension of said metal tape, heat bonding said metal tape to a plastics tape having a larger width than that of said metal tape with both side edge portions of said plastics tape remaining exposed and with said exposed side edge portions of said plastics tape folded back over the edges of said metal tape, thus completing a composite tape, longitudinally forming said composite tape about a cable core to overlap the opposite side edges of said composite tape with said metal tape positioned inside and said plastics tape outside and with said folded back side edge portions of said plastics tape positioned between said overlapped side edges of said composite tape, extruding an

the formed composite tape. By the heat and pressure applied by the extruder, the overlapped side edges of the composite tape are firmly bonded together against peel off and since the inner side of the plastics sheath is urged against the outer surface of the plastics tape 3 having high bonding power, there is no fear of forming an air gap at the right hand side of the overlapped side edges of the composite tape 9 as viewed in Fig. 4.

Fig. 4 shows a cross-section of a completed cable utilizing the composite tape with only one side edge portion 3a of the plastics tape folded back as shown in Fig. 3D whereas Fig. 6 shows a cross-section of a completed cable utilizing the composite tape with both side edge portions 14a and 14b folded back as shown in Fig. 5D. With the latter embodiment, either one or both of folded edge portions 14a and 14b of the plastics tape are always interposed between overlapped side edges of the composite tape irrespective of which one of the side edges lies above the other. Moreover, either one of the folded side edge portions 14a and 14b is always in contact with the plastics sheath. In other words, the direction of wrapping of the composite tape is not essential thus increasing the flexibility of manufacturing. Bonding of the overlapped side edges may be effected by the heat and pressure applied by the extruder or by heating them with an independent heating device, such as a high frequency heating device for example. Alternatively, the heat for bonding the overlapped side edges may be applied by the composite tape former and thereafter the outer sheath 5 may be applied by the extruder 17.

By increasing the travelling speed of the cable core 11 above the extrusion speed of the plastics sheath 5 by the extruder 17, the applied plastics sheath 5 is orientated to increase the bonding strength or clamping force applied to the overlapped side edges.

It should be noted that the composite tape may be fabricated beforehand, wound into a coil and such coil of the composite tape may be used.

The cable applied with the outer sheath by means of the extruder is then suitably cooled.

WHAT WE CLAIM IS:—

1. A method of manufacturing an electric cable, comprising the steps of fabricating a composite tape by bonding together a metal tape and a plastics tape having a width larger than that of said metal tape with at least one side edge portion of said plastics tape remaining exposed and with said exposed side edge portion or portions of said plastics tape folded back

over the adjacent edge or edges respectively of said metal tape, longitudinally forming said composite tape about a cable core so that the opposite side edges of said composite tape overlap and so that a folded back side edge portion of said plastics tape is interposed between the overlapped side edges of said composite tape, and extruding an outer sheath of plastics material about said formed composite tape so as to bond said outer sheath to said composite tape.

2. A method of manufacturing an electric cable as claimed in claim 1, wherein said plastics tape is made of at least one material selected from the group consisting of ionomer, ethylene-ethylacrylate copolymer, ethylene-methylacrylate copolymer, ethylene-acrylic acid copolymer, ethylene-vinyl acetate copolymer, polyethylene and vinyl chloride.

3. A method of manufacturing an electric cable as claimed in claim 1 or claim 2, wherein said metal tape is laminated on said plastics tape so that said tapes are aligned along one side edge thereof thus leaving exposed one side edge portion of said plastic tape.

4. A method of manufacturing an electric cable as claimed in claim 1 or claim 2, wherein said metal tape is laminated on said plastics tape so that their lateral centers are aligned thus leaving exposed both side edge portions of said plastics tape.

5. A method of manufacturing an electric cable as claimed in claim 1 or claim 2, wherein said metal tape and plastics tape are heat bonded together, said composite tape is thereafter cooled, and said exposed side edge portion or portions of said plastics tape prior to said composite tape being so cooled is or are respectively folded back on to said metal tape by means of a mechanical folding device.

6. A method of manufacturing an electric cable, comprising the steps of feeding an annealed metal tape of a predetermined width, adjusting the tension of said metal tape, heat bonding said metal tape to a plastics tape having a larger width than that of said metal tape with both side edge portions of said plastics tape remaining exposed and with said exposed side edge portions of said plastics tape folded back over the edges of said metal tape, thus completing a composite tape, longitudinally forming said composite tape about a cable core to overlap the opposite side edges of said composite tape with said metal tape positioned inside and said plastics tape outside and with said folded back side edge portions of said plastics tape positioned between said overlapped side edges of said composite tape, extruding an



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outer sheath of plastics material about said formed composite tape, and cooling the resulting cable.

7. Any of the methods of manufacturing
5 an electric cable, substantially as herein described with reference to the accompanying drawings.

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