

Making an Electrical Tape Cable

This invention relates to making a tape cable, and more particularly to an apparatus for making an electrical tape cable by aligning a plurality of conductors in parallel and sandwiching the conductors between insulating plastic tapes bonded together to form an elongate body.

Electronic equipment is now provided with many functions and its size tends to be small. Consequently these devices, have a high packaging density, it therefore becomes impossible to use a conventional connector plug which requires sufficient space for wiring between each substrate. A popular solution is to use a thin flexible electrical tape cable having a portion of conductor exposed in a window. The window is prepared by laminating an insulating plastic film tape, having a square window, longitudinally on to both sides of a plurality of conductors arrayed in parallel so that each window of the film is positioned. The film is then bonded together to form an elongate body (Japanese Utility Model Application Laid-Open No.3-64424).

As shown in Figure 7, an electrical tape cable 25 used for such an application has a construction wherein conductors 1, are separated by a predetermined space, aligned and sandwiched between two sheets of insulating plastic tape 3, 4 to be bonded into a body. Each end of the conductors 1 at a window is stripped and laminated with a reinforcing tape 14 on one surface of the stripped portion

at the both ends of the window.

As shown in Figures 8 and Figure 9 it is known to use apparatus comprising a pair of iron rollers 20, 21 having an adjustable temperature for sandwiching and bonding the aligned conductors 1 between the two insulating plastic tapes 3, 4. The iron rollers 20, 21 perform three functions, i.e., positioning each conductor 1 between the two sheets of insulating plastic tape 3, 4, feeding the conductors 1 and tapes 3, 4 and pressing them together. To laminate the components (i.e., the conductors 1 and tapes 3,4) bonding adhesive is introduced between the tapes 3, 4. The excess adhesive is a problem because it is either expelled from the edges of the plastic tapes 3, 4 or trapped between the tapes 3, 4 where it produces undesirable wrinkles on the electrical tape cable or causes a change in the pitch of the conductors.

In order to solve these problems, an apparatus shown in Figure 10 has been used which consists of a pair of silicone rollers 29, 28. One roller is a driving roller and the other is a follower roller which is pushed towards the driving roller by an air cylinder. Laminating and driving of the tape are achieved by the surface friction of the roller and the tape in this apparatus.

The apparatus above has drawbacks as follows.

The rollers have to be rotating with their surfaces being deformed since the rollers 28 and 29 do not have enough space between them to transmit a sufficient driving force to the follower roller. silicone has a large thermal

expansion coefficient which causes a difference in diameter between the rollers when there is little difference between their temperatures. This results in changes of peripheral velocity at the surface of the roller which causes distortion or miss-positioning of the windows or weaving of the tape. A lack of uniformity of hardness of the roller surfaces can cause a shift of the center line of the cable on laminating. This results in the same condition as a change of diameter of a roller whereby a change in the peripheral velocity of the roller occurs.

Due to one side driving, the driving force transmitted to the follower roller decreases or increases depending upon the number of conductors or the strength of take-up and constant working conditions can not be obtained. During running of the insulating plastic tapes 3, 4, any unbalance between the tapes causes miss-positioning of the window or the occurrence of wrinkles.

Because a silicone roller has an inferior precision of its diameter (diametric dimensional stability) and the driving roller and the follower roller can not rotate at the same peripheral velocity, the follower delays (slips) constantly and back tension to the insulating plastic tape on the follower roller has to be applied by an air cylinder. A change in nip pressure due to variation of pressure of the air cylinder causes a change of running speed of the tape and an inadequate pressing force. With one side driving, driving force is transmitted by friction between the rollers. Therefore, a nip gap necessary for manufacturing

the electrical tape cable can not be obtained, therefore distortion or miss-positioning of the windows and wrinkles occurs.

The object of the present invention is to provide an apparatus for making electrical tape cable which alleviates at least some of the aforementioned disadvantages of the prior are.

Accordingly the present invention provides an apparatus for making an electrical tape cable by bonding an adhesive insulating plastic tape to each side of a plurality of conductors arrayed in parallel the insulating plastic tape having windows longitudinally on the tape with a predetermined interval comprising,

a pair of primary heat bonding rollers which temporarily bond said conductors with said plastic tapes and

a pair of secondary heat bonding rollers which permanently bond said temporarily bonded conductors to the plastics tapes.

According to the apparatus for making the electrical tape cable, the plastic tapes sandwiching a plurality of the conductors are bonded temporarily by the primary rollers and these temporarily bonded conductors and films are then bonded (permanently) by the secondary rollers

to get the adhesion necessary for the product. Therefore, the performance of the product can be improved without causing bad positioning of plastic tapes or wrinkles.

Embodiments of an apparatus and method for making a tape cable constructed in accordance with the present invention, will now be described, by way of example only, with reference to the accompanying drawing, in which:-

Figure 1 is a perspective view of an apparatus for making a tape cable,

Figure 2 is a side view of a portion of the apparatus of Figure 1,

Figure 3 is a side view of a second embodiment,

Figure 4 is a side view showing the operation of the apparatus of Figure 3.,

Figure 5 is a side view of a third embodiment,

Figure 6 is a side view showing the operation of the apparatus of Figure 5,

Referring to Figure 1 and 2, a tape-shaped elongate body of conductors 1 and plastic tapes 3 and 4 is formed by laminating adhesive insulating plastic tapes 3, 4 on each side of an array of a plurality of parallel coextending conductors 1, to obtain an electrical tape cable 25 (Figure 7). The apparatus for making the electrical tape cable is provided with a pair of primary bonding rollers 50, 60 for temporarily bonding the conductors 1, together with each plastic tape 3, 4 and a pair of secondary bonding rollers 48, 58 for tightly or permanently tight bonding these temporarily bonded conductors and tapes.

The primary rollers are placed with a predetermined space and arranged to keep a sufficient pressure to temporarily stick each plastic tape on to the conductors. The rollers typically consist of a metal roller having a thermal control function and are driven synchronously. The secondary rollers 48, 58 for tight fixing the temporarily-bonded conductors and tapes typically consist of a silicone roller having a thermal control function and are driven separately to perform take-up motion by surface friction between a roller and a tape together with fixed bonding.

Referring again to Figure 1, there are provided with window-forming devices represented by 8A, 8B, for forming a square window in each of the plastic tapes 4, 3 with a predetermined interval.

The window-forming devices 8A, 8B are so designed that they make windows 9, in the plastic tapes 3, 4 at a certain interval and are moved synchronously with the running speed of the plastic tapes 3, 4 by an AC servomotor. The plastic tapes 3, 4 with the window 9, at a predetermined interval are introduced to the primary bonding roller 50, 60. Parallel aligned conductors 1, are introduced between the primary rollers 50, 60. The plastic tapes 3, 4 are temporarily bonded to each side of the array of the conductors so that each window is fit in position with each other, thereby forming an elongate body. At that time the primary rollers are driven synchronously with the secondary rollers which function also as take-up rollers.

The elongate tape body 24 is fed to a supply of a reinforcing tape 14, where the reinforcing tape 14 has a size to cover the whole window and is placed on to the window 9 to which it is heat-bonded by a press heater 15 with a heat plate 15A, which functions as bonding means for the reinforcing tape. The press heater 15 with the heat plate 15A may be moved synchronously with the running speed of the plastic tape 3, 4 by an AC servo-motor. The window 9 may be sensed by a photo-sensor.

The conductors and the plastic tapes with reinforcing tape thus bonded temporarily are permanently bonded by the secondary bonding rollers 48, 58. The rotation speed of the secondary rollers 48, 58 is controlled so as to maintain a constant speed of the product.

Both edges of the elongate body having a heat-bonded reinforcing tape 14 are cut, as shown by Figure 1, to form a elongate tape body 27 without edges, which is then introduced to an end-cutter 40. The elongate tape body 27 is divided into two parts rectangular to its length whereby the electrical tape cable 25 (Figure 7) is prepared.

The primary roller of the apparatus, since it is made of metal, has a small thermal expansion coefficient and a change of its diameter is within an allowable range with regard to the precision of the size of the product even under the practical controlled temperature ($\pm 1^{\circ}\text{C}$). The temperature of the metal roller is easily controlled and distribution of the temperature in the roller can be uniform. Further, since the metal roller can be made

to have a good precision, it enables synchronous operation of both rollers 50, 60 and each roller to be driven separately. Since the metal roller has a good uniformity in its hardness, the center line of the tape body does not become eccentric and a change in the peripheral velocity does not occur. The high precision of the roller enables mechanical maintenance of a desired gap for temporary bonding, and a separate driving of the rollers enables a necessary nip (gap between the rollers) for the product.

Further, since there can be provided in the rollers 50, 60 with the space between the conductors for an adhesive material to flow into which is required for making the electrical tape cable, the occurrence of wrinkles on the tape or changes in the pitch can be avoided. In that case, adhesion strength may be insufficient but this is solved by tight laminating by the secondary rollers formed of a silicone roller. Thus desired performance of the product can be maintained.

Moreover, the secondary rollers 48, 58, because of being disposed next to the primary rollers 50, 60 in the apparatus, can also take up the product and the primary rollers 50, 60 are operated only for positioning and temporary bonding. Accordingly, the electrical tape cable can be prepared without any influence of numbers of the conductors or the strength of take-up.

The arrangement where the press heater 15 with the heat plate 15A is placed next to the primary rollers 50, 60 enables the reinforcing tape 14 to be bonded at a relatively

low temperature (approximately 80°C) and, together with tight fixing by the secondary rollers, enables a reduction in press cycle time and avoids the flow of adhesion materials out to the surface of the conductors.

The press heater 15 can be placed in a downstream position, next to the primary rollers 50, 60 or it may be placed in an upstream position next to the primary rollers. In the case, shown in Figure 3, a roller-shifting mechanism 5 for shifting the primary rollers 50, 60 with respect to the center line CL of the conductors so as to make a space S between the rollers when the reinforcing tape 14, is passing through the rollers and an accumulating mechanism 6 absorbing a change in running speed of the tape caused by the shift of the roller. The accumulating mechanism 6 comprises accumulating rollers 46, 56 and back-up rollers 44, 54. The accumulating rollers 46, 56 are placed backward and opposite to the primary rollers 50, 60 and the back-up rollers 44, 54 are placed backward and opposite to the accumulating rollers 46, 56, i.e., on the same side of the primary rollers 50, 60.

According to the apparatus for making the electrical tape cable, as shown by Figure 4, one of the primary rollers 50, 60 is shifted with respect to the center line CL by the shifting mechanism 5 so that the space between the rollers is formed when the reinforcing tape 14, is passing through the rollers 50, 60. The change of running speed of the tape caused by the shift of the roller is absorbed in the accumulating mechanism 6. Thus, even if

the thickness of the reinforcing tape 14 is added to the plastic tapes 3, 4 sandwiching a plurality of conductors, temporary bonding at the primary rollers can be accomplished and the change in the running speed of the tapes is absorbed.

Both the primary rollers and the secondary rollers may consist of silicone. In that case as shown by Figure 5, each of the primary rollers 50, 60 is provided with a function for controlling its temperature, is placed with a predetermined space so as to maintain a sufficient pressure required for temporary bonding of the conductors and the tapes, and is driven separately. The secondary rollers 48, 58 may also be silicone and have a thermal control function and be operated as take-up rollers.

According to this example, the plastic tapes 3, 4 sandwiching a plurality of the conductors 1, are bonded temporarily by the primary rollers 50, 60 and then further bonded permanently by the secondary rollers 48, 58 to obtain the bond strength required for the product performance. As shown in Figure 6, since the primary rollers 50, 60 are spaced a predetermined distance to maintain a desired pressure for bonding when the reinforcing tape 14, is passing through the rollers 50, 60 it makes sure the tapes are bonded and any change in the running speed of the tapes 3, 4 can be avoided.

In the case that both of the primary and the secondary rollers are silicone rollers, the space between the rollers is made by separately driving the rollers so

that deformation of the surface of the roller does not occur, thereby difference of the peripheral velocity of two rollers can be avoided. Since the secondary rollers 48, 58 function as take-up rollers, the primary rollers, which are driven separately, are controlled only to accomplish temporary bonding and a good positioning of the plastic tapes 3, 4. Therefore, it is possible to prepare the electrical tape cable without influence of numbers of the conductors and the strength of take-up. By driving the primary rollers, 50, 60 separately, they can be driven synchronously without discrepancy between the two rollers.

Further, since the primary rollers can be recessed upon passing through the reinforcing tape 14, change of a thickness of the tapes does not cause wrinkles on the tapes.



Claims

1. An apparatus for making an electrical tape cable by bonding an adhesive insulating plastic tape to each side of a plurality of conductors arrayed in parallel the insulating plastic tape having windows longitudinally on the tape with a predetermined interval comprising,
a pair of primary heat bonding rollers which temporarily bond said conductors with said plastic tapes and
a pair of secondary heat bonding rollers which permanently bond said temporarily bonded conductors to the plastics tapes.
2. Apparatus according to claim 1 comprising means for applying a reinforcing tape to one of the plastic tapes.
3. Apparatus according to claim 1 or claim 2 wherein said primary bonding rollers are made of metal.
4. Apparatus according to claim 3 comprising means for shifting said primary rollers.
5. Apparatus according to any preceding claim wherein said secondary bonding rollers are made of silicone.
6. Apparatus according to any of claim 1, 2 or 4 wherein said primary rollers and said secondary rollers are made of silicone.



7. Apparatus according to any preceding claim wherein said primary rollers are placed with a predetermined space there between.

8. Apparatus according to any one of claims 2 to 7 wherein said means for supplying a reinforcing tape is positioned upstream of said primary rollers.

9. Apparatus according to any one of claims 1 to 7 wherein said means for supplying a reinforcing tape is positioned downstream of the rollers.

10. Apparatus for making an electrical tape conductor as herein described with reference to the accompanying figures 1 to 6.