

Description

The present invention relates to laminated insulation papers and to method of manufacturing the same.

In Fig. 1A of the accompanying drawings there is shown a conventional laminated insulation paper 30, usable as a low-loss insulation paper for an electric power cable, which paper is integrally formed of two cellulose papers 10 and 12 and a film-like plastics sheet 20 sandwiched therebetween. An insulating oil is infiltrated between the sheets for improved electrical insulation.

In the cable insulation assembly using the laminated insulation paper 30 thus constructed, oil flow resistance in the circumferential direction is undesirably very large.

Under these circumstances, it has been proposed to provide through holes 22 in the plastic sheet 20 as shown in Fig. 1B. An example of such a construction is disclosed in British Patent 1,057,744. In the cable insulation assembly using a tape with the above through holes thus constructed, the through holes 22 undesirably form oil gaps, where the gap length d in the electric field direction is equal to the thickness of the plastics sheet 20, thereby causing electrical defects.

Further, the conventional laminated insulation paper 30 having the plastics sheet 20 with the through holes 22 has been made in a manner such that, at first, through holes 22 are provided in the plastics sheet 20 as shown in Fig. 1C; cellulose papers 10 and 12 are then laminated on the front back surfaces respectively of the plastics sheet 20, and are then passed between a pair of heat rollers 40 and 42 to thereby integrally form the three layers.

In such a case, however, the plastics sheet 20 is heated by the heat rollers up to near its melting point and is pressed by the heat rollers, and therefore the through holes 22 have been apt to be crushed.

An object of the present invention is to provide laminated insulation paper having a plastics portion with through holes and a method of making the same, the laminated insulation paper having low oil flow resistance, and few electrical defects without through holes in the plastics portion being crushed.

According to one aspect of the invention there is provided a laminated insulation paper, comprising an integral construction of two sheets of cellulose paper and a film-like plastics sheet sandwiched therebetween, through holes being provided in said plastics sheet, characterized in that at least one of said two sheets of cellulose paper is pressed into said through holes to fill said through holes, and in that said two sheets of cellulose paper are in close contact with each other by way of said through holes.

According to another aspect of the invention there is provided a method of making a laminated insulation paper including a plastics portion formed with through holes, characterized by

pressing a heated element such as a pin against at least one of two sheets of cellulose paper composing said laminated insulation paper, which paper is integrally formed of said two sheets of cellulose paper and a film-like plastics sheet sandwiched therebetween, and heating and melting said plastics sheet through said cellulose paper to form through holes in said plastics sheet at a portion corresponding to the position of said pin.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1A is a cross-sectional view for explaining a conventional laminated insulation paper;

Fig. 1B is a similar view of a laminated insulation paper having a plastics sheet with through holes;

Fig. 1C is a view illustrating a conventional method of making a laminated insulation paper;

Fig. 2 is a view for explaining the construction of one embodiment of the present invention;

Fig. 3 is a schematic view showing a cable insulation assembly according to the invention;

Figs. 4, 5, 6 and 7 are views illustrating steps in the construction of an embodiment of the present invention;

Fig. 8 is a view showing another method of making a laminated insulation paper according to the present invention;

Figs. 9 and 10 are views of an embodiment of an apparatus of use in the present invention;

Fig. 11 is an enlarged view of features appearing in Fig. 10;

Figs. 12, 13 and 15 are views of different apparatuses of use in the present invention; and

Fig. 14 illustrates a method of heating a heated roller.

Referring now to Fig. 2 of the accompanying drawings, an embodiment of the present invention will be hereinafter explained. In Fig. 2, the laminated insulation paper 30 is characterized in that:

(1) There are provided through holes 24 in the plastics sheet 20;

(2) The through holes 24 are blocked by at least one of the two cellulose papers 10 and 12; and

(3) The two cellulose papers are in close contact through the holes 24.

Fig. 3 shows an example of a cable insulation layer made by winding the laminated insulation paper 30 thus constructed.

As mentioned above, the through holes 24 per se are filled by the cellulose papers 10 and 12, and therefore no oil gap is formed. However, oil gaps 26 are formed at recessed portions 28 of the papers 10 and 12. The length D in the electric field direction is half of the thickness of the plastics sheet 20, and therefore is half of the length of the oil gaps due to the through holes shown in Fig. 1B. This achieves a similar effect as where the length of the insulation oil gaps in the electric field direction produced at a contact portion when a thin tape is wound are made small, to thereby reduce the electrical defect.

Referring to the construction of this embodi-



ment of the invention, the method of making the laminated insulation paper is characterized by the following steps:

(1) Firstly, a laminated insulation paper 30 is provided which is integrally formed with two cellulose papers 10 and 12 and a film-like plastics sheet 20 therebetween, as shown in Fig. 4.

(2) A heated element such as a cylindrical pin 44, the end point of which is rounded, is pressed onto at least one of the cellulose papers 10 and 12 to produce a recess in and to heat and melt a portion of the plastics sheet 20 through the cellulose paper 10, as shown in Fig. 5.

(3) The pin 44 is further depressed to the extent that the cellulose paper 10 contacts the opposite cellulose paper 12 as shown in Fig. 6, and is then stopped and pulled from the cellulose paper 10 as shown in Fig. 7.

Thus, the melted plastics sheet 20 is pressed and the plastics material displaced and the heated pin 44 then removed to thereby form a through hole in the plastics sheet 20. In the through holes of the plastics sheet 20 the cellulose papers are closely contacted with each other. Insulating oil can flow into the laminated insulation paper 30 through the contacted portion of the cellulose papers.

Fig. 7 shows the state of the laminated insulation paper in which the cellulose paper 12, as well as the cellulose paper 10, has risen upwardly by the resiliency of the cellulose paper 10 itself after the pin 44 is removed from the upper paper.

In Figs. 5 to 7, numeral 46 designates a supporting base for the laminated insulation paper 30. It is preferable for the operation of providing the through holes to maintain the supporting base at a predetermined temperature slightly lower than that of the melting temperature of the plastics sheet 20.

Further, it may be preferable to press the laminated insulation paper simultaneously with an upper heated pin 44 and a lower heated pin 48, as shown in Fig. 8, for example.

Referring to Figs. 9 and 10, an embodiment of an apparatus for providing the through holes will be explained. Heated rollers 50 and 54 having the same diameter are uniformly rotated by an electric motor 58 and a well-known chain drive mechanism 60. The heated roller 50 has a plurality of pins 52 corresponding to the pin 44 mentioned above. The pins 52 have dimensions of about 0.8 mm in diameter, about 0.5 mm in length and a cylindrical formation. The outer surface 520 of the pin 52 is formed in such a manner that it is composed of a portion of an outer surface 522 of a cylindrical body coaxial to the heated roller 50. The temperature of the heated roller 50 is maintained at a predetermined temperature slightly higher than the melting temperature of the plastics sheet 20, and the temperature of the heated roller 54 is maintained at a predetermined temperature slightly lower than the melting temperature thereof. Numeral 62 designates a pinch roller.

When the synthetic insulation paper 30 shown

in Fig. 4 is passed through the heated rollers 50 and 54, the through holes mentioned above are provided in the plastics sheet 20 by the pins 52.

In Fig. 12, a driving roller 64 is additionally provided, and the moving speed of the laminated insulation paper 30 between the driving roller 64 and the heated rollers 50 and 54 is made adjustable.

Referring to Fig. 13, an alternative embodiment is illustrated, wherein a preheating device 66 is preferably provided for the laminated insulation paper 30.

Fig. 14 shows a method of heating the heated rollers 50 or 54. In particular, the heated rollers are composed of a heat pipe. Namely, a space 504 is provided between the outer wall 500 and an axle 502 and a composition such as one of diphenyl and diphenyl oxide is enclosed in the space 504 as a heat medium. Numeral 506 designates fins, and the pins 52 are formed at positions corresponding to the fins 506, respectively. The inner surface of the axle 502 is provided with an oxide layer. Numerals 508 designate bearings and 510 designates a heater such as a sheath heater or an induction heater.

Thus constructed, the axle 502 is heated by the heater 510 to thereby heat the outer wall 500 due to the operation of the heat pipe. According to the above configuration, the temperature distribution in the longitudinal direction on the outer surface of the heated roller 50 becomes uniform, and as a result the provision of holes in the plastics sheet 20 with uniform dimensions can be achieved.

Fig. 15 shows an example utilizing heat plates 70 and 74 with numeral 72 designating pins. In this case, the laminated insulation paper 30 is intermittently moved, and is pressed by the pins 72 during the stationary state of the same. The other operations of this example are the same as that of the embodiment described above.

As stated above, by use of the invention, an effect of reduced oil flow resistance in the radial direction can be obtained without increased electrical defects in an electric cable.

Further, according to the invention, a laminated insulation paper having a plastics portion formed with through holes can be made without introducing problems such as the filling of the through holes by the plastics sheet itself.

Claims

1. A laminated insulation paper, comprising an integral construction of two sheets (10, 12) of cellulose paper and a film-like plastics sheet (20) sandwiched therebetween, through holes (27) being provided in said plastics sheet, characterized in that at least one of said two sheets (10, 12) of cellulose paper is pressed into said through holes (24) to fill said through holes, and in that said two sheets of cellulose paper are in close contact with each other by way of said through holes (24).

2. A laminated insulation paper as claimed in claim 1, characterized in that through holes (24)

ment of the invention, the method of making the laminated insulation paper is characterized by the following steps:

(1) Firstly, a laminated insulation paper 30 is provided which is integrally formed with two cellulose papers 10 and 12 and a film-like plastics sheet 20 therebetween, as shown in Fig. 4.

(2) A heated element such as a cylindrical pin 44, the end point of which is rounded, is pressed onto at least one of the cellulose papers 10 and 12 to produce a recess in and to heat and melt a portion of the plastics sheet 20 through the cellulose paper 10, as shown in Fig. 5.

(3) The pin 44 is further depressed to the extent that the cellulose paper 10 contacts the opposite cellulose paper 12 as shown in Fig. 6, and is then stopped and pulled from the cellulose paper 10 as shown in Fig. 7.

Thus, the melted plastics sheet 20 is pressed and the plastics material displaced and the heated pin 44 then removed to thereby form a through hole in the plastics sheet 20. In the through holes of the plastics sheet 20 the cellulose papers are closely contacted with each other. Insulating oil can flow into the laminated insulation paper 30 through the contacted portion of the cellulose papers.

Fig. 7 shows the state of the laminated insulation paper in which the cellulose paper 12, as well as the cellulose paper 10, has risen upwardly by the resiliency of the cellulose paper 10 itself after the pin 44 is removed from the upper paper.

In Figs. 5 to 7, numeral 46 designates a supporting base for the laminated insulation paper 30. It is preferable for the operation of providing the through holes to maintain the supporting base at a predetermined temperature slightly lower than that of the melting temperature of the plastics sheet 20.

Further, it may be preferable to press the laminated insulation paper simultaneously with an upper heated pin 44 and a lower heated pin 48, as shown in Fig. 8, for example.

Referring to Figs. 9 and 10, an embodiment of an apparatus for providing the through holes will be explained. Heated rollers 50 and 54 having the same diameter are uniformly rotated by an electric motor 58 and a well-known chain drive mechanism 60. The heated roller 50 has a plurality of pins 52 corresponding to the pin 44 mentioned above. The pins 52 have dimensions of about 0.8 mm in diameter, about 0.5 mm in length and a cylindrical formation. The outer surface 520 of the pin 52 is formed in such a manner that it is composed of a portion of an outer surface 522 of a cylindrical body coaxial to the heated roller 50. The temperature of the heated roller 50 is maintained at a predetermined temperature slightly higher than the melting temperature of the plastics sheet 20, and the temperature of the heated roller 54 is maintained at a predetermined temperature slightly lower than the melting temperature thereof. Numeral 62 designates a pinch roller.

When the synthetic insulation paper 30 shown

in Fig. 4 is passed through the heated rollers 50 and 54, the through holes mentioned above are provided in the plastics sheet 20 by the pins 52.

In Fig. 12, a driving roller 64 is additionally provided, and the moving speed of the laminated insulation paper 30 between the driving roller 64 and the heated rollers 50 and 54 is made adjustable.

Referring to Fig. 13, an alternative embodiment is illustrated, wherein a preheating device 66 is preferably provided for the laminated insulation paper 30.

Fig. 14 shows a method of heating the heated rollers 50 or 54. In particular, the heated rollers are composed of a heat pipe. Namely, a space 504 is provided between the outer wall 500 and an axle 502 and a composition such as one of diphenyl and diphenyl oxide is enclosed in the space 504 as a heat medium. Numeral 506 designates fins, and the pins 52 are formed at positions corresponding to the fins 506, respectively. The inner surface of the axle 502 is provided with an oxide layer. Numerals 508 designate bearings and 510 designates a heater such as a sheath heater or an induction heater.

Thus constructed, the axle 502 is heated by the heater 510 to thereby heat the outer wall 500 due to the operation of the heat pipe. According to the above configuration, the temperature distribution in the longitudinal direction on the outer surface of the heated roller 50 becomes uniform, and as a result the provision of holes in the plastics sheet 20 with uniform dimensions can be achieved.

Fig. 15 shows an example utilizing heat plates 70 and 74 with numeral 72 designating pins. In this case, the laminated insulation paper 30 is intermittently moved, and is pressed by the pins 72 during the stationary state of the same. The other operations of this example are the same as that of the embodiment described above.

As stated above, by use of the invention, an effect of reduced oil flow resistance in the radial direction can be obtained without increased electrical defects in an electric cable.

Further, according to the invention, a laminated insulation paper having a plastics portion formed with through holes can be made without introducing problems such as the filling of the through holes by the plastics sheet itself.

Claims

1. A laminated insulation paper, comprising an integral construction of two sheets (10, 12) of cellulose paper and a film-like plastics sheet (20) sandwiched therebetween, through holes (27) being provided in said plastics sheet, characterized in that at least one of said two sheets (10, 12) of cellulose paper is pressed into said through holes (24) to fill said through holes, and in that said two sheets of cellulose paper are in close contact with each other by way of said through holes (24).

2. A laminated insulation paper as claimed in claim 1, characterized in that through holes (24)



are formed only in said plastics sheet (20), indentations (26) being provided on at least one of said cellulose paper sheets (10, 12) in correspondence with said through holes (24) whereby inner surfaces of said two cellulose paper sheets (10, 12) are in contact with one another.

3. A method of making a laminated insulation paper including a plastics portion (20) formed with through holes (24), characterized by pressing a heated element such as a pin (44) against at least one of two sheets (10, 12) of cellulose paper composing said laminated insulation paper (30), which paper is integrally formed of said two sheets (10, 12) of cellulose paper and a film-like plastics sheet (20) sandwiched therebetween, and heating and melting said plastics sheet through said cellulose paper to form through holes (24) in said plastics sheet at a portion corresponding to the position of said pin.

4. A method as claimed in claim 3, characterized in that at least one (10) of said cellulose sheets (10, 12) is pressed by said element (44) until a portion thereof beneath said element contacts the other said cellulose sheet (12).

5. A method as claimed in claim 3 or 4, characterized by preheating said synthetic insulation paper (30) prior to said pressing.

6. A method as claimed in any one of claims 3 to 5, characterized by backing said laminated insulation paper during said pressing.

7. A method as claimed in claim 6, characterized in that the temperature of said backing is maintained below the melting temperature of said plastic sheet.

8. A method as claimed in any one of claims 3 to 7, characterized by simultaneously pressing a plurality of said heated element (40) against one (10) of said sheets.

9. A method as claimed in claim 8, when dependent on claim 5 or 7, characterized in that said elements (40) are supported on a plate (70), and said synthetic insulation paper being supported on a heated plate (74).

10. A method as claimed in claim 8, characterized in that said elements (40) are rounded and disposed on a rotatable roll (50).

11. A method as claimed in claim 10, characterized in that said rotatable roll (50) comprises a heat pipe for uniformly transmitting heat to said plurality of elements (52).

12. A method as claimed in claim 8, 9, 10 or 11, characterized in that said elements are maintained at a temperature above the melting temperature of said plastics sheet.

13. A method as claimed in claim 10, 11 or 12, when dependent on claims 5 or 7, characterized by backing said synthetic insulation paper during said pressing with a heated backing roller (54).

14. A method as claimed in any one of claims 3 to 13, characterized by transporting said synthetic insulation paper away from a station where said pressing is carried out at a selectable speed.

Revendications

1. Papier stratifié isolant, comprenant une construction en une seule pièce de deux feuilles (10, 12) de papier cellulosique et d'une feuille de matière plastique analogue à un film (20) disposée entre elles, des trous débouchants (27) étant formés dans la feuille de matière plastique, caractérisé en ce que l'une des deux feuilles (10, 12) de papier cellulosique au moins est enfoncée dans les trous débouchants (24) afin que ceux-ci soient remplis, et en ce que les deux feuilles de papier cellulosique sont en contact intime l'une avec l'autre par l'intermédiaire des trous débouchants (24).

2. Papier stratifié isolant selon la revendication 1, caractérisé en ce que des trous débouchants (24) sont formés uniquement dans la feuille de matière plastique (20), des creux (26) étant formés sur l'une au moins des feuilles de papier cellulosique (10, 12) dans les positions correspondant à celles des trous débouchants (24), si bien que les faces internes des deux feuilles de papier cellulosique (10, 12) sont en contact mutuel.

3. Procédé de fabrication d'un papier stratifié isolant, comprenant une partie (20) de matière plastique formée avec des trous débouchants (24), caractérisé par l'enfoncement d'un élément chauffé tel qu'une tige (44) contre l'une au moins de deux feuilles (10, 12) de papier cellulosique composant le papier stratifié isolant (30), ce papier étant formé en une seule pièce de deux feuilles (10, 12) de papier cellulosique et d'une feuille de matière plastique analogue à un film (20) placée entre elles, et par chauffage et fusion de la feuille de matière plastique à travers le papier cellulosique afin que des trous débouchants (24) soient formés dans la feuille de matière plastique dans une partie qui correspond à la position de la tige.

4. Procédé selon la revendication 3, caractérisé en ce que l'une au moins (10) des feuilles celluloses (10, 12) est enfoncée par ledit élément (44) jusqu'à ce qu'une partie de celle-ci qui est sous l'élément soit au contact de l'autre feuille cellulosique (12).

5. Procédé selon l'une des revendications 3 et 4, caractérisé par le préchauffage du papier isolant synthétique (30) avant ledit enfoncement.

6. Procédé selon l'une quelconque des revendications 3 à 5, caractérisé par l'appui du papier stratifié isolant pendant l'enfoncement.

7. Procédé selon la revendication 6, caractérisé en ce que la température de l'organe d'appui est maintenue au-dessous de la température de fusion de la feuille de matière plastique.

8. Procédé selon l'une quelconque des revendications 3 à 7, caractérisé par l'enfoncement simultané de plusieurs éléments chauffés (40) contre l'une (10) desdites feuilles.

9. Procédé selon la revendication 8, dépendant de l'une des revendications 5 et 7, caractérisé en



ce que lesdits éléments (40) sont supportés par une plaque (70), et le papier synthétique isolant est supporté sur une plaque chauffée (74).

10. Procédé selon la revendication 8, caractérisé en ce que lesdits éléments (40) sont arrondis et sont disposés sur un rouleau rotatif (50).

11. Procédé selon la revendication 10, caractérisé en ce que le rouleau rotatif (50) est un caloduc destiné à transmettre uniformément la chaleur aux éléments (52).

12. Procédé selon l'une quelconque des revendications 8 à 11, caractérisé en ce que lesdits éléments sont maintenus à une température supérieure à la température de fusion de la feuille de matière plastique.

13. Procédé selon l'une quelconque des revendications 10 à 12, dépendant de l'une des revendications 5 et 7, caractérisé par l'appui du papier synthétique isolant pendant l'enfoncement, à l'aide d'un rouleau chauffé d'appui (54).

14. Procédé selon l'une quelconque des revendications 3 à 13, caractérisé par le transport du papier synthétique isolant à distance d'un poste auquel est réalisé ledit enfoncement, à une vitesse qui peut être choisie.

Patentansprüche

1. Laminiertes Isolierpapier mit einem integrierten Aufbau von zwei Blättern (10, 12) aus Cellulosepapier und einem filmähnlichen Kunststoffblatt (20), welches sich dazwischen befindet, wobei sich in dem Kunststoffblatt Durchgangslöcher (22) befinden, dadurch gekennzeichnet, daß zumindest eines der genannten beiden Blätter (10, 12) aus Cellulosepapier in die genannten Durchgangslöcher (24) gedrückt ist, um die Durchgangslöcher zu füllen und daß die beiden Blätter aus Cellulosepapier mittels der gefüllten Durchgangslöcher (24) in enger Berührung miteinander stehen.

2. Mehrschichtiges Isolierpapier nach Anspruch 1, dadurch gekennzeichnet, daß die Durchgangslöcher (22) nur in dem Kunststoffblatt (20) ausgebildet sind, daß Ausnehmungen (26) auf zumindest einem der Cellulosepapierblätter (10, 12) in Übereinstimmung mit den gefüllten Durchgangslöchern (24) vorgesehen sind, wodurch die Innenflächen der beiden Cellulosepapierblätter (10, 12) in enger Berührung miteinander stehen.

3. Verfahren zum Herstellen eines mehrschichtigen Isolierpapiers, umfassend einen Kunststoffabschnitt (20), welcher mit Durchgangslöchern (22) versehen ist, gekennzeichnet durch Drücken eines erwärmten Elementes, wie einen Stift (24) gegen zumindest eines der beiden Blätter (10, 12) aus Cellulosepapier, aus dem sich das mehrschichtige Isolierpapier (30) zusammensetzt,

welches Papier integral aus den genannten beiden Blättern (10, 12) aus Cellulosepapier und einem dazwischen befindlichen filmähnlichen Kunststoffblatt (20) gebildet ist, Erwärmen und Schmelzen des Kunststoffblattes durch das genannte Cellulosepapier, um die Durchgangslöcher in dem Kunststoffblatt an einer Stelle auszubilden, die der Lage des genannten Stiftes entspricht.

4. Verfahren nach Anspruch 3, dadurch gekennzeichnet, daß zumindest eines (10) der genannten Celluloseblätter (10, 12) durch das genannte Element (44) gedrückt wird, bis ein Teil desselben unterhalb des genannten Elementes das andere Celluloseblatt (12) berührt.

5. Verfahren nach Anspruch 3 oder 4, gekennzeichnet durch Vorwärmen des synthetischen Isolierpapiers (30) vor dem genannten Pressen.

6. Verfahren nach einem der Ansprüche 3 bis 5, gekennzeichnet durch Unterstützen des mehrschichtigen Isolierpapiers während des Pressens.

7. Verfahren nach Anspruch 6, dadurch gekennzeichnet, daß die Temperatur der Unterstützung unterhalb der Schmelztemperatur des Kunststoffblattes gehalten wird.

8. Verfahren nach einem der Ansprüche 3 bis 7, gekennzeichnet durch gleichzeitiges Pressen einer Vielzahl von erwärmten Elementen (40) gegen eines (10) der genannten Blätter.

9. Verfahren nach Anspruch 8, wenn abhängig von 5 oder 7, dadurch gekennzeichnet, daß die genannten Elemente (40) auf einer Platte (70) abgestützt werden, und daß das genannte synthetische Isolierpapier auf einer beheizten Platte (74) abgestützt wird.

10. Verfahren nach Anspruch 8, dadurch gekennzeichnet, daß die genannten Elemente (40) abgerundet sind und sich auf einer drehbaren Rolle (50) befinden.

11. Verfahren nach Anspruch 10, dadurch gekennzeichnet, daß die drehbare Rolle (50) ein Heizrohr zum gleichförmigen Übertragen von Wärme zu der Vielzahl von Elementen (52) umfaßt.

12. Verfahren nach Anspruch 8, 9, 10 oder 11, dadurch gekennzeichnet, daß die genannten Elemente auf einer Temperatur gehalten werden, die oberhalb der Schmelztemperatur des genannten Kunststoffblattes liegt.

13. Verfahren nach Anspruch 10, 11 oder 12, wenn abhängig von den Ansprüchen 5 oder 7, gekennzeichnet durch Unterstützen des synthetischen Isolierpapiers während des Pressens mit einer beheizten Unterstützrolle (54).

14. Verfahren nach einem der Ansprüche 3 bis 13, gekennzeichnet durch Transportieren des genannten synthetischen Isolierpapiers weg von einer Station, in der das Pressen mit einer ausgewählten Geschwindigkeit durchgeführt wird.

