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(54) Method of insulating an elongated conductor comprised of high-temperature-superconductive, substantially ceramic material and an apparatus for the implementation of the method

(57) A method of insulating an elongated conductor comprised of high-temperature-superconductive, substantially ceramic material having a rectangular cross section with substantially flat main surfaces and adjoining lateral surfaces.

The method comprises the steps of providing a film strip provided at one side with a previously applied adhesive layer bonding under pressure at room temperature, bonding to the adhesive layer a main surface of the conductor to a central portion of the film strip parallel to its longitudinal direction, folding over the portions of the film strip at both sides of the conductor (to form an angle of substantially 90 degrees) and applying the adhesive layer bonded to the film strip to the lateral surfaces of the conductor, and successively again folding the portions of the film strip at both sides of the conductor (to form an angle of substantially 90 degrees), and applying the adhesive layer bonded to the film strip to the other main surface of the conductor. While the method is being carried out, bending forces, pressure forces and tensile stresses exerted on the conductor are outside the range of values that have a negative effect on the superconductive properties of the conductor material and that the adhesive is of a type that adheres both to the film strip and to the conductor at the temperature of superconduction without having a negative effect on the superconductive properties of the conductor material.

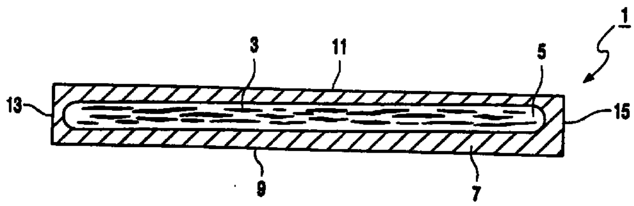

FIG. 1

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Description

[0001] The invention generally relates to a method of insulating an elongated conductor comprised of high-temperature-superconductive, substantially ceramic material and having, at least by approximation, a rectangular cross section with substantially flat main surfaces and adjoining lateral surfaces, comprising the application of an insulating strip around the elongated conductor, and to an apparatus for the implementation of said method.

[0002] A method of the above-mentioned kind is described, for example, in the article "Evaluation of a strengthening and insulation system for high temperature BSCCO-2223 superconducting tape" by C. King, K. Herd, T. Laskaris, A. Mantone, published in Advances in Cryogenic Engineering, Volume 42, published by Plenum Press, New York, 1996. The method described in this article comprises the insulation of a BSCCO-2223 conductor with the aid of an insulating paper such as was previously used with conductors comprised of Nb_3Sn which are superconductive at low temperatures. In the present specification "low temperature" is understood to be the temperature of liquid helium or lower, and "high temperature" is understood to be the temperature of liquid nitrogen, that is to say a temperature of approximately 70° Kelvin or higher.

[0003] Superconductors for superconducting at high temperatures are known to suitably consist of ceramic superconductive fibres incorporated in a matrix of, for example, silver. Such conductors are very brittle and have to be treated with the necessary care as the superconducting properties may easily be affected, which means that the conductor has to exhibit electrical resistance at the temperature at which it is supposed to be superconductive. The object of the invention is an improved method compared with the one mentioned in the preamble, providing excellent insulation of the superconductor without affecting the superconductive properties, and is characterized in that the method comprises the steps of providing a film strip of a width equal to or greater than the cross sectional circumference of the conductor, and which is provided at one side with a previously applied adhesive layer adhering under pressure at room temperature, in that the method further comprises the following steps to be carried out at room temperature: bonding to the adhesive layer a main surface of the conductor to a central portion of the film strip parallel to its longitudinal direction, folding over the portions of the film strip at both sides of the conductor to form an angle of substantially 90 degrees, and applying the adhesive layer bonded to the film strip to the lateral surfaces of the conductor and then successively again folding the portions of the film strip at both sides of the conductor to form an angle of substantially 90 degrees, and applying the film strip bonded to the adhesive layer to the other main surface of the conductor, that while the method is being carried out, bending forces, pressure forces and tensile stresses exerted on the conductor are outside the range of values that have a negative effect on the superconductive properties of the conductor material and that the adhesive is of a type that adheres both to the film strip and to the conductor at the temperature of superconduction without having a negative effect on the superconductive properties of the conductor material.

[0004] In the method according to the invention it is for the first time that a film strip is used for the insulation of a conductor comprised of high temperature-super conducting material comprising an adhesive that bonds under pressure at room temperature. This results in a simplification of the method and has been shown to be able to produce a product posessing the desired qualities. One of the advantages is that the entire method can take place at room temperature, thereby preventing degradation of the conductor material caused by the influence of temperature. Furthermore, by employing the method according to the invention the conductor is treated with great care to avoid any undesirable mechanical stresses in the conductor, which could also be the source of negative effects on the superconductive properties.

[0005] A preferred embodiment of the method according to the invention is characterized in that the conductor material of the superconductive conductor comprises fibres chosen from BSCCO-2223, BSCCO-2212, layers of YBCO, in a silver-containing matrix or another conducting or non-conducting matrix, in that while the method is being implemented, the stresses exerted on the conductor in the longitudinal direction range from 0 to 10 N/mm^2, and in that while the method is being implemented, surface pressures exerted on the conductor range from 1 to 15 N/mm^2.

[0006] Nowadays, conductors of the type used in this embodiment of the invention can be produced commercially in lengths of several hundred metres and are available (specifying the type "Multifilamentary Bi-2223-tape") from, for example, VAC Vacuumschmelze GmbH, a German company having an office in Hanau. Experiments have shown that keeping within the ranges indicated with regard to stresses and surface pressures will guarantee that the superconductive properties will not be negatively affected while the conductor is being insulated. Another preferred embodiment of the invention is characterized in that the film strip is chosen from a selection comprising: polyimide, polyester. It has been shown that films chosen from this selection are suitable to be used at the temperature of superconduction without having a negative effect on the superconductive properties of the conductor. Other kinds of film are probably also usable although applicants have not tested this.

[0007] Another preferred embodiment of the invention is characterized in that the material of the adhesive layer is chosen from the selection comprising: adhesives on an acryl base, adhesives on a silicon base, adhesive on a siloxane base. Adhesives according to this selection have been used within the framework of the invention and appear to meet the most important requirements, namely that even at the temperature of superconduction, the adhesive will retain a sufficient degree of its bonding power and further, that it will have no negative effect on the superconductive properties of the conductor.

[0008] An interesting embodiment of the invention is characterized in that on its reverse side the film strip is provided with a microroughening in the range of 0.1 to 5μ and that the adhesive layer of the film strip is provided with a removable strip to be removed from the adhesive layer before the same is brought into contact with the conductor. The use of this embodiment provides an insulated superconductor whose windings, when the conductor is wound on a product reel, will have little tendency to adhere to one another, allowing the conductor to be wound off the product reel without undesirable stress in the conductor material, which could diminish the superconductive properties.

[0009] A following embodiment of the method according to the invention is characterized in that the reverse side of the film strip is previously provided with a strip of fibre material, preferably glass fibre material. By this method an insulated superconductor is obtained provided with a strip of fibre material bonded with the film strip, which facilitates the production of reels that are impregnated with an impregnating agent such as epoxy resin. Suitable material to be used in combination with such an impregnating agent is fibre material, in particular glass fibre material. The advantage with this embodiment is that the strip of fibre material is previously bonded with the film strip. This avoids the fibre material having to be bonded with the film strip at a later stage, which could put a stress on the conductor and detract from the properties of the superconductive material.

[0010] A further embodiment of the method that proved to be convenient in practice is characterized in that the film strip has a thickness in the order of 20 to 25 microns, and that the adhesives layer has a thickness in the order of 35 microns.

[0011] The method according to the invention preferably possesses the following characteristics: The uninsulated conductor is wound off a conductor supply reel and the insulated conductor is wound onto a product supply reel that is located at some distance from the conductor supply reel in such a manner that the conductor's direction of curvature on the product supply reel corresponds with the direction of curvature on the conductor supply reel, in that the film strip is unwound from a film supply reel onto which the film strip with the adhesives layer is wound, in that between the conductor supply reel and the product supply reel the conductor is fed through an insulation section, where the conductor that is wound off the conductor supply reel and the film strip that is wound off the film supply reel are brought together and, in that in the insulation section the film strip is pressed to the main surfaces and the lateral surfaces of the conductor at both sides of the main surfaces and the lateral surfaces between press-on elements which are positioned opposite one another comprising elements from the selection: rollers, belts, shoes, combinations thereof, in that the transport of the conductor between the conductor supply reel and the product supply reel occurs exclusively in a condition that leaves the superconductive properties of the conductor unimpaired, such as in the straight condition and/or in a curved condition that corresponds with the direction of curvature of the conductor on the conductor supply reel and the product supply reel, and in that the said transport of the conductor takes place under automatic control to ensure that the stresses in the conductor stay within the range mentioned in claim 2. In this connection, another method is of importance, characterized in that prior to insulation, the conductor is wound off a conductor supply reel and after insulation is wound onto a product supply reel, and in that the diameter of the smallest winding of the conductor on the conductor supply reel and on the product supply reel is minimally 200 mm. This allows the conductor to be wound and unwound while avoiding unacceptable bending stresses.

[0012] It has been shown that this method of insulation of the conductor provides a product that can be fabricated economically while maintaining the required superconductive properties.

[0013] The invention also relates to an apparatus, especially for the implementation of the method according to the last-mentioned preferred embodiment of the invention, characterized in that electromotive driving units are present for the conductor supply reel, the product supply reel and the film supply reel, in that electrical control means are present for the control of the electromotive driving units such as to allow during said transport the stresses occurring in the longitudinal direction of the conductor to be maintained within the range mentioned in claim 2, and in that the surface pressure exerted by the press-on elements on the film strip in order to press the film strip to the band, will stay within the range mentioned in claim 2.

[0014] This apparatus may additionally be characterized in that the press-on elements comprise one or more transversely movable press-on elements that are rotatable about a rotation axis, having in the transverse direction flexibly loaded presser means which, within the range of the conductor's dimensions, will in any position generate a surface pressure within the range mentioned in claim 2.

[0015] The invention will now be described for the exclusive purpose of elucidating the illustration of a non-limitative exemplary embodiment, in which illustration:

Figure 1 shows a cross section of a typical conductor of the type Bi-2223, that is superconductive at high temperature,

Figure 2 schematically shows an apparatus for insulating a conductor of the type shown in Figure 1,

Figures 3A to 3D schematically show details of parts of the apparatus of Figure 2.

[0016] The method according to the invention will be discussed with reference to the Figures. Similar parts in the Figures will be indicated by identical reference numbers.

[0017] Figure 1 shows a cross section of a typical conductor 1 of the type for which the method according to the invention is exceptionally suitable. The conductor has, for example, a width of approximately 3.7 mm and a thickness of 0.25 mm. This type of conductors is brought on the market by, for example, VAC Vacuumschmelze GmbH, a German company established in Hanau. This firm sells, for example, high-temperature superconductors comprising approximately 55 superconductive fibres 3 comprised of ceramic material, for example, comprising $Bi_2Sr_2Ca_2Cu_3O_{10}$. The fibres are embedded in a matrix 5 made substantially of silver or made entirely or partially of a silver alloy comprising, for example, magnesium or gold. This assembly is housed in a casing 7 comprised of silver or one of the aforenamed alloys. The thus formed conductor possesses parallel main surfaces 10 and 11, and parallel lateral surfaces 13 and 15, arranged perpendicularly thereto. Usually, conductors of this type are available in lengths of less than 1000 metres, for example, 100 to 500 metres.

[0018] The conductor 1 is provided with insulation by applying an insulating strip 17. The strip consists of a film strip, preferably made of polyimide or polyester. A suitable strip of polyimide film is brought on the market carrying the type number 221 by Stokvis Tapes & Lijmen BV, having an establishment in Ridderkerk, the Netherlands. This firm also markets a strip of polyester film suitable for the invention carrying the type number P280. The film strip of the type P 221 is available with an adhesive layer made from a material on silicone base and the film strip of the type P 281 is available with an adhesive layer on an acryl base. Although the documentation from Stokvis Tapes & Lijmen BV does not describe the two above-mentioned strips of film as being suitable for use at a temperature of approximately 70° Kelvin, it was nevertheless surprisingly shown that strips of film of this kind are suitable for the invention and provide good insulation while when used correctly, will not detract from the superconductive properties of the conductor. The film strip 17 has a width of approximately 11 mm and a thickness of approximately 25 microns. Thus the width of the film strip is greater than the cross sectional circumference of the conductor 1. At one side the film strip is provided with a previously applied layer 19 of adhesive that bonds under pressure at room temperature. For the sake of clarity, the thickness of the conductor 1, the thickness of the film strip 17 and the thickness of the adhesive layer 19 are in the Figures 3A to 3D drawn oversized instead of to scale. The main surface 9 of the conductor 1 is placed on a middle portion of the film strip 17, parallel in its longitudinal direction. Then the portions of the film strip at both sides of the conductor 1 are folded over in a manner that will be discussed later, whereby the adhesive layer 19, is allowed to bond with the lateral surfaces 13 and 15 of the conductor. Then the portions of the film strip 17, at both sides of the conductor are again applied that an angle of 90° to the other main surface 11 of the conductor 1.

[0019] It is of the utmost importance to ensure that while the method according to the invention is being carried out, no bending forces, pressure forces or tensile stresses great enough to negatively affect the superconductive properties of the conductor material are exerted on the conductor 1, because the brittle fibres 3 of the ceramic BSC-CO-material could easily be damaged by mechanical stress with the result that superconduction through the respective fibres is no longer possible.

[0020] In this respect the adhesive used is also of great importance, because at the temperature of superconduction, the adhesive must not negatively affect the superconductive properties of the conductor material either, and must remain bonded with the conductor. If the latter is not the case, there is a possibility of air becoming trapped between the film strip and the conductor, and this could locally raise the temperature in the conductor to above the critical temperature of superconduction.

[0021] Figure 2 shows schematically and not on scale the principle of the apparatus for implementing a preferred embodiment suitable for the invention for the fabrication of an insulated high-temperature superconductor. The uninsulated conductor 1 is wound off a conductor supply reel 21, and the ready insulated conductor is wound onto a product supply reel 23, located at some distance from the conductor supply reel 21. This unwinding and winding occurs such as to ensure that with respect to the direction, the curvature that the conductor 1 is subjected to on the product supply reel 23, will in every situation correspond with the curvature that was already present on the conductor supply reel 21. Moreover, in the embodiment of the apparatus according to the invention and according to Figure 2, care is also taken to ensure that while the conductor is transported between the conductor supply reel 21 and the product supply reel 23, said conductor is never bent more than until it is straightened, optionally care can be taken that the conductor will remain curved in the direction corresponding with the curvature of the conductor on the two reels mentioned, during all stages of said transport through the apparatus from the conductor supply reel to the product supply reel. It is important that the conductor is transported in a condition such that the superconductive properties will not deteriorate.

[0022] The film strip is unwound from a film supply reel 25, on which the film strip with the adhesive layer is wound.

[0023] The conductor 1 is fed between the conductor supply reel 21, and the product supply reel 23 through an insulation section 27 where the conductor, unwinding from the conductor supply reel 21, and the film strip 17 unwinding from the film supply reel 25, come together. The insulation section 27 comprises the two rollers 29A and 29B (see Figure 3A) as well as the two rollers 31A and 31B (see Figure 3D). The insulation section further comprises a section portion 33 symbolically indicated as a rectangle with dash-dot lines, which will be discussed below.

[0024] In the insulation section 27, the film strip is pressed to the main surfaces 9 and 11, and to the lateral surfaces 13 and 15 of the conductor 1. With the apparatus according to the invention elucidated with reference to the Figures 2 and 3A to 3D, this is done with the aid of the rollers, but bands, shoes and combinations of rollers, bands and/or shoes may also be used. The rollers 29A,B and 31A,B rotate about rotation axes 35A,B and 37A,B, respectively. To this end the rollers 29A,B are bearing-mounted with the aid of on both sides laterally projecting journals 39A,B in suitable bearings, which are not shown in the drawing. In the same manner the rollers 31A,B are rotationally supported by bearings with the aid of the journals 41A,B.

[0025] Transport of the conductor 1 between the conductor supplier reel 21, and the product supply reel 23 controlled automatically, the control means being symbolically represented and comprising a control unit 43. The automatic control ensures that the stresses occurring in the conductor remain within the previously mentioned range, in order to prevent the deterioration of the superconductive properties of the conductor. In the exemplary embodiment shown, the control unit 43 is connected with electromotive drive units for the conductor supply reel 21, the product supply reel 23, and further with electromotive drive units for the rollers 29A,B, 31A,B and all other rollers present in the section portion 33. The electromotive drive units comprise electromotors 45 and 47, represented only schematically in Figure 2, which are connected with the conductor supply reel 21 and the product supply reel 23, respectively, to allow rotation about the respective rotation axes 49 and 51. Figure 2 further shows electromotors 53, 55, 57 and 59 to allow rotation about the respective rotation axes 35A, 37A, 35B and 37B. The motors are connected with the control unit 43 by means of signal leads 61, 63, 67, 69, 71 and 73, symbolically represented by dash-lines. The control unit is fed with a number of input signals 77 which represent the adjusted values of the torques to be carried out by the electromotors, as well as a number of symbolically indicated feed-back signals 79 from sensors (not shown in the drawing) measuring the various stresses in the conductor 1 within the section from the conductor supply reel 21 to the product supply reel 23, or of parameters directly related thereto. Instead of electromotors, it is in principle also possible to employ other motors such as, for example, hydraulic or pneumatic motors.

[0026] The film supply reel 25 also is driven with the aid of an electromotor 81. This is connected with the film supply reel 25 for the rotation of the film supply reel about a rotation axis 83. From the film supply reel, the film strip 17 progresses via a diversion roll 85 to the pressure zone between the rollers 29A and 29B. On the way, the tensile stress in the film strip 17 is measured by means of a rotating sensor arm 87 that is connected with a rotating transmitter 89. The electromotor 81 and the transmitter 89 are connected via signal lines 91 and 93, respectively with a separate control unit 95 for regulating the tensile stress in the film strip 17. For the adjustment of the tensile stress an input signal 97 is fed to the control unit 95.

[0027] Thus it is clear from Figure 2, that all the elements shown in the drawing and exerting a force on the conductor 1 are under automatic control which guarantees that the stresses occurring in the conductor will remain within the previously-mentioned safe range. The means for pressing on the rollers 29A, 29B and 31A, 31B that are present for pressing the film strip 17 to the conductor 1, and which will be discussed below, also exert forces within the respective range.

[0028] The method of applying the film strip 17 with the aid of the rollers 29A, 29B, 31A, 31B and the means present within the insulation section 33, will now be discussed with reference to the Figures 3A to 3D. Figure 3A shows the manner in which the film strip 17 is applied to the main surfaces 9 of the conductor 1, Figure 3B shows how the film strip is pressed to the two lateral surfaces 13 and 15, Figure 3C shows how the left-hand portion of the film strip 17 is applied to the main surfaces 11 of the conductor, and Figure 3D shows how the right-hand portion of the raised film strip is applied to the main surface 11 of the conductor 1, and partly also to the already folded left-hand portion of the film strip.

[0029] The Figures 3B and 3C show rollers with the reference numbers 99A,B and 101A,B respectively, provided with the laterally projecting journals 103A,B and 105A,B for rotation about the respective rotation axes 107A,B and 109A,B with the aid of bearings which are not shown in the drawing. All rollers in the Figures 3A to 3D, their bearings and the pressing on of the same (which will be discussed later) are essentially alike, so that there is no need to give a detailed description of each one individually.

[0030] As can be seen in Figure 3A, the rollers 29A and 29B, which are rotatable about the respective rotation axes 35A and 35B, are pressed on at the respective journals 39A and 39B by means of a transversely directed force, symbolically indicated with F. To this end transversely movable presser means are provided (not shown in the drawing) which may be of the conventional type and which may, for example, consist of springs exerting a spring-activated force F on the bearings that support the journals 39A and 39B. The forces F are chosen such that the surface pressure exerted on the two main surfaces 9 and 11 of the conductor 1 remain within the desired range while at the same time guaranteeing proper bonding of the adhesive layer 19 on the film strip 17 to the main surface 9 of the conductor. The use of rollers and careful implementation of the apparatus ensures that no air is trapped between the adhesive layer and the conductor. The presser means are designed such that the force F exerted by them varies very little when applied to different thicknesses of conductor 1 so that the surface pressure will under any circumstance remain within the allowable range.

[0031] Within the insulation section 33 and with the aid of rollers, bands, shoes and combinations thereof, the film strip 17 at both sides of the conductor is folded over after which the rollers 99A and 99B press the portions of the film strip 17 at both sides to the lateral surfaces 13 and 15. Due to the fact that the lateral surfaces 13, and 15, are smaller compared with the main surfaces 9 and 11, the forces F2 exerted by the presser means will be smaller than the forces F1 in Figure 3A. After the description of the Figures 3A and 3B it will be clear that with the aid of the rollers 101A and 101B in the Figures 3C and 3D, the film strip 17 is first pressed to the left-hand side of the conductor A and that subsequently the portion of film strip 17 remaining at the right-hand side is pressed from the top to the conductor 1 so as to partially overlap the left-hand portion of the film strip. The forces F3 and F4 from the respective presser means are yet again adapted to the intended purpose.

[0032] Figure 3D is merely a schematic representation which may create the impression that because the film strip is pressed to the upper side of the conductor with an overlap, air may become trapped between the conductor and the right-hand portion of the film strip. In reality there is no such air inclusion because the film strip is very thin and slightly flexible. Optional extra provisions may ensure that with pressing on no air is trapped. An alternative possibility is not to have the film strip overlapping, but to choose the widths such as to form an adjoining seam at the upper side of the conductor or even a small gap. This is not necessarily always a disadvantage.

[0033] It has been shown that a conductor insulated in concurrence with the method according to the invention possesses superconductive properties comparable to those of a similar conductor without insulation. To this end measurements were carried out on a conductor obtained from the previously-mentioned firm VAC Vacuumschmelze GmbH, Hanau, Germany, of the type No. BSCCO-2223/AG. According to the manufacturers, the critical current through the conductor over a specific length varies ±5%. The critical current is the current measured at an electrical voltage per unit of conductor length of 10^{-4} Volt per metre.

[0034] To measure the critical current, a straight piece of conductor is placed into boiling liquid nitrogen at atmospheric pressure. An electrical current from a low noise electrical source is passed through the conductor via electrical connections, and the current is measured with the aid of an accurate current meter with the aid of connections welded onto the conductor at a mutual distance L and using a sensitive voltage metre the voltage V is measured over a length of conductor. The current is adjusted such that V/L is 10^{-4} per metre. During measurement no external magnetic fields are developed. The thus measured current is the critical current.

[0035] In order to compare the superconductive properties of the uninsulated conductor and of conductors insulated in accordance with the invention, a certain length of conductor of the above-mentioned type that had not yet been insulated was cut into 5 equal pieces (first series). Another length of conductor that had already been provided with insulation, was cut into four equal pieces (second series). The critical current of all samples was measured. The result showed that the average critical current of the first series of samples was 47.7 Ampère ± 2%, and the critical current of the second series of samples was 49.9 Ampère ± 4%. From this result it may be concluded that the application of the insulation according to the invention involves no significant reduction of the critical current compared with conductors that have not been insulated.

[0036] The sensitivity of the conductor to mechanical bending will be apparent from the following data obtained by measurements. When a conductor with features as represented in Figure 1 and of dimensions as described earlier in the specification was bent in the same direction as the direction in which it was wound on the conductor supply reel 21 (see Figure 2), up to a radius of 35 mm, the result was an approximately 20% reduction of critical current at 77° Kelvin. Bending in the other direction, the same result was already reached at a radius of 100 mm.

[0037] When bending over the narrow side, a radius of 500 mm incurs a 30% reduction of critical current, and a radius of 300 mm a 50% reduction of critical current.

[0038] Although in the foregoing the invention has been discussed substantially with reference to merely one single exemplary embodiment, the invention is in no way limited thereto. On the contrary, the invention comprises every possible embodiment within the scope of the appended claims.

Claims

1. A method of insulating an elongated conductor (1) comprised of high-temperature-superconductive, substantially ceramic material (3) and having, at least by approximation, a rectangular cross section with substantially flat main surfaces (9,11) and adjoining lateral surfaces (13,15), comprising the application of an insulating strip around the elongated conductor, **characterized**

in that the method comprises the steps of providing a film strip (17) of a width equal to or greater than the cross sectional circumference of the conductor (1), and which is provided at one side with a previously applied adhesive layer (19) bonding under pressure at room temperature,
in that the method further comprises the following steps to be carried out at room temperature:

- bonding to the adhesive layer (19) a main surface (9) of the conductor (1) to a central portion of the film strip (17) parallel to its longitudinal direction,
- folding over the portions of the film strip at both sides of the conductor (1) to form an angle of substantially 90 degrees, and applying the film strip (17) by means of the adhesive layer (19) to the lateral surfaces (13,15) of the conductor (1) and
- successively again folding the portions of the film strip (17) at both sides of the conductor (1) to form an angle of substantially 90 degrees, and applying the adhesive layer bonded to the film strip to the other main surface (11) of the conductor (1),

in that while the method is being carried out, bending forces, pressure forces and tensile stresses exerted on the conductor (1) are outside the range of values that have a negative effect on the superconductive properties of the conductor material and
in that the adhesive is of a type that adheres both to the film strip (17) and to the conductor (1) at the temperature of superconduction without having a negative effect on the superconductive properties of the conductor material..

2. A method according to claim 1, **characterized**

- in that the conductor material of the superconductive conductor (1) comprises fibres (3) chosen from BSCCO-2223, BSCCO-2212, layers of YBCO, in a silver-containing matrix (5) or another conducting or non-conducting matrix,
- in that while the method is being implemented, the stresses exerted on the conductor (1) in the longitudinal direction range from 0 to 10 N/mm^2, and
- in that while the method is being implemented surface pressures exerted on the conductor range from 1 to 15 N/mm^2.

3. A method according to one or more of the preceding claims, **characterized**

- in that the material is chosen from the selection comprising: polyimide, polyester.

4. A method according to one or more of the preceding claims, **characterized**

- in that the material of the adhesive layer (19) is chosen from the selection comprising: adhesives on an acryl base, adhesives on a silicon base, adhesive on a siloxane base.

5. A method according to claim 1, **characterized**

- in that on its reverse side the film strip (17) is provided with a microroughening in the range of 0.1 to 5µ and
- in that the adhesive layer (19) of the film strip (17) is provided with a removable strip to be removed from the adhesive layer before the same is brought into contact with the conductor (1)

6. A method according to claim 1, **characterized**

- in that on its reverse side the film strip (17) is previously provided with a strip of fibre material, preferably glass fibre material.

7. A method according to one or more of the preceding claims, **characterized** in that the film strip (17) has a thickness in the order of 20 to 25 microns, and that the adhesives layer (19) has a thickness in the order of 35 microns.

8. A method according to one or more of the preceding claims, **characterized**

- in that the uninsulated conductor (1) is wound off a conductor supply reel (21) and the insulated conductor is wound onto a product supply reel (23) that is located at some distance from the conductor supply reel (21) in such a manner that the conductor's (1) direction of curvature on the product supply reel (23) corresponds with the direction of curvature on the conductor supply reel (21),
- in that the film strip (17) is unwound from a film supply reel (25) onto which the film strip with the adhesives layer (19) is wound,
- in that between the conductor supply reel (21) and the product supply reel (23) the conductor is fed through an insulation section (27), where the conductor (1) that is wound off the conductor supply reel (21) and the film strip (17) that is wound off the film supply reel (25) are brought

together and,

- in that in the insulation section (27) the film strip (17) is pressed to the main surfaces (9,11) and the lateral surfaces (13,15) of the conductor (1) by press-on elements positioned opposite one another at both sides of the main surfaces (9,11) and the lateral surfaces (13,15) and comprising elements from the selection: rollers, belts, shoes, combinations thereof,
- in that the transport of the conductor (1) between the conductor supply reel (21) and the product supply reel (23) occurs exclusively in a condition that leaves the superconductive properties of the conductor (1) unimpaired, such as in the straight condition and/or in a curved condition that corresponds with the direction of curvature of the conductor (1) on the conductor supply reel (21) and the product supply reel (23), and
- in that the said transport of the conductor (1) takes place under automatic control to ensure that the stresses in the conductor stay within the range mentioned in claim 2.

9. A method according to claim 2, **characterized** in that prior to insulation, the conductor (1) is wound off a conductor supply reel (21) and after insulation is wound onto a product supply reel, (23) and

- in that the diameter of the smallest winding of the conductor (1) on the conductor supply reel (21) and on the product supply reel (23) is minimally 200 mm.

10. An apparatus for the implementation of the method according to claim 8 or 9, **characterized**

- in that motor driving units (45,47; 81) are present for the conductor supply reel (21), the product supply reel (23) and the film supply reel (25),
- in that control means (43; 95) are present for the control of the motor driving units (45,47; 81) such as to allow during said transport the stresses occurring in the longitudinal direction of the conductor (1) to be maintained within the range mentioned in claim 2, and
- in that the surface pressure exerted by the press-on elements on the film strip in order to press the film strip to the band, remains within the range mentioned in claim 2.

11. An apparatus according to claim 10, **characterized**

- in that the press-on elements comprise one or more transversely movable press-on elements having in the transverse direction flexibly loaded presser means which, within the range of the conductor's dimensions, will in any position generate a surface pressure within the range mentioned in claim 2.

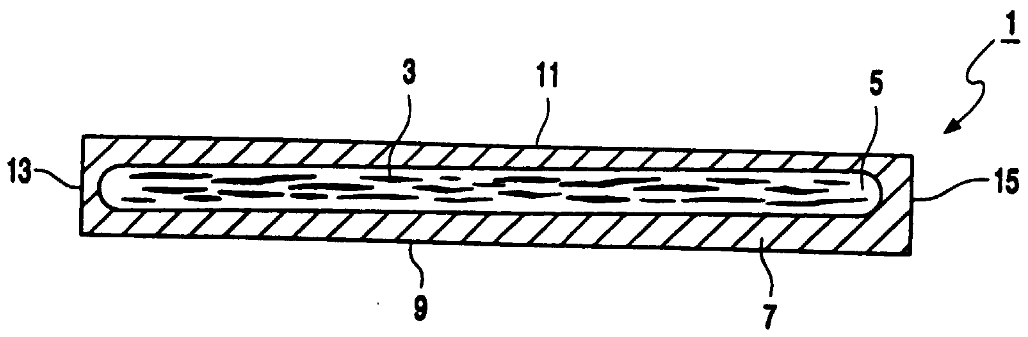
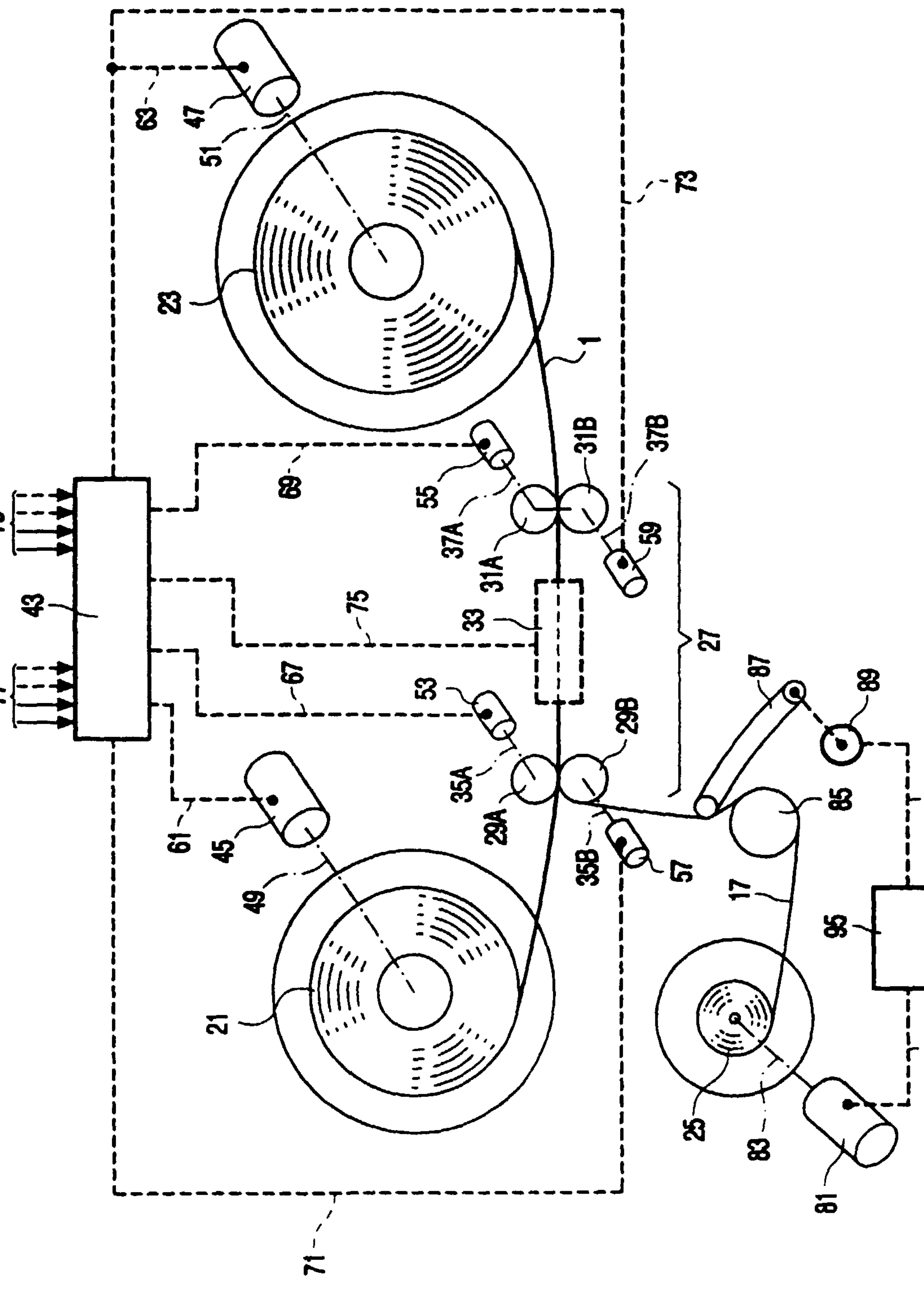


FIG. 1


63
47
51
73
23
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31B
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27
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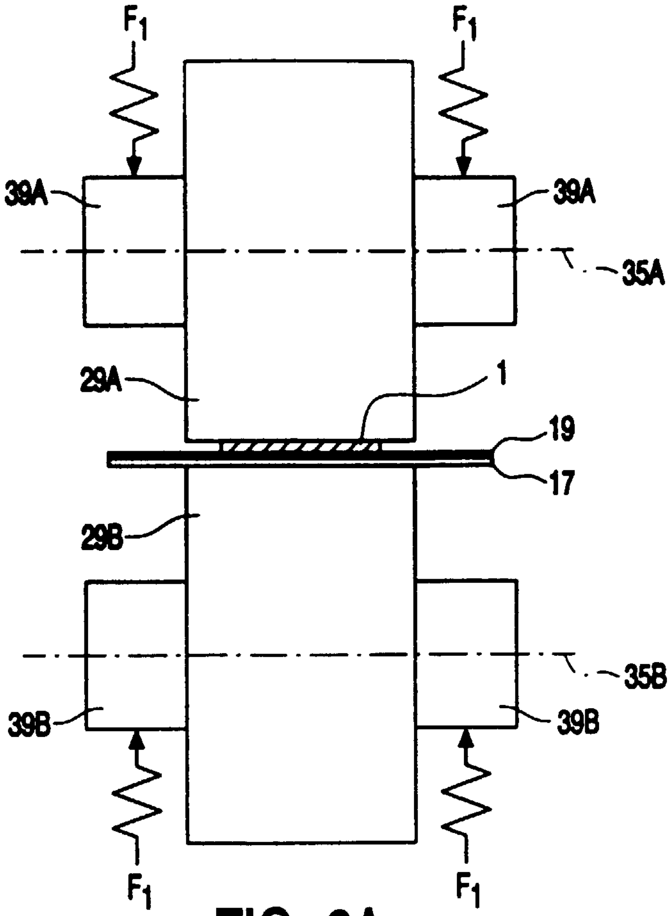
89
77
67
53
29B
35A
29A
93
85
61
45
35B
57
17
49
95
97
21
25
83
91
81
71

FIG. 2


F1
F1
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19
17
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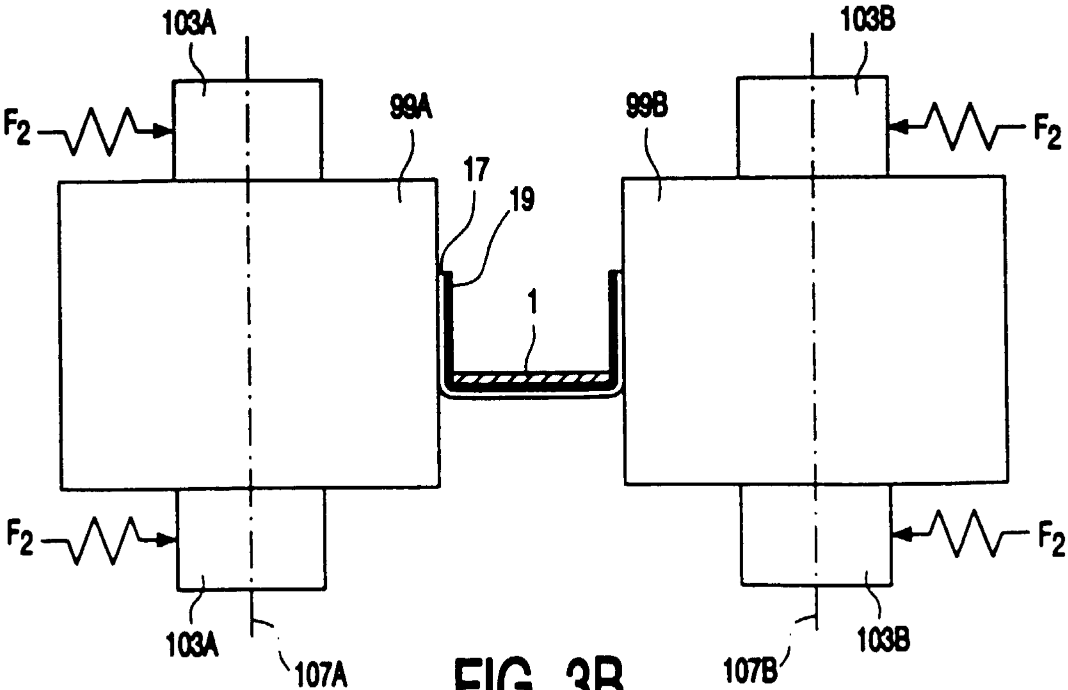
39B
39B
F1
F1

FIG. 3A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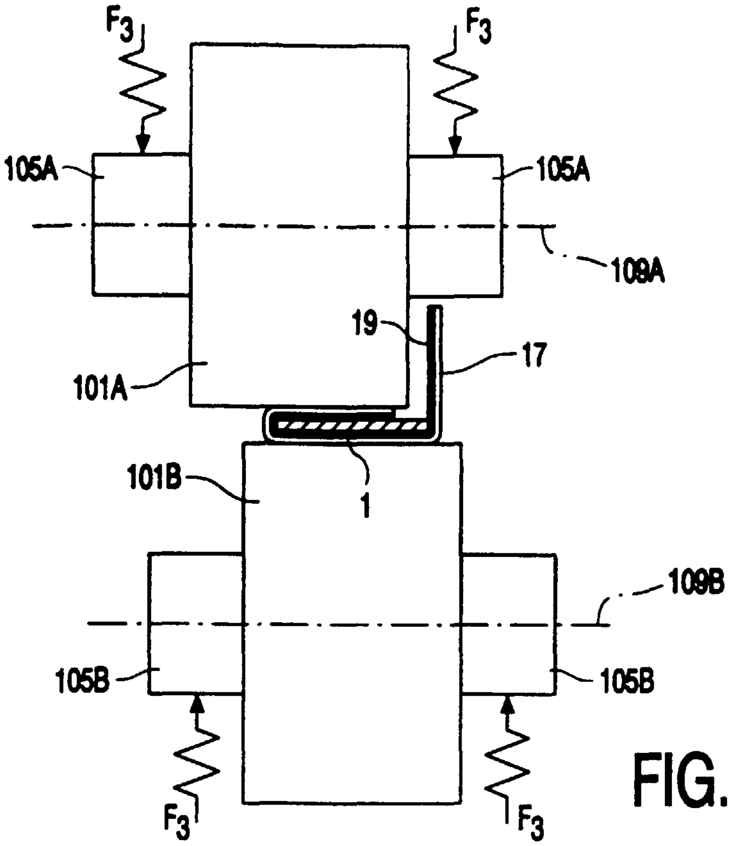
107B
103B

FIG. 3B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101B
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109B
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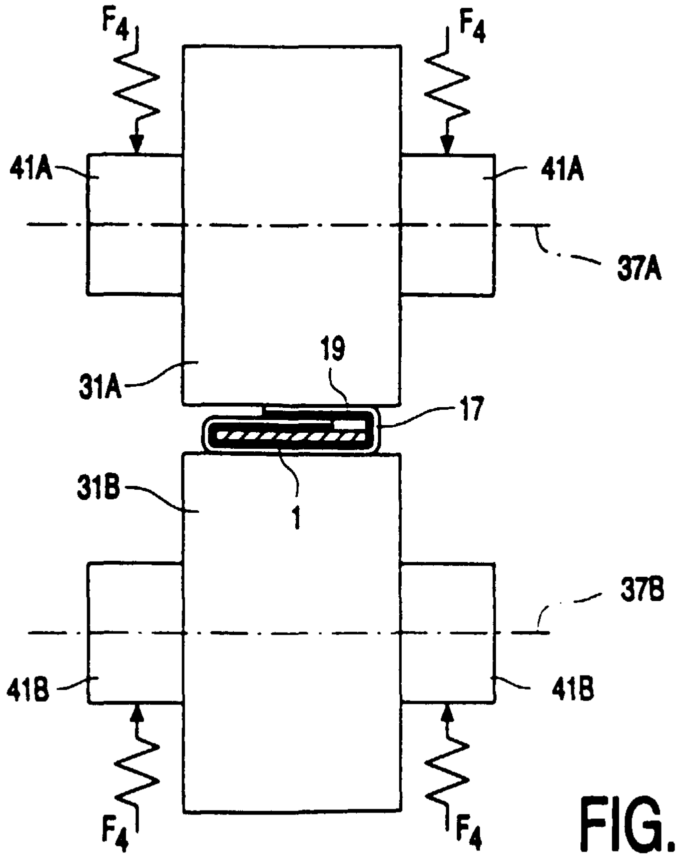
105B
F3
F3

FIG. 3C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31A
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31B
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37B
41B
41B
F4
F4

FIG. 3D

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 20 3389

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 3 989 561 A (COTTON DALE L) 2 November 1976 (1976-11-02) * claim 1; figures 1-5 * ---	1,10	H01B13/10
A	US 4 259 141 A (ANDERSSON GUNNAR ET AL) 31 March 1981 (1981-03-31) * claim 1; figures 1-9 * -----	1,10	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)
H01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 January 2001	Demolder, J

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