

Description

This invention relates generally to the manufacture of mineral insulated metal sheathed cables.

Mineral insulated metal sheathed cables typically comprise one or more metallic conductors embedded in a body of compacted mineral insulating material which is in turn housed within an outer metallic sheath. The conductors and sheath are usually copper and the insulating material may be a ceramic powder such as magnesium oxide.

One method of manufacturing such cables is by packing the mineral insulating material into a vertically extending metallic tube already fitted with conductor cores, and then subjecting the filled length of tube to a succession of drawing and annealing operations. This method suffers from several disadvantages. It is a batch process and cannot be adapted to continuous cable production. The initial tube is a relatively expensive source of the sheath metal, although it has been suggested (U.S. Patent 4,614,024) that the tube could be prepared within the process by forming flat metal strip. The multiple drawing and annealing steps require substantial time. Each annealing step is slow because the conductors, which must be subjected to the annealing along with the sheath, are protected from the heat by the mineral insulating material.

A modification of the method just described is disclosed in U.S. Patent 4,420,881. The method disclosed in U.S. Patent 4,420,881 comprises treating mineral insulating material to form an extrudable substance, said treatment including mixing the material at least with a binder, extruding a cylindrical body of the substance to provide an insulating body, treating the insulating body to remove and/or decompose the binder, and applying a metal sheath to the body.

More particularly, according to U.S. Patent 4,420,881, the mineral insulating material is mixed with an organic binder and either palletised under high pressure or simply extruded, in either case producing a cylindrical preform structure with one or more longitudinal ducts. The preform structure is cut into lengths which are, in the extruded case, heated to burn off the binder and then, in each case, inserted into a metal sheathing tube. A conductor is then passed through each duct and the resultant structure drawn and annealed in the known manner. However the extrusion technique of this U.S. Patent is still a batch process and still requires a pre-formed metal tube for the sheath.

An object of the invention is to provide a continuous manufacturing process and apparatus. To achieve this object the invention is characterised in that the body is continuously extruded around at least one continuously moving conductor to provide a continuously moving assembly consisting of insulation with the conductor embedded therein, and then continuously applying the metal sheath around the continuously moving assembly.

British patent application 2,205,263 proposes continuously forming the metallic sheath in an annular die by means of conform extrusion, a technique described generally in British patent 1,370,894. Although this is a continuous process, it does not result in a satisfactory end product as regards uniformity of the insulating and dielectric properties. The sheath is disposed vertically, at least at its mouth, so that the mineral insulating material can be fed into the extruded sheath from a hopper. Conductors are fed into the sheath from respective guide tubes. Drawing and annealing follow as before. This proposal suffers from the disadvantage that there is not adequate control in the compaction of the insulating material during filling of the sheath which results in inadequate control of the insulating and dielectric properties of the cable. In addition, displacement of the conductors can occur during subsequent processing stages.

The invention differs from this prior proposal by means of the steps defined above which provides uniformity in the properties of the end product.

The sheath is advantageously formed about said co-extruded cylindrical body by conform extrusion through an annular die. In an alternative arrangement, the sheath might be physically formed from flat strip.

Where the cable is to be an electrical power cable, the conductor(s) and sheath are preferably copper or aluminium and the insulating material is advantageously a ceramic powder such as magnesium oxide, aluminium oxide, or other oxides, carbides, or nitrides.

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

Figure 1 is a partially sectioned schematic diagram of apparatus for manufacturing mineral insulated metal sheathed cables in accordance with the invention; and

Figure 2 is a flow chart depicting the steps of an embodiment of the process of the invention utilising the apparatus shown in Figure 1.

The apparatus 10 depicted in Figure 1 includes a co-extruder 12 and a conform extruder 20. Mineral insulating material, pre-mixed with water or water and alcohol, and a suitable binder to form an extrudable feed-stock 8, is continuously fed to co-extruder 12 and co-extruded about one or more travelling elongate metallic conductors 5 to form a generally cylindrical body 30 of the material in which the or each conductor is thereby embedded. At conform extruder 20, a metallic sheath 32 is formed about body 30 by conform extrusion from

an annular die. The conform extrusion technique is generally as described in British patent 1,370,894, utilising feedstock such as rod 34. The feedstock for the conform extruder may alternatively comprise metallic powder or granules.

5 The sheathed and insulated cable 36 discharged from conform extruder 20 is drawn in at least one drawing stage 40 for example comprising a series of rolls or extrusion dies, to compact the mineral insulation and reduce the cable to the required size. Thereafter the cable is wound onto formers 41 as successive coils 42 of continuous cable. Alternatively, the coiling may be completed on a bull block or similar device where size reduction is simultaneously achieved.

10 Coils 42 are annealed in a bell furnace 44, or continuously annealed by other suitable means, according to conventional practice with mineral insulated metal sheathed cables, and passed for storage or transport 46. More than one drawing and/or annealing step may be required or found desirable, depending on the end-product sought, but typically only one drawing and annealing are required.

Conductor 5 and rod 34 are respectively reduced in section from metallic wire 5' and metallic rod 34 by any suitable deformation process such as rolling, drawing, or conform. The reduction steps for the conductor 15 5 and rod 34 are shown schematically at 5a and 34a. As mentioned, the mineral insulating powder is mixed with both water (or water and alcohol) and a suitable binder to form plastic feedstock 8 for co-extruder 12. Before reaching conform extruder 20, the cylindrical body 30 is treated by heating in a zoned furnace 16 to at least partially drive off the water and to decompose the binder and other additives. The two treatments of the mineral insulating material - the pre-treatment to form the co-extruder feedstock and the treatment of the extruded body in furnace 16 - are such as to optimise the subsequent insulating properties of the cylindrical body 20 while sufficiently preserving the latter's integrity before it is encased by the sheath. If there is to be a subsequent reduction step, there is a further requirement that the extruded and debindered body remains sufficiently plastic to extrude with the conductor(s) and sheath. The characteristics required for the mineral insulating material used in the process of the invention will be discussed in greater detail hereinafter.

25 The conform extruder 20 preferably applies sufficient energy to also anneal the sheath; the furnace 16 may in similar fashion anneal the conductor(s) prior the sheathing step.

The sequence of steps set out above is depicted as a process flow chart in Figure 2.

30 This flow chart further shows pre-treatment 50 of the mineral insulating powder to grade the powder according to particle size and to detect and remove magnetics, indicates at 51 the treatment of this powder by mixing in water (or water and alcohol) and binder, and shows that the co-extrusion step may entail vacuum degassing of the extruder feedstock to remove trapped air. Preparation of the conductor may include welding and straightening steps 52, 53.

35 Where the cable is to be electrical power cable, the conductor and sheath are typically copper or aluminium, although other metals may of course be employed. The mineral insulating material may be a ceramic powder, e.g. magnesium oxide, aluminium oxide, zirconium oxide or other oxides, or carbides or nitrides which have a high melting point and good insulation resistance.

40 Suitable binders for mixing with the mineral insulating material include those developed for the extrusion of ceramic materials and are typically water soluble resins, such as gums, polyvinyl alcohols, cellulosic materials and high molecular weight homopolymers or polyethylene oxide. Other additives may be used to improve the formulation, such as wetting agents to assist with dispersion of the binder, extrusion aids to reduce the extrusion forces and lower wear, lubricant to lower wear, and biocides to facilitate preservation. High shear mixing is preferably used to achieve a uniform mix. Heating may be applied at the co-extruder as some binders undergo a gel transition at higher temperatures.

45 Extrusion of ceramic materials is well known for use in the production of sintered components. The technique is to mix ceramic powder with water and binders to provide a fluid mix which is easily extrudable. Typically the amount of water will be in excess of 15% by weight and the binders will be in the range of 1 to 4% by weight. The extruded product is cut into lengths which are put in batches into a furnace in which the product are heated to remove the binder and then to sinter the particles. A sintered product normally requires a particle size of 25 microns or less in order to provide rapid sintering and sufficient final strength. The small particle size and high 50 liquid content does, however, mean that long heating times (usually several hours) are required to remove the liquid and binder prior to sintering, the long heating times being necessary due to the relatively small amount of free space available within the product for escape of any volatiles and any decomposition products of the binder on heating. Between removal of the binder and sintering, the product is in a fragile condition but remains in the furnace during this phase and does not therefore need to be handled.

55 The parameters for the ceramic extrusion process are, however, different when used in the process of the invention. The extrusion process again requires the addition of water or other liquid to the ceramic powder to provide an extrudable mixture and also the addition of binder which assists the retention in the shape of the extruded product, with extrusion becoming easier as the added liquid content is increased. However, as the

amount of liquid is increased, the product density is reduced which leads to reduced product strength after heating to remove the binder. In a conventional ceramic extrusion process for producing a sintered product in which the product is heated in a furnace to remove the binder and then to sinter the product with no product handling being required between these stages, low product strength after binder removal and prior to sintering does not have a serious affect. In the process of the invention the product is not sintered after binder removal (although a degree of sintering may occur during heating to remove the binder) and the product must have sufficient strength after binder removal to enable the product to be transported to the conform extruder and to thereafter withstand the forces applied during conform extrusion at which the sheath is applied. For this reason, the amount of liquid added to plasticise the mix for extrusion must be a balance between that necessary to achieve adequate extrusion characteristics while preserving adequate product strength after removal of the binder to permit the handling of the product to and through the conform extruder. It is also to be noted that these difficulties cannot be overcome by fully sintering the product after binder removal as this would render the product incapable of being reduced down to the required size after conform extrusion.

To avoid substantial sintering effects during heating and also to permit removal of liquid and binder during the heating phase over a relatively short period of time (measured in minutes rather than hours), the particle size of the mix will be larger than that used in conventional ceramic extrusion. The major portion of the mix will have a particle size of at least about 30 microns although inevitably the mix will contain a proportion of smaller size particles. Particle size will also affect strength of the product after binder removal, with increased particle size leading us to reduced strength. Accordingly, a compromise is necessary in the particle size to meet these different requirements. Ceramic powders are capable of wide variation in particle size depending on such factors as the source of the product and method of size reduction, and it is possible to mix different grades of powder to obtain a mix with a particle size distribution within the limits necessary to achieve the required characteristics.

Further preferred aspects of the extrudable mix for use in the process of the invention will now be given.

The particle size of the ceramic powder is mainly in the range of 10 microns to 200 microns with the major portion being in the range 30 microns to 125 microns. The actual size distribution is highly variable and this controls the final formulation.

The liquid additive to plasticise the mix is applied in the range of 4-14% by weight, with the most suitable range being 5-8% by weight. The actual value is dependant on the nature of the particles including particle size and surface area. The liquid may be water or a mixture of water and alcohol which will evaporate more readily on heating.

The amount of binder added is typically in the order of 1-8% by weight. The actual amount used is most likely to be in the range of 2-6%. Too high a level will make it more difficult to debinder rapidly enough, while too little and the material will not have sufficient plasticity to be extruded. Again, the actual amount is dependant on the specific grade of ceramic powder used.

Plasticisers may be used to improve the plasticity of the mix. These must be readily decomposed and provide little ash to contaminate the ceramic material. This contamination would lower the resistivity and dielectric characteristics particularly at elevated temperatures. Typical plasticisers are polyethylene or polypropylene glycols with specific molecular weights. A typical material is polyethylene glycol 400 used at the 2-10% of the total binder content. Surfactants may be used to improve the wetting of the ingredients by lowering the surface tension of the aqueous system. These are usually used in the range of 0.1-0.5% by weight.

Lubricant may also be added to improve the lubrication between particles and between the extruder die and walls and the material being extruded. Typical lubricants are stearates (compatible with the ceramic), stearic acid or diglycol stearate. The level of lubricant used is preferably in the range 0.1-2% by weight with 0.5% being especially preferred.

The extruded product is dried rapidly and heated to remove the binder and other additives so that the original resistive and dielectric properties are returned. This usually requires heating to about 900-1000°C using a heating time of several minutes. The total heating time is recorded in minutes rather than hours which is more typical of that used for debinding in conventional ceramic extrusion. Heating is at a temperature below that at which substantial sintering occurs.

All additives used in the mix must be either readily decomposed on heating to provide little or no ash, or alternatively, the product of decomposition must be compatible with the ceramic material being extruded. For example, magnesium stearate can be used as a lubricant for the extrusion of MgO as the product of decomposition is MgO.

Details of suitable mixes will now be given by way of example only

Example I

		wt%
	Ceramic powder (MgO) 50-125 micron	89.0
5	Binder (Cellulosic)	2.8
	Water	8.2

Example II

10	Ceramic powder (MgO) 50-125 micron	88.3
	Polyethylene glycol	0.4
	Binder (Cellulosic)	2.8
15	Water	7.5
	Magnesium stearate	1.0

Example III

20	Ceramic powder (MgO) 30-100 micron	86.2
	Binder (Cellulosic)	5.4
	Alcohol	2.3
25	Water	5.6
	Magnesium stearate	0.5

30 In the above examples, the ceramic powder particle size range is given for the majority of the particles, and it is to be understood that the powder may also include some particles outside of this range. The above examples are given in order to provide an understanding of the nature of a typical ceramic mix which can be used in the process of the invention. It is, however, to be understood that the present invention is not restricted just to the use of these formulations

35 The furnace in which the extruded product is heated may be a tunnel furnace through which the product continuously moves, the length of the furnace being such that movement through the furnace at a rate determined by the ceramic extrusion and conform operations provides the required heating time. The furnace may be heated by conventional means or alternatively the furnace may be an induction furnace or a microwave furnace. The product is substantially continuously supported on a conveyor during passage through the furnace and during passage from the furnace to the conform extruder. The conveyor may be a moving belt conveyor, a roller conveyor or a combination of both rollers and belts. Due to the fragility of the product during heating and prior to sheathing the product moves along a substantially horizontal rectilinear path from the furnace to the conform extruder.

45 The described process has a number of advantages over prior disclosed techniques. Continuous rather than batch production of cable may be conveniently achieved. There is less annealing, drawing and handling, because the cable is initially produced close to finished size. The sheath feedstock used in conform extrusion is an inexpensive source of the metal rather than relatively expensive tube. Copper rod for example, is much less than the cost of copper tube for a given weight of metal. Treatment of insulation is achieved prior to covering it with the sheath, and a more uniform density is evident in the extruded body of insulating material than with the prior packing methods. Much of the desirable compaction of the insulating material occurs during the co-extrusion step whereas prior methods need the extensive amount of drawing to, inter alia, compact the insulating material.

50 Although conform extrusion is preferably used to apply the sheath as the feedstock for this process is relatively inexpensive, the sheath can be formed by other techniques such as forming flat strip into U-shape into which the extruded body is laid and the tube formed and the gap welded. This technique may provide some advantages in handling the fragile extruded ceramic body during sheathing.

55 The described arrangement has been advanced merely by way of explanation.



Claims

- 5 1. A method of manufacturing a mineral insulated metal sheathed cable, said method comprising treating mineral insulating material to form an extrudable substance, said treatment including mixing (51) the material at least with a binder, extruding (12) a cylindrical body of the substance to provide an insulating body (30), treating (16) the insulating body (30) to remove and/or decompose the binder, and applying (20) a metal sheath (32) to the body (30), characterised in that the body (30) is continuously extruded around at least one continuously moving conductor (5) to provide a continuously moving assembly consisting of insulation (30) with the conductor (5) embedded therein, and then the metal sheath (32) is continuously applied around the continuously moving assembly.
- 10 2. A method according to claim 1, characterised in that the treatment of the insulating material to form the extrudable substance further comprises mixing the material with liquid which is removed prior to application of the sheath (32) around the extruded insulating body (30), the amount of liquid mixed with the material being such that after the treatment of the extruded insulating-body (30) to remove the liquid the body (30) has sufficient strength to permit the continuous movement of the body (30) to a station at which the metal sheath (32) is applied.
- 15 3. A method according to claim 2, characterised in that the said treatment of the body (30) comprises heating (16) the body (30) while moving with the conductor (5) embedded therein.
- 20 4. A method according to claim 3, characterised in that the mineral insulating material comprises ceramic particles, and the heating (16) of the extruded insulating body (30) prior to application of the sheath (32) takes place at a temperature range below that at which substantial sintering of the particles occurs.
- 25 5. A method according to claim 4, characterised in that the size of the particles, the amount of liquid and the amount of binder is such that removal of liquid, and removal and/or a decomposition of the binder in the heating stage (16) occurs within several minutes.
- 30 6. A method according to claim 5, characterised in that a majority of the particles are in a size range of from about 30 to 125 microns.
- 35 7. A method according to any one of claims 2 to 6, characterised in that the amount of added liquid is between about 4 and 14% by weight.
- 40 8. A method according to any one of claims 2 to 7, characterised in that the amount of binder is between about 1 and 8% by weight.
- 45 9. A method according to any one of claims 2 to 8, characterised in that the body (30) is substantially continuously supported during movement from the treatment stage (10) to the station (20) at which the sheath (32) is applied.
- 50 10. A method according to any one of claims 1 to 9, characterised in that the sheath (32) is applied by conform extrusion (20) through an annular die.
- 55 11. A method according to claim 10, characterised in that treatment of the body (30) and sheathing by conform extrusion (20) takes place on a substantially horizontal rectilinear path of movement of the body (30).
12. A method according to any one of claims 1 to 10, characterised by the step of reducing the sheathed body to a required size (40).
13. Apparatus for carrying out a method according to claim 1 comprising an extruder (12) for the substance to produce a cylindrical extruded body (30), means (16) for treating the extruded body to remove and/or decompose the binder, and means (20) for applying a metal sheath (32) to the body (30), characterised in that the extruder (12) continuously extrudes the body (30) around at least one continuously moving conductor (5) and while the body (30) with the conductor (5) embedded therein is moving, the sheath (32) is continuously formed around the moving body after the treatment to remove or decompose the binder.
14. Apparatus according to claim 13, characterised in that the treatment means (16) comprises a furnace through which the body moves, the furnace being so arranged that it heats the body (30) to a temperature



range at which the binder is removed and/or decomposed without causing substantial sintering of the body.

15. Apparatus according to claim 13 or claim 14, characterised in that the sheathing means (20) comprises a conform extruder.
16. Apparatus according to claim 15, characterised in that the body (30) is moved substantially horizontally and rectilinearly between the treatment means (16) and the conform extruder (20).
17. Apparatus according to any one of claims 13 to 16, comprising conveyor means for substantially continuously supporting the body (30) during movement between the treatment means (16) and the sheathing means (20).

Patentansprüche

1. Verfahren zum Herstellen mineralisierter Kabel mit Metallaußenhülle durch Behandeln von mineralisierendem Material zum Ausbilden einer extrudierbaren Substanz, wobei das Material zumindest mit einem Bindemittel gemischt (51) wird, Extrudieren (12) eines zylindrischen Körpers aus der Substanz, um einen Isolierkörper (30) zu bilden, Behandeln (16) des Isolierkörpers (30) zum Entfernen und/oder Zersetzen des Bindemittels und Aufbringen (20) einer Metallhülle (32) auf den Körper (30), dadurch gekennzeichnet, daß der Körper (30) um mindestens einen kontinuierlich sich bewegenden Leiter (5) kontinuierlich extrudiert wird, um einen sich kontinuierlich bewegenden Aufbau zu bilden, der aus der Isolation (30) mit dem darin eingebetteten Leiter (5) besteht, und daß dann die Metallhülle (32) kontinuierlich um den sich kontinuierlich bewegenden Aufbau aufgebracht wird.
2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Behandlung des Isoliermaterials zum Ausbilden der extrudierbaren Substanz ferner das Mischen des Materials mit einer Flüssigkeit umfaßt, die vor dem Aufbringen der Hülle (32) um den extrudierten Isolierkörper (30) entfernt wird, wobei die mit dem Material vermischte Flüssigkeitsmenge derart ist, daß nach der Behandlung des extrudierten Isolierkörpers (30) zum Entfernen der Flüssigkeit der Körper (30) ausreichende Festigkeit hat, so daß der Körper (30) kontinuierlich zu einer Station bewegt werden kann, an der die Metallhülle (32) aufgebracht wird.
3. Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß die Behandlung des Körpers (30) das Erwärmen (16) des Körpers (30) umfaßt, während er sich mit dem darin eingebetteten Leiter (5) bewegt.
4. Verfahren nach Anspruch 3, dadurch gekennzeichnet, daß das mineralisierende Material Keramiktellchen aufweist und das Erwärmen (16) des extrudierten Isolierkörpers (30) vor dem Aufbringen der Hülle (32) in einem Temperaturbereich unterhalb der Temperatur stattfindet, bei der eine wesentliche Versinterung der Teilchen erfolgt.
5. Verfahren nach Anspruch 4, dadurch gekennzeichnet, daß die Teilchengröße, die Flüssigkeitsmenge und die Bindemittelmenge derart bemessen sind, daß die Entfernung von Flüssigkeit und die Entfernung und/oder Zersetzung des Bindemittels in der Heizstufe (16) innerhalb weniger Minuten erfolgt.
6. Verfahren nach Anspruch 5, dadurch gekennzeichnet, daß der Hauptteil der Teilchen im Größenbereich von etwa 30 bis 125 µm liegt.
7. Verfahren nach einem der Ansprüche 2 bis 6, dadurch gekennzeichnet, daß die Menge an zugegebener Flüssigkeit zwischen etwa 4 und 14 Gew.-% liegt.
8. Verfahren nach einem der Ansprüche 2 bis 7, dadurch gekennzeichnet, daß die Bindemittelmenge zwischen etwa 1 und 8 Gew.-% liegt.
9. Verfahren nach einem der Ansprüche 2 bis 8, dadurch gekennzeichnet, daß der Körper (30) während der Bewegung aus der Behandlungsstufe (10) zur Station (20), bei der die Hülle (32) aufgebracht wird, im wesentlichen kontinuierlich abgestützt wird.
10. Verfahren nach einem der Ansprüche 1 bis 9, dadurch gekennzeichnet, daß die Hülle (32) durch eine Ringdüse koextrudiert (20) wird.



11. Verfahren nach Anspruch 10, dadurch gekennzeichnet, daß die Behandlung des Körpers (30) sowie die Umhüllung durch Koextrusion (20) auf einer im wesentlichen horizontalen, geradlinigen Bewegungs-
strecke des Körpers (30) erfolgt.
- 5 12. Verfahren nach einem der Ansprüche 1 bis 10, gekennzeichnet durch den Schritt zum Reduzieren des umhüllten Körpers auf eine gewünschte Größe (40).
- 10 13. Vorrichtung zum Ausführen des Verfahrens nach Anspruch 1, mit einem Extruder (12) für die Substanz, um einen zylindrischen, extrudierten Körper (30) zu erzeugen, einer Einrichtung (16) zum Behandeln des extrudierten Körpers zum Entfernen und/oder Zersetzen des Bindemittels und mit einer Einrichtung (20) zum Auftragen einer Metallhülle (32) auf den Körper (30), dadurch gekennzeichnet, daß der Extruder (12) den Körper (30) um mindestens einen sich kontinuierlich bewegenden Leiter (5) kontinuierlich extrudiert und, während sich der Körper (30) mit dem darin eingebetteten Leiter (5) bewegt, die Hülle (32) um den sich bewegenden Körper nach der Behandlung zum Entfernen oder Zersetzen des Bindemittels kontinu-
15 ierlich gebildet wird.
14. Vorrichtung nach Anspruch 13, dadurch gekennzeichnet, daß die Behandlungseinrichtung (16) einen Ofen aufweist, durch den sich der Körper bewegt, wobei der Ofen so angeordnet ist, daß er den Körper (30) ohne wesentliche Versinterung auf einen Temperaturbereich erwärmt, bei dem das Bindemittel ent-
20 fernt und/oder zersetzt wird.
15. Vorrichtung nach Anspruch 13 oder 14, dadurch gekennzeichnet, daß die Umhüllungseinrichtung (20) ei-
nen Koextruder aufweist.
- 20 16. Vorrichtung nach Anspruch 15, dadurch gekennzeichnet, daß der Körper (30) im wesentlichen horizontal und geradlinig zwischen der Behandlungseinrichtung (16) und dem Koextruder (20) bewegt wird.
- 25 17. Vorrichtung nach einem der Ansprüche 13 bis 16, mit einer Transporteinrichtung zum im wesentlichen kontinuierlichen Abstützen des Körpers (30) während der Bewegung zwischen der Behandlungseinrich-
30 tung (16) und der Umhüllungseinrichtung (20)

Revendications

- 35 1. Procédé de fabrication d'un câble à gaine métallique et à isolation en matière minérale, ledit procédé comprenant les étapes consistant à traiter un matériau isolant en matière minérale pour former une substance extrudable, ledit traitement comprenant le mélange (51) du matériau au moins avec un liant, à ex-
truder (12) un corps cylindrique de la substance pour obtenir un corps isolant (30), à traiter (16) le corps
40 isolant (30) pour éliminer et/ou décomposer le liant, et à appliquer (20) une gaine métallique (32) au corps (30), caractérisé en ce que le corps (30) est extrudé en continu autour d'au moins un conducteur se dé-
plaçant de façon continue (5) pour fournir un assemblage se déplaçant en continu constitué d'un isolant (30) avec le conducteur (5) inséré dans celui-ci, et qu'ensuite la gaine métallique (32) est appliquée en
continu autour de l'assemblage se déplaçant en continu.
- 45 2. Procédé selon la revendication 1, caractérisé en ce que le traitement du matériau isolant pour former la substance extrudable comporte encore le mélange du matériau avec un liquide qui est éliminé avant l'ap-
plication de la gaine (32) autour du corps isolant extrudé (30), la quantité de liquide mélangé avec le ma-
50 tériel étant telle que, après le traitement du corps isolant extrudé (30) pour éliminer le liquide, le corps (30) présente une résistance mécanique suffisante pour permettre le déplacement en continu du corps (30) jusqu'à un poste auquel la gaine métallique (32) est appliquée.
3. Procédé selon la revendication 2, caractérisé en ce que ledit traitement du corps (30) comprend le chauff-
55 age (16) du corps (30), tandis que celui-ci se déplace avec le conducteur (5) inséré à l'intérieur.
4. Procédé selon la revendication 3, caractérisé en ce que le matériau isolant en matière minérale comporte des particules de céramique, et le chauffage (16) du corps isolant extrudé (30) avant l'application de la
gaine (32) se produit dans une plage de températures inférieure à celle à laquelle un frittage substantiel
des particules se produit.



5. Procédé selon la revendication 4, caractérisé en ce que la taille des particules, la quantité de liquide et la quantité de liant sont telles que l'élimination du liquide, et l'élimination et/ou une décomposition du liant pendant l'étape de chauffage (16) se produisent en l'espace de plusieurs minutes.
- 5 6. Procédé selon la revendication 5, caractérisé en ce qu'une majorité de particules se trouvent dans une gamme de tailles comprise entre environ 30 et 125 microns.
7. Procédé selon l'une quelconque des revendications 2 à 6, caractérisé en ce que la quantité de liquide ajouté est comprise entre environ 4 et 14% en poids.
- 10 8. Procédé selon l'une quelconque des revendications 2 à 7, caractérisé en ce que la quantité de liant est comprise entre environ 1 et 8% en poids.
9. Procédé selon l'une quelconque des revendications 2 à 8, caractérisé en ce que le corps (30) est supporté de façon sensiblement continue pendant son déplacement depuis l'étape de traitement (10) jusqu'au poste (20) auquel la gaine (32) est appliquée.
- 15 10. Procédé selon l'une quelconque des revendications 1 à 9, caractérisé en ce que la gaine (32) est appliquée par filage à la presse (20) à travers une filière annulaire.
- 20 11. Procédé selon la revendication 10, caractérisé en ce que le traitement du corps (30) et le gainage par filage à la presse (20) se produisent sur une trajectoire de mouvement rectiligne sensiblement horizontale du corps (30).
- 25 12. Procédé selon l'une quelconque des revendications 1 à 10, caractérisé par l'étape de réduction du corps gainé à une dimension requise (40).
- 30 13. Appareil pour réaliser un procédé selon la revendication 1 comprenant un extrudeur (12) pour la substance afin de produire un corps extrudé cylindrique (30), des moyens (16) pour traiter le corps extrudé afin d'éliminer et/ou de décomposer le liant, et des moyens (20) pour appliquer une gaine métallique (32) au corps (30), caractérisé en ce que l'extrudeur (12) extrude le corps (30) en continu autour d'au moins un conducteur se déplaçant de façon continue (5) et tandis que le corps (30) avec le conducteur (5) inséré dedans se déplace, la gaine (32) est formée en continu autour du corps mobile après le traitement destiné à éliminer ou décomposer le liant.
- 35 14. Appareil selon la revendication 13, caractérisé en ce que le moyen de traitement (16) comprend un four à travers lequel le corps se déplace, le four étant installé de sorte qu'il chauffe le corps (30) dans une gamme de températures à laquelle le liant est éliminé et/ou décomposé sans provoquer de frittage substantiel du corps.
- 40 15. Appareil selon la revendication 13 ou la revendication 14, caractérisé en ce que le moyen de gainage (20) comprend une presse à filer.
- 45 16. Appareil selon la revendication 15, caractérisé en ce que le corps (30) se déplace de façon sensiblement horizontale et rectiligne entre le moyen de traitement (16) et la presse à filer (20).
- 50 17. Appareil selon l'une quelconque des revendications 13 à 16, comprenant un moyen de transport pour supporter de façon sensiblement continue le corps (30) pendant son déplacement entre le moyen de traitement (16) et le moyen de gainage (20).
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