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(19)

(54) CONDUCTIVE CONNECTIONS

(71) We, LUC TECHNOLOGIES LIMITED, a British Limited Company, of P.O. Box 6, 856 Wilmslow Road, Didsbury, Manchester, M20 85A, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

This invention relates to electrically-conductive connections, and concerns connections between a metallised outer surface of a film material and a metallic surface of a structure such as a substrate or body, to which the film material is arranged to cover at least partially. By "metallised outer surface of a film" is meant the surface remote from the surface of the structure when the film covers, at least partially, the structure.

In one requirement for such an electrical connection a metal body, or a non-metallic body having a metal coating or a metallised surface, is covered with a film of an insulating material having its outer surface metallised. For operational reasons it is necessary that the metallised surface of the film material is electrically connected to the metal part of the body to avoid the build up of high electrical charge on it which could interfere with electronic mechanisms in the body or cause arcing and damage to such mechanisms or to parts of the structure. The requirement is therefore for the metallised surface to be "grounded" to the body preferably by means of a low resistance electrical connection. This has been found very difficult to achieve in practice.

Because of the complex shapes the body can take, it has been found necessary to use many small pieces of the film, or tape, in order to ensure that the body is covered satisfactorily with the result that it is then necessary to ground each piece of film individually and "in situ", either by "direct" connection made between the pieces of film and the body or indirectly between a piece of first film material attached to the body and to adjacent or adjoining pieces of the first film material. Such indirect connections being termed "bridging contacts". These are grounded to the body by way of the "direct" connections.

One example of such a body has a honeycomb structure clad with aluminium and then covered with a film such as Kapton polyimide film (Trade Mark) about 12 μ thick and having a vacuum deposited layer of aluminium about 0.06 μ thick on its surface remote from the body. The film is generally secured to the body by, for example, a double sided adhesive tape. Kapton polyimide film is manufactured by Du Pont and is the subject of a bulletin H-2 issued by Du Pont De Nemours International SA and metallised Kapton polyimide film is the subject of a bulletin H-77 issued by the Electrical Insulation Products Division of Du Pont Film Department.

Difficulty arises when attempting to make an electrical connection to such a metallised film in particular because of the extremly thin metallised layer which does not allow a mechanically strong connection to be made by soldering or conventional welding means, or one having a low resistance to current flow.

Three problems which can be encountered in grounding such a tape are:–

(1) Any connection between the aluminised surface of the Kapton tape must itself be grounded to the basic structure it is covering in particular to prevent build up of high electrostatic charge. The connection cannot be made by soldering or welding to the main structure by conventional means. The configuration and nature of the different elements of the whole structure also make it difficult if not impossible to bolt, tap or screw a connection to it, and such connections are found to deteriorate rapidly with time, either by oxidisation or in conditions of extreme variations in temperature where expansion and contraction rates of the

elements will vary, causing loss of electrical contact or giving contacts of high resistance value. This is paricularly true when this structure is made of aluminium honeycomb with a thin aluminium skin on top, or of anodised aluminium as in some spacecraft for example.

(2) As aforementioned the metallised layer can be less than 1 μ thick, is fragile and has comparatively poor adhesion to the film on which it has been deposited. Therefore a mechanically strong electrical connection having a low resistance value has heretofore been found impossible to accomplish. Soldering or welding will volatise or damage such a thin layer.

(3) The Kapton film is infusible, having no melting point. It can resist extremes of temperature and has no known organic solvent. It is therefore very often used as thermal and/or electrical insulation, but as a result it cannot itself assist in securing a mechanically strong electrical connection. This is a further reason why it has been found impossible to weld this material or to weld a metal contact to it by conventional means.

According to the invention there is provided a electrically conductive connection comprising: a first film material having an extremely thin metallised layer on a surface thereof; a structure having a metallic surface onto which said first film is applied with the surface of the film having the metallised layer facing away from the metallic surface of the structure. a conductive member having one portion connected to the metallic surface of the structure and another portion disposed adjacent the metallised layer of the first film material; and a second, thermoplastic film material having a portion bonded to the portion of the conductive member adjacent the first film material and a portion bonded to the metallised layer of the first film material; whereby electrical connection of said metallised layer of the first film material to the metallic surface of said structure is established and mechanically secured.

Further according to the invention there is provided a method of making an electrical connection between a metallised outer surface of a first film material and a metal or metallised surface of a structure to which the film material is applied, the method comprising the steps of conductively attaching a portion of a conductive member to the said surface of the structure and arranging a second film material having a metallised surface over respective portions of the metallised surface of the first film material and the conductive member and bonding said second film material to said first film material and to said conductive member.

The conductive member may have a portion arranged to overlie a portion of the metallised surface of the first or second film material.

The second film material may have a non-metallised surface or surfaces, but preferably at least one surface is metallised, such as the surface bonded to the first film material and to the conductive member but it has been found that it is not necessary that the metallised surface of the second film be in contact with the two latter materials prior to bonding. In the first case the second film material is bonded to secure, or bond, the conductive member against or to the metallised surface of the first film. In the second case, electrical connection is additionally made between the metallised surface of the first film material and the conductive material by way of the metallised surface of the second film.

Preferably the conductive member is an electrically-conductive material, such as a metal foil or tape of aluminuim, copper, silver, gold or other metal and is preferably of the same nature as the said surface of the structure or the metallised layer of the first film material, or both. Alternatively, the conductive member can if required be of a metallised material, such as a material similar to the second film material. The second film material can be of oriented polyester such as orientated polyethylene terephthalate, a film of polyamide such as nylon, fluorocarbon such as fluoroethylene propylene copolymer, or a polyamide-imide material such as "Film 700" (Trade mark of Rhone Poulenc).

The first and second film materials may be the same or different and preferably are of a plastics material. For example, the first film material may be a polyimide film, such as that sold under the Trade Mark KAPTON, a polyamidimide, a silicone material, or a thermoplastics material and the second film material may be a plastics material such as a polyimide, an orientated polyester such as oriented polyethylene terephthalate, a thermoplastic material, a polyamide such as nylon, a fluorocarbon such as fluorethylene propylene copolymer or a polyamide-imide material such as Film 700 (Trade mark). When a polyimide film is used for the first film material, the second film material is preferably a polyester material.

The first film material may be applied to the substrate so as to be firmly secured, for example by the use of a suitable adhesive such as a contact adhesive, or may be laid on or formed around the substrate and secured thereto, if necessary, by other means.

Preferably the second film material is bonded to the said metallised surface of the first film material and to the conductive material and the conductive member to the first film material or to the substrate by a process as disclosed and/or claimed in the Complete Specifications of British Patents Nos. 1,080,442; 1,224,891; 1,380,558 or 1,385,473.

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

Figure 1 is a cross-sectional view of an

embodiment of an electrical connection according to the invention,

Figure 2 is a cross-sectional view of another embodiment of an electrical connection according to the invention,

Figure 3 is a cross-sectional view of another embodiment of a connection according to the invention,

Figure 4 is a cross-sectional view of another embodiment of a connection according to the invention,

Figure 5 is a cross-sectional view of another embodiment of a connection according to the invention, and

Figures 6 and 7 are perspective views of other embodiments of a connection,

Figures 8 and 9 are perspective views of connections between two metallised films.

In various figures of the drawings, which are not drawn to scale, certain like parts are given like references. In each case, the connection is shown before the welding operation is carried out.

Referring to Figure 1, there is shown an electrical connection according to the invention. A film 12 of KAPTON (Trade Mark) polyimide material about 12 μ thick is secured to an aluminium substrate 14 by means of suitable adhesive 16 such as double sided tape supplied by the 3M Company (for example SCOTCH Trade Mark No. 467), or some classes of adhesives such as epoxies and phenolics. The film 12 has its outer, upper surface 18 (in the drawing) metallised by the vacuum deposition of aluminium to a thickness of about 0.06 μ and the electrical connection is made between this metallised layer 18 and the aluminium substrate 14.

A strip 20 of aluminium foil has a portion 20*a* near one end welded to the substrate 14 and is formed so that a portion 20*b* near its other end overlies and is in contact with the layer 18. To make an electrically conductive and mechanically strong joint between these materials a second film 22 of a thermoplastics material such as an oriented polyester such as Melinex or Mylar (Trade Marks) is provided with a metallised surface 24 and which is laid over portions of the layer 18 and the conductive member 20 as shown with its metallised layer 24 in contact with the layer 18 and member 20.

The film 22 is then bonded to the layer 18 of film 12 and to the strip 20 to provide a permanent electrical connection from layer 18, through layer 24 and aluminium strip 20 to the substrate 14. The film 22 may be bonded to the film 12 and strip 20 by a process such as disclosed in the Specifications of British Patents Nos. 1,080,442; 1,224,891; 1,380,558 or 1,385,473.

In a similar arrangement (not shown) the film 22 can be arranged with its metallised layer 24 remote from the surfaces of layer 18 and the strip 20 to provide a permanent electrical connection from the layer 18 to the substrate 14. Both surfaces of the film 22 could also be metallised.

In another similar arrangement (not shown) the film 22 could be non-metallised and bonded to the metallised layer 18 of film 12 and to the strip 20 securely to hold the strip 20 in position and in good electrical contact with the metallised layer 18. During the bondings process the film 22 can be bonded to the strip 20 and the strip 20 is bonded to the metallised layer 18 of film 12.

Figure 2 shows a cross-sectional view of a modification of the connection of Figure 1 in which the member 20 extends through a slit formed in the film 12 as shown. In addition, a further film 26 of a thermoplastics material, such as a polyester material, is laid over the film 22 and bonded around its periphery thereto to provide some protection for the film 22. Again, the film 26 may be bonded to the film 22 by one of the aforementioned processes.

In the foregoing embodiments, the conductive strip 20 is shown overlying the film 12 but, while preferable in many cases, it is not necessary. It can also be arranged to overly film 22 when, during the bonding process, it will be secured to films 18 and 22.

Figure 3 is a cross-sectional view of another embodiment, similar to that described with reference to Figure 1, wherein two further layers 12*a*, 12*b* of Kapton film are secured to substrate 14 by means of a suitable adhesive 16. The metallised layer 18 of layer 12 is "grounded" to the substrate 14 as hereinbefore described. The metallised layer 18*b* of film 12*b* is electrically connected to the metallised layer 18*a* of film 12*a* by means of a film 22*b* having a metallised surface 24*b* bonded to the layers 18*a*, 18*b* as before. Similarly layer 18*a* is electrically connected to layer 18 by way of a film 22*a* having a metallised surface 24*a*. It has been found that a good electrical connection can be made even if the metallised layers 24*a* and *b* are uppermost (in the drawing), for example by means of the methods disclosed in the aforementioned patent specifications and this has the advantage that a layer 24 *a* and/or 24*b* can be grounded by laying the metallised film 22 over it and/or them and/or as well as over the strip 20. This is presumably because of the thinness of film 22.

Figure 4 shows a cross-sectional view of a part of another embodiment of the invention in which the metallised surfaces 18, 18*a* of two adjacent films 12, 12*a* are electrically connected by bonding a film 28 of a plastics material such a polyethylene terephthalate, Melinex or Mylar polyester film to the metal-said layers 18, 18*a* and then bonding a conductive aluminium, foil 30 to the film 28 and to the layers 18, 18*a* to effect good electrical connection. Layer 18 being connected to the structure 14 on a manner as described with reference to Figure 1.

In the foregoing examples it is believed that one or more of the various films or conductive strips could be secured to its associated part, additionally by means of an adhesive. In all cases the adhesive used must of course be suitable both with regard to compatibility with other materials and the physical and chemical conditions to which it is to be subjected.

Figure 5 shows a cross-sectional view of an embodiment of a connection according to the invention which is similar in many respects to the connections as described in relation to Figure 1 except that the conductive member 20 overlies film 23. In Figure 5 a film 23, such as a film of a polyester material, a polyamide, a polyamide-imide or a fluoro-carbon, having metallised surfaces 23*a* and 23*b* is inserted between the metallised layer 18 and the metal strip 20 which has one end welded to the substrate 14 as described with reference to Figure 1, and the layers 18, 23 and 20 are bonded together to form an electrical connection between layer 18 and the substrate 14. It is found that a good electrical connection can be made if only one surface of the film 23 is metallised. It has also been found advantageous to form an aperture, or apertures through the film 23 to facilitate contact between the aluminium foil 20 and the metallised layer 18.

Another contact configuration is shown in Figure 6 in which a strip 50 of aluminium foil is welded to the metal substrate 14 and then to the uppermost metallised side 52*a* of a strip 52 of a metallised film of polyester, this film 52 is then placed metallised face 52*a* up onto the metallised surface 18 and a small flap 54 is cut in the strip 52 and turned under so as to bring the metallised surface 52*a* of the polyester film into contact with the metallised layer 18. This flap 54 and the contacting end of the film strip is now welded in place thus forming the electrical connection.

In another contact configuration as shown in Figure 7 the metallised surface 56*a* of a polyester film 56 is placed face down on the metallised layer 18 of the Kapton film 12 and welded to it. It is then welded to a strip 58 of aluminium or other metal foil by turning the end of the strip back on itself and so welding its metallised side to the aluminium foil through the foil.

Electrical connections have been made between the metallised surfaces of an insulating material such as polyimide, polyamide-imide and silicone materials and thermoplastics materials such as polyamide, polyester or polyolefin and another metallised surface of a similar or dissimilar material by the use of a bridging strap, strip or wire formed of a material capable of being welded under the conditions of a friction welding process, to both materials. For example two pieces of Kapton having metallised surfaces which can be either adjoining or superimposed, can be connected by means of a metallised film of polyester, or of a polyamide-imide, or a polyamide. The film of polyester can be placed metallised face down onto the metallised Kapton or metallised face up, but the electrical contact will nevertheless be established during the welding operation.

When two pieces 62, 64 of polyester or polyamide-imide or polyamide material having metallised surfaces 62*a*, 64*a* are to be electrically connected, this can be done by welding the ends of a strip 66 of a similar material, itself metallised, to each piece to be connected. This will form a bridging contact between the two as shown in Figure 8. Alternatively, the ends of a strip of metal foil or a wire 68 such as aluminium or copper can be welded to each piece of the metallised material 62, 64 as shown in Figure 9.

A connection according to this invention of the type shown in Figure 5 which will "ground" the metallised surface of the first film material to the substrate, can be made in the following manner. A polyimide (Kapton type H) film metallised on both surfaces comprises the first film material and is applied to a substrate in the form of a circular tube-like body, forming part of a larger structure, by means of a double sided adhesive. A small slit is made in this first film material before it is applied to the substrate. The metallised vacuum deposited layers are of aluminium approximately 1 to 3 μ thick.

To fabricate the connection method steps are as follows:

(1) A length of half hard aluminium foil 15 μ thick and measuring 20 mm x 6 mm comprising the conductive member has one end spot welded to the structure through the slit in the first film material by means of a wheel of hardened steel having a diameter of 25 mm and a contact surface width of 1.5 mm rotating at a speed of 70,000 rpm, which is brought into contact with the upper surface of the foil for 0.25 sec. welding the lower surface of the foil to the substrate.

(2) A second film material of oriented polyester having a vacuum deposited aluminium surface is placed between the first film material and the free end of the conductive member which is folded onto it. The metallised layer of the second film material may be placed either against the metallised layer of the first film material or against the conductive member.

(3) The connection is then welded to achieve the electrical connection by carrying out four spot welds which weld the foil to the second and first film materials and the second film material to the first film material and which are achieved by means of a wheel made of Vespel (Trade Mark of Du Pont de Nemours) polyimide material filled with molybdenum disulphide of 13 mm diameter and having a contact surface or width of 2 mm. While the wheel is rotating at 40,000 rpm its edge or perimeter is bought into contact with a buffer material of

polytetrafluoroethylene coated glass cloth covering the connection in the areas where the welds are to be achieved for a period of 0.45 seconds under very light pressure. The welds achieved in this manner establish the electrical connection between the substrate and the metallised surface of the first film material. The weld interconnects the conductive member and the first and second film materials. The resistance of this connection when measured remotely is not greater than 10 ohms, while the cover to the connection formed of one end of the conductive member which is welded to the substrate has an electrical connection to this substrate of not more than 0.06 ohms.

The metallised surface of the first film material has a surface resisitivity of 3 ohms per centimetre square. The low resistance of the electrical connection to the structure will however prevent any high electrostatic charge build up on the first film material.

According to this invention an electrical connection of the type shown in Figure 3 and which serves to create an electrical connection or bridging contact between two sections of similar or dissimilar first film materials can be achieved by laying a length of two side aluminium metallised polyester film 13 mm long and 6 mm wide and welding it respectively to each section of the first film material. This is done by placing a barrier material in the form of a Kapton type H film over the connection and securing the connection by two spot welds by use of a wheel of Vespel polyimide material having a diameter of 13 mm and a contact surface or width of 2 mm rotating at a speed of 30,000 rpm which is brought into contact with the barrier material for a period of 0.25 seconds. spot welding the metallised layers of the first film materials to the adjacent metallised layer of the polyester film to an electrical connection between the sections of the first film material. The electrical connection thus formed has a resistance when measured remotely, of less than 15 ohms.

WHAT WE CLAIM IS:

1. An electrically conductive connection comprising: a first film material having an extremly thin metallised layer on a surface thereof; a structure having a metallic surface onto which said first film is applied with the surface of the film having the metallised layer facing away from the metallic surface of the structure. a conductive member having one portion connected to the metallic surface of the structure and another portion disposed adjacent the metallised layer of the first film material; and

a second, thermoplastic film material having a portion bonded to the portion of the conductive member adjacent the first film material and a portion bonded to the metallised layer of the first film material. whereby electrical connection of said metallised layer of the first film material to the metallic surface of said structure is established and mechanically secured.

2. A conductive connection according to Claim 1, in which the resistance between the metallised layer of the first film material and the metallic surface of the structure is less than about 10 ohms.

3. An electrically conductive connection according to Claim 1 or 2, in which the said one portion of the conductive member is bonded to the structure.

4. An electrically conductive connection according to Claim 1, 2 or 3, in which said one portion of the conductive member is welded to the structure by a friction bonding process.

5. A conductive connection according to Claim 1, 2, 3 or 4, in which the said other portion of the conductive member is arranged to overlie in electrical contact a portion of the metallised surface of the first film material.

6. A conductive connection according to any one of Claims 1 to 5, in which the said portions of the second film material overlay the respective portions of the metallised surface of the first film material and the conductive member to which they are bonded.

7. A conductive connection according to any one of Claims 1 to 6, in which the second film material is metallised on at least one surface, which surface is bonded to the metallised layer of the first film material and is in contact with the portion of the conductive member adjacent the metallised layer of the first film material.

8. A conductive connection according to any one of Claims 1 to 6, in which the second film material has at least one non-metallised surface which surface overlies the portion of the conductive member adjacent the metallised layer of the first film material to maintain contact of said portion of the conductive member with the metallised layer of the first film material.

9. An electrically conductive connection according to any one of the preceding Claims, in which the said other portion of the conductive member is bonded to the second film material and to the metallised surface of the first film material.

10. An electrically conductive connection according to any one of the preceding Claims, in which said other portion of the conductive member is bonded to the first and second film materials and is mechanically secured by the bond established between the said other portion of the conductive member and the second film material, and the bond between the second film material and the first film material.

11. An electrically conductive connection according to Claims 1 to 10, in which prior to bonding the conductive member is positioned to overly the second film material which itself overlies the first film material and during the bonding operation the conductive member is bonded to the first and second film materials and the second film material to the first film

material.

12. A conductive connection according to any one of the preceding Claims, in which a portion of the conductive member intermediate the said portions respectively secured to the structure and bonded to the second film material extends through an aperure in said first film material.

13. A conductive connection according to any one of the preceding Claims, comprising a third layer of film material having a metallised surface applied to the structure adjacent the first film material with its metallised surface facing away from the metallic surface of the structure, a fourth film material metallised on at least one surface and having portions bonded to the metallised layer of the adjacent first film materials whereby an electrical connection is made between the metallised layers of said adjacent first film materials and to the structure by way of the conductive member.

14. A conductive connection according to any one of Claims 1 to 12 comprising additionally a further layer of first film material having a metallised surface positioned adjacent the first film material with its metallised surface facing away from the metallic surface of the structure and at least one further layer of a conductive material overlying and having a portion bonded to a fourth film material which overlies portions of the first and second films and further portions of the further conductive layer being bonded to the metallised layers of the adjacent first film materials whereby an electrical connection is made between the metallised layer of said adjacent first film materials and the metallic surface of said structure through the first mentioned conductive member.

15. A conductive connection according to Claim 14, in which a further portion of the second film material overlies and is bonded to the further layer of conductive material.

16. A conductive connection according to Claim 1, in which the second film material is metallised on its one surface remote from the metallised surface of the first material and has one portion arranged between the surface of the structure and the portion of the conductive member to which it is bonded and a second portion having a folded part overlapping the metallised surface of the first film material whereby the metallised surfaces of the two films are in contact, the folded part of the second film material being bonded to the first film material.

17. A conductive connection according to Claim 16, in which the folded part of said second film comprises a flap formed in the said second portion of the second film material.

18. A conductive connection according to Claim 2, in which the second film material is metallised on at least one surface and is arranged between the metallised surface of the first film material and said conductive member.

19. A conductive connection according to Claim 1, in which the second film material has a metallised surface bonded to the metallised surface of the first film material and is folded back between the conductive member and the metallic surface of the structure, whereby its metallised surface is in conductive contact with the structure and with the conductive member to which it is bonded.

20. A conductive connection between any one of the preceding Claims, in which the bonding is effected by holdiing said portion of the second film material in initimate contact with said metallised layer of the first film material or to said conductive member or to both and applying a friction bonding process to said portion of the second film or said conductive member or both, the friction resulting from the rapid relative movement between a friction bonding means and a working surface overlying said portion of the second film.

21. A method of making an electrical connection between a metallised outer surface of a first film material and a metal or metallised surface of a structure to which the film material is applied, the method comprising the steps of conductively attaching a portion of a conductive member to the said surface of the structure and arranging a second film material having a metallised surface over respective portions of the metallised surface of the first film material and the conductive member and bonding said second film material to said first film material and to said conductive member.

22. A method according to Claim 21, in which the conductive member is so attached to the said surface of the structure that it overlies a portion of the metallised surface of the first film material and the second film material is arranged to have at least one metallised surface between the metallised surface of the first film material and the conductive meaterial to both of which it is bonded.

23. A method according to Claim 21 or 22, or a method of making a connection as claimed in any one of Claims 1 to 19 in which the second film material is bonded to the first film material and the conductive material to both friction bonding process.

24. A method according to Claim 21, 22 or 23, in which the conductive member is secured to the structure by a friction bonding process.

25. A method according to Claim 21 or 22 or a method of making a connection as claimed in any one of Claims 1 to 19 in which the conductive member is bonded to the first film material through the body of the second film material to which it is simultaneously bonded by a friction bonding process.

26. A method according to Claim 23, 24 or 25, in which the friction bonding process produces a spot weld between the bonded portions.

27. A method according to any one of Claims 23 to 26, in which the friction bonding

process comprises holding two parts to be bonded together in intimate contact in the area in which the bond is to be formed at an interface between them and subjecting them while in intimate contact to a frictional bonding process on a working surface opposite to the area where the bond is to be formed, the frictional bonding process including a relative rubbing movement between a tool and the working surface, parameters of this process being selected so as to produce a high energy level when measured as temperature for an extremely short period of time.

28. A method according to Claim 27 in which the friction bonding process comprises a relative rapid rubbing movement between a friction tool and a working surface on the second film and/or the conductive member remote from the surface to be bonded.

29. A method according to Claim 28 wherein the tool is applied to one surface of a working surface of an intervening material.

30. A method according to Claim 29, in which the intervening material is a layer of polyimide film or glass cloth coated with polytetrafluoroethylene.

31. A method according to Claim 29 or 30 in which the friction bonding step uses a rotating wheel of between 0.3 and 10 cms diameter rotating at 10,000 rpm or above.

32. A method according to any one of Claim 27 to 31, in which the step of bonding the conductive member to the structure comprises using a wheel of about 25 mm diameter and 1.5 mm width rotating at about 60,000 to 80,000 rpm, and contacting the rotating wheel to the conductive member.

33. A method according to Claim 32, using a wheel made wholly or partially of a hardened metal.

34. A method according to Claim 33, in which the wheel is of hardened steel.

35. A method according to any one of Claims 27 to 34 for bonding the second film to the first film and/or the conductive member, using a wheel of about 13 mm diameter and 0.2 mm width rotating at about 30,000 to 50,000 rpm.

36. A method according to Claim 35, in which the wheel is made of a hard insulating material.

37. A method according to Claim 36, in which the wheel is made of polyimide with a molybdenum disulphide filler.

38. A conductive connection made by a method as claimed in any one of Claims 21 to 37.

39. A conductive connection according to any one of Claims 1 to 20 or 38, in which the first film material is a plastics material.

40. A conductive connection according to Claim 38, in which the first film material is a polyimide film, a polyamideimide, a silicone material, or a thermoplastics material.

41. A conductive connection according to Claim 39 or 40, in which the first film material is metallised by vacuum deposition of a metal such as aluminuim.

42. A conductive connection according to any one of Claims 1 to 20 or 38 to 41, in which the second film material is a plastics material such as a polyimide, an oriented polyester-oriented polyethylene teraphthalate, a thermoplastics material, a polyamide, a fluorocarbon, a fluoroethylene propylene copolymer or a polyamide-mide material.

43 A conductive connection according to any one of Claims 1 to 20 or 38 to 41, in which the conductive member is flexible.

44. A conductive connection according to any one of Claims 1 to 20 or 38 to 41, in which the conductive member is a metal.

45. A conductive connection according to any one of Claims 1 to 20 or 38 to 43, in which the conductive member is a metallised film of a plastics material such as oriented polyester, for example, polyethylene terephthalate, nylon, a fluorocarbon, a fluoroethylene propylene copolymer, or a polyamide-imide material.

46. A conductive connection according to any one of Claims 1 to 20 or 38 to 45, in which one or more of said film materials and conductive member is or are secured to an associated part by means of an adhesive.

47. A conductive connection according to any one of Claims 1 to 20 or Claims 38 to 46, in which another first film material having an extremly thin metallised layer on a surface thereof is aplied to said structure with the metallised surface of said film facing away from the structure and another, second metallised film is provided having portions bonded to the metallised layers of the two first said layers to provide an electrical connection between the metallised surfaces of the two first film materials.

48. A method according to any one of Claims 21 to 37, in which one or more of said film materials and conductive member is or are secured to an associated part by means of an adhesive.

49. A conductive connection substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

50. A method of making a conductive connection substantially as hereinbefore described with reference to the accompanying drawings.

52. A method according to any one of Claims 15 to 18, in which the friction bonding process comprises any suitable process as described or claimed in the complete specifications of U.K. Patents Numbers 1,224,891; 1,380,558; 1,385, 473 or 1,080,442.

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1574699 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

FIG. 1

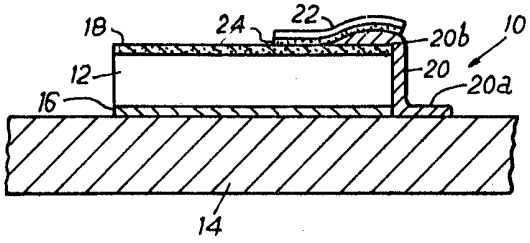

FIG. 2

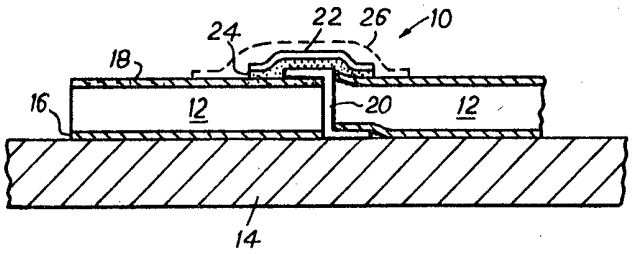

FIG. 3

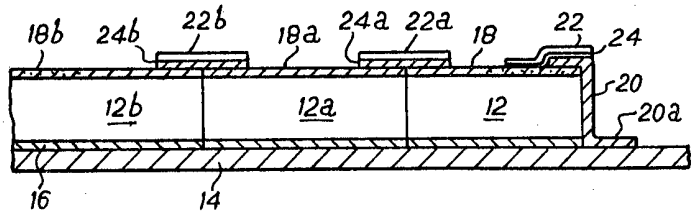

FIG. 4

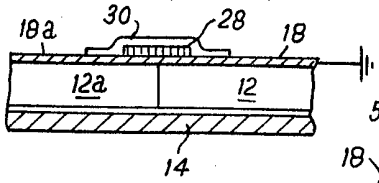

FIG. 7

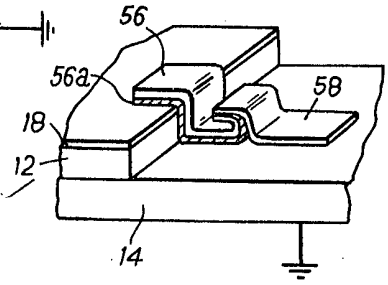

FIG. 8

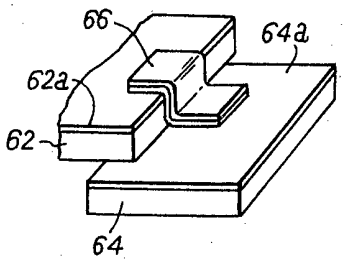

FIG. 5

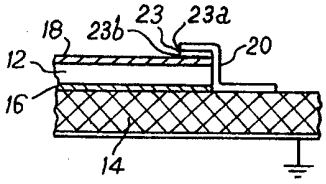

FIG. 6

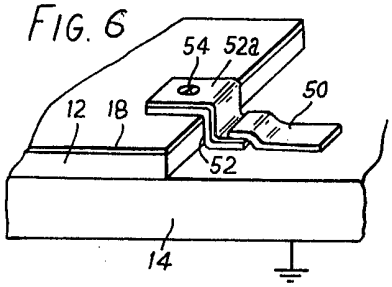

FIG. 9