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Iiyama et al.

[11] **3,808,675**

[45] **May 7, 1974**

[54] **METHOD OF MAKING PIN ELECTRODES FOR ELECTROSTATIC RECORDING**

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[52] **U.S. Cl.** ..... **29/592,** 346/74 ES

[51] **Int. Cl.** **G01d 15/08,** H01s 4/00

[58] **Field of Search** ..... 29/592, 604; 346/139 C, 346/74 ES

[56] **References Cited**

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Assistant Examiner—J. W. Davie
Attorney, Agent, or Firm—Eric H. Waters

[57] **ABSTRACT**

A method of making a pin electrode for electrostatic recording by forming two insulating support plates, each having insulating rod sections juxtaposed thereon in contact with each other and electric wires disposed in successive recessed portions between adjacent insulating rod sections. The two support plates are bonded together while causing the electric wires thereof to face each other with insulation between them.

18 Claims, 6 Drawing Figures

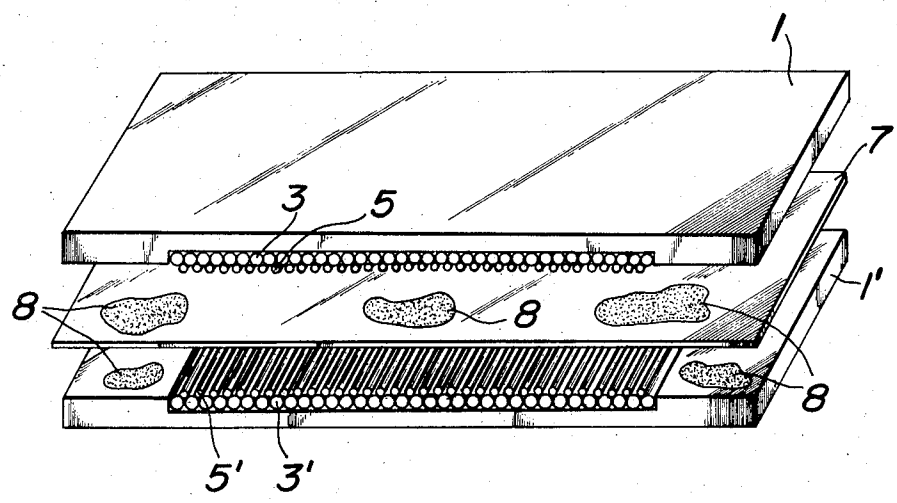


FIG_1

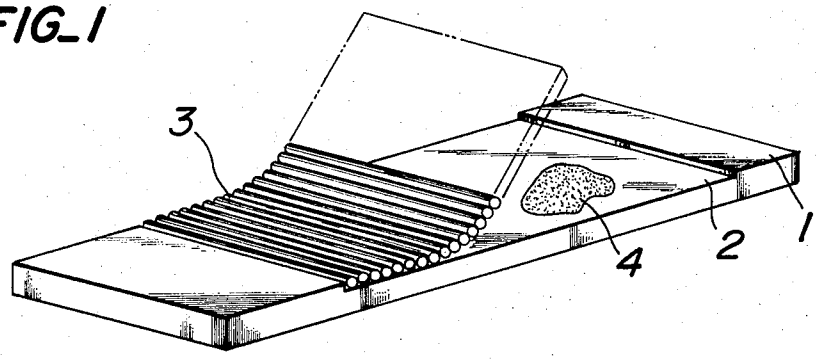


FIG_2

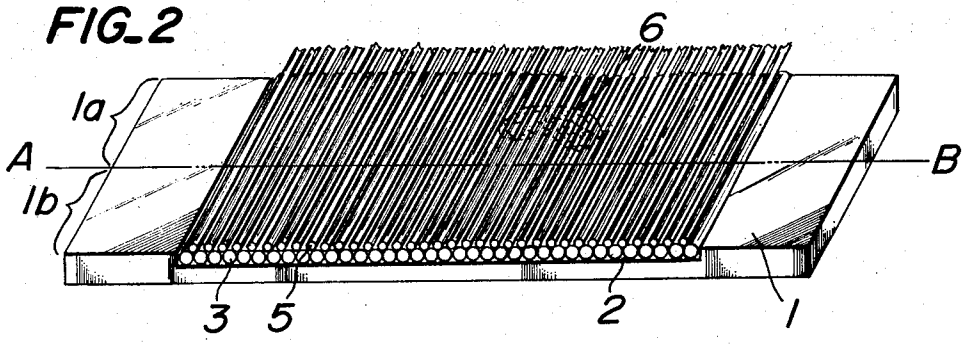


FIG_3

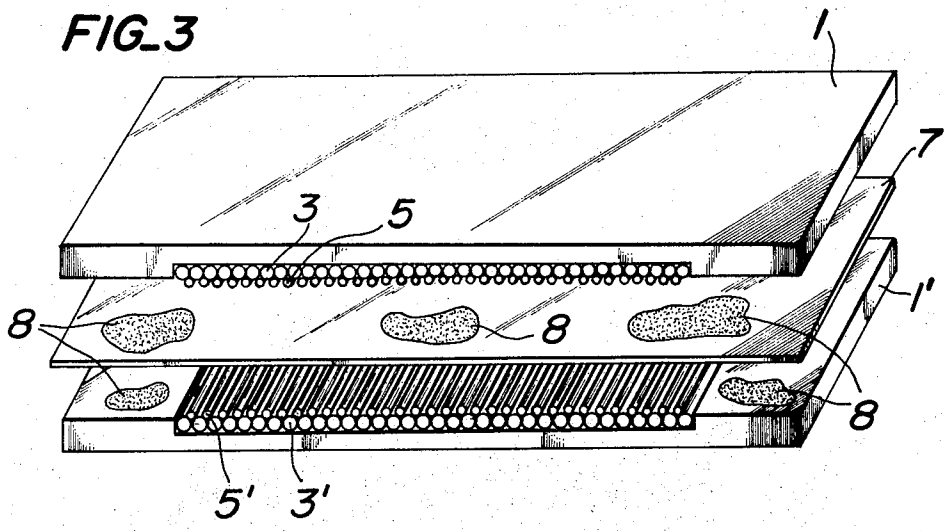


FIG_4

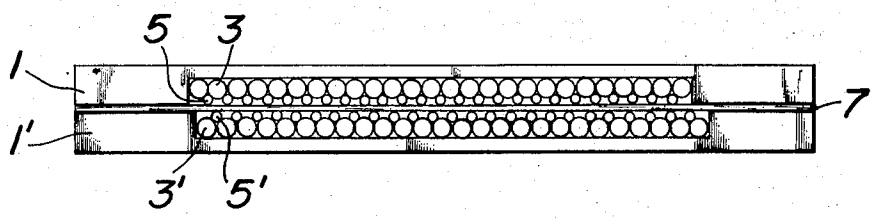


FIG_5

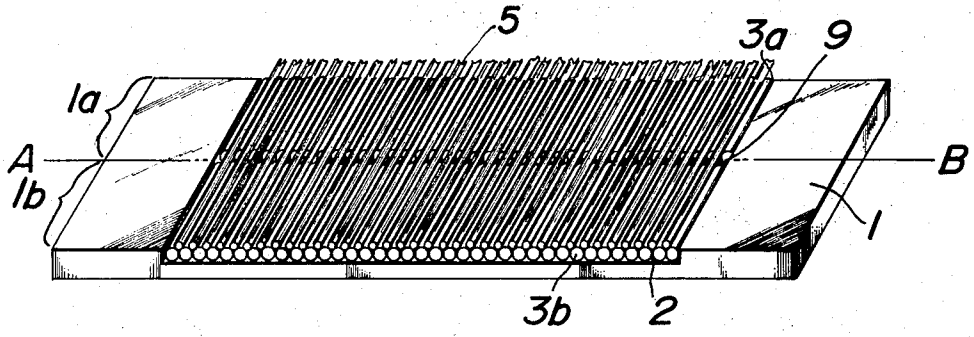
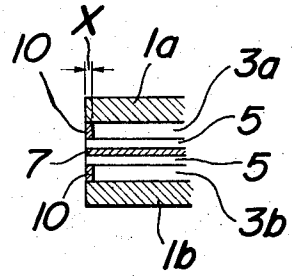


FIG_6



METHOD OF MAKING PIN ELECTRODES FOR ELECTROSTATIC RECORDING

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method of making pin electrodes for electrostatic recording, such as for fascimile communication.

2. Description of the Prior Art

With pin electrodes for electrostatic recording, a very large number of electric wires must accurately be disposed at a very small pitch. Several methods have heretofore been proposed for making such pin electrodes for electrostatic recording, but conventional methods have a shortcoming in that it is difficult or laborious or time-consuming to achieve a high accuracy. Especially, it has been very difficult to make a pin electrode having two parallel rows of electric wires, one row being disposed above the other row with desired relations therebetween.

An object of the present invention is to provide a simple method for making a pin electrode having two rows of electric wires with a very high accuracy.

SUMMARY OF THE INVENTION

An example of the method according to the present invention is characterizied in that parallel rod sections, each made of electric insulating material and having a certain dimeter, are juxtaposed in contact with each other within a wide groove of a given depth which is formed on a support plate made of an electric insulating material. The insulating rod sections are bonded to the support plate by a suitable adhesive. Thus, a continuously waved surface is formed on the insulating rod sections at the side opposite to the support plate. Electric wires are disposed in and bonded to the successive recessed portions of the waved surface, so that a first row of parallel electric wires are bonded to the support plate through the parallel insulating rod sections. A second row of parallel electric wires are similarly formed by using another insulating support plate and insulating rod sections. The two insulating support plates are bonded together while inserting an electrically insulating space therebetween, so that the two rows of parallel electric wires face each other across the spacer. Thus, a pin electrode is formed.

With such method of making the pin electrode, the pitch of the parallel electric wires, or the spacing between the adjacent electric wires, is determined by the diameter of the insulating rod sections which are bonded to the groove of the support plate. Accordingly, the pitch of the electric wires becomes accurate as the accuracy of the insulating rod sections is improved. The relative position of one row of the electric wires to the other row can easily be controlled simply by adjusting the relation between the two insulating support plates. For instance, the electric wires of a first row and the corresponding electric wires of a second row may be aligned with each other on planes which are perpendicular to the plane of the support plate, or the electric wires of the first row may be staggered with the corresponding electric wires of the second row.

In another example of the method according to the present invention, insulating rod sections of a certain diameter are juxtaposed in contact with each other within a wide groove of a given depth which is formed on a support plate made of an electric insulating material. The insulating rod sections are bonded to the support plate by a suitable adhesive. Electric wires are disposed in and bonded to the successive recessed portions between the adjacent insulating wire sections. The assembly of the insulating support plate having the insulating rod sections and the electric wires thus bonded is cut into two halves along a line which is perpendicular to length direction of the insulating rod sections and the electric wires. The two halves thus made may be bonded together in a manner similar to the first example: namely, the two halves are bonded together while inserting an electrically insulating spacer therebetween, so that the two rows of electric wires face each other across the spacer.

With the two halves made by bisecting one insulating support plate, the uniformity of the electric wire distribution among the two rows is considerably improved as compared with that in the case of using two insulating support plates. Thus, the homogeneity of the pin electrode can be easily improved.

In another example of the method according to the present invention, parallel rod sections, each made of electric insulating material and having a certain diameter, are juxtaposed in contact with each other within a wide groove of a given depth which is formed on a support plate made of an electric insulating material. The insulating rod sections are bonded to the support plate by a suitable adhesive. Electric wires are disposed in and bonded to the successive recessed portions between the adjacent insulating rod sections, so that a first row of parallel electric wires are bonded to the support plate through the parallel insulating rod sections. Similarly, a second row of parallel electric wires is formed by using another insulating support plate and insulating rod sections. The two insulating support plates are bonded together while inserting an electrically insulating spacer therebetween, in such a manner that the two rows of parallel electric wires face each other across the spacer and exposed end portions of the electric wires extend outwardly at least beyond the corresponding edges of the row of insulating rod sections or the corresponding edges of the insulating support plates.

With the electric wires having end portions thus extended, the service life of the pin electrode can be improved. When the insulating rod sections of the pin electrode of the aforesaid construction are made of glass fibers, if the end portions of the glass fiber wire sections and the electric wires are simultaneously brought in contact with moving recording papers, the electric wires are worn off faster than the insulating rod sections, because the abrasion resistance of glass fiber is greater than that of the electric wire. Such quick wear of the electric wires results in a relatively short service life of the pin electrode. When the end portions of the electric wires are extended beyond the edge of the insulating rod sections or the edge of the insulating support plate, the overall service life of the pin electrode can be improved.

With the pin electrode which is made by the method according to the present invention, the electric wires of the two rows may be scanned individually for applying recording signals thereto. Instad, it is also possible to simultaneously apply identical recording signals to a pair of electric wires, one each from each of the two rows. In either case, the improved homogeneity or the improved accuracy of the disposition of the electric

wires in the pin electrode of the invention results in a better resolution of recorded images.

BRIEF DESCRIPTION OF THE DRAWING

For a better understanding of the invention, reference is made to the accompanying drawing: in which,

FIG. 1 is a perspective view, showing a row of insulating rod sections which are disposed in a wide groove of a support plate, according to the present invention;

FIG. 2 is a perspective view, showing the manner in which electirc wires are disposed in successive recessed portions on the row of the insulating rod sections;

FIG. 3 is a perspective view of two support plates, each having the row of insulating rod sections and electric wires, which are going to be bonded together with a spacer inserted therebetween;

FIG. 4 is a side view of a pin electrode made by the method according to the present invention, as shown in FIGS. 1 to 3;

FIG. 5 is a perspective view of the manner in which a support plate having a row of insulating rod sections and electric wires is bisected, according to an embodiment of the method of the present invention; and

FIG. 6 is a fragmentary sectional view of a pin electrode made by the bisected halves of the support plate, as illustrated in FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention will now be described by referring to the figures of the accompanying drawing. In FIG. 1, a support plate 1 is made of a suitable electric insulating material, such as Bakelite (which is a Trademark for a phenolic resin, sold by Bakelite Corporation, U.S.A.), and a wide groove 2 with a given depth is bored on one surface of the plate 1. Rod sections 3, which are also made of a suitable electric insulating material, are juxtaposed in the groove 2 in parallel and in contact with each other, as shown in FIG. 1. The insulating rod sections 3 are bonded to the support plate 1 by an adhesive 4.

In the method according to the present invention, the pitch or the spacing between adjacent electric wires is determined by the diameter of the insualting rod sections 3. Therefore, the diameter of the rod sections 3 must be accurate. The insulating rod sections 3 are, for instance, made of glass fibers of 300 to 400 micron diameter. With the currently available techniques, the accuracy of the diameter of such glass fiber can be kept within an allowance of ±2 microns. Accordingly, the error in the pitch of the electric wires in the pin electrode can be kept below ±2 microns.

Referring to FIG. 2, electric wires 5, e.g., copper wires, are disposed within successive recessed portions between adjacent insulating rod sections 3 which are juxtaposed in the groove 2 of the support plate 1. The electric wires 5 are bonded to the insulating rod sections 3 by a suitable adhesive 6. The diameter of the electric wire 5 may be smaller than that of the insulating rod section 3, and it may be, for instance, 180 to 200 microns.

In the embodiment of FIG. 2, the electric wires are disposed on the successive recessed portions between the adjacent insulating sections. It is also possible to dispose the electric wires at every other recessed portions of the insulating rod sections, or at any other suitable intervals. The depth of the groove 2 is such that the farthest edge of each electric wire 5 thus bonded, relative to the bottom of the groove 2, is flush with or projects beyond the plane of the non-grooved portions of the grooved surface of the support plate 1.

The length of each insulating rod section 3 may be substantially the same as the width of the support plate 1. On the other hand, each electic wire 5 should preferably be long enough to facilitate connection to a signal source means (not shown). In the embodiment illustrated in FIG. 2, all electric wires 5 are aligned on a common plane at one end thereof, for the purpose of providing an acting surface of a desired pin electrode, while the opposite ends of the wires 5 are left free for connection to suitable signal source terminals (not shown).

A second support plate 1', which is identical with the first support plate 1, is grooved, and insulating rod sections 3' and electric wires 5' are bonded to the grooved portion of the plate 1' in the same manner as the insulating rod sections 3 and the electric wires 5 of the first support plate 1.

The two support plates 1 and 1' are bonded together by an adhesive 8, while inserting an electrically insulating spacer 7 therebetween, so as to cause the electric wires 5 and 5' face with each other across the spacer 7, as shown in FIG. 3. Upon grinding the edges of the plates 1 and 1' thus bonded, a desired pin electrode can be obtained, as shown in FIG. 4. With the example of FIG. 4, the electric wires 5 of the first support plate 1 are parallel to but staggered with the electric wires 5' of the support plate 1'. Such arrangement of the electric wires 5 relative to the other electric wires 5' can be achieved simply by properly adjusting the relative position between the two support plates 1 and 1'. It is, of course, possible to vertically align the electric wires 5 with the other electric wires 5'.

In another embodiment of the present invention, a support plate 1 having insulating rod sections 3 and electric wires 5 bonded thereto may be biseected along a line AB, as shown in FIG. 2. Thereby, two halves 1*a* and 1*b* of the support plate 1 are provided. The two halves 1*a* and 1*b* are folded along the line AB and bonded together with a spacer 7 inserted therebetween, in the same manner as the two support plates 1 and 1' of FIG. 4. In this case, each wire 5 should have the opposite ends thereof left free for connection to the corresponding signal source terminals (not shown).

With the halves 1*a* and 1*b*, the identity of the diameter between the insulating rod sections 3 and between the electric wires 5 of the two halves is improved, at least in comparison with that in the case of using two separately prepared support plates 1 and 1'. Accordingly, the uniformity of the electric wire distribution in the pin electrode can be improved.

FIG. 5 shows another embodiment of the invention. Two rows of longitudinally aligned insulating rod sections 3a and 3b are juxtaposed within the groove 2 of an insulating support plate 1, with a gap 9 between the two rows. The insulating rod sections 3*a* and 3*b* have an identical length which is slightly shorter than one half of the width of the groove 2. Electric wires 5, each having a length which is substantially the same as the width of the groove 2, are placed in successive recessed portions between adjacent insulating rod sections 3*a* and 3*b* as shown in FIG. 5. The insulating rod sections 3*a*, 3*b* and the electric wires 5 are bonded to the support plate 1 by a suitable adhesive 10, while filling up

the gap 9 with the adhesive. The support plate 1 is bisected along the center line AB of the gap 9, so as to form two halves 1*a* and 1*b* of the support plate. The two halves 1*a* and 1*b* are folded along the center line AB and bonded together with a spacer inserted therebetween, in the same manner as the two support plates 1 and 1′ of FIG. 4. FIG. 6 shows an enlarged sectional view of an edge portion of the pin electrode thus formed. The conductors 5, 5 and the spacer 7 extend beyond the edges of the insulating rod sections 3*a* and 3*b* by a distance X. In the embodiment of FIG. 6, the space corresponding to the distance X is filled with the adhesive 10. In the embodiment of FIG. 5, each wire 5 should have the opposite ends thereof left free for connections to the corresponding signal source terminals (not shown). FIG. 5 shows only one end of each wire 5 being left free, and the opposite ends are fictitiously shown as aligned for the sake of clarity of the illustration.

The electric wire 5 is usually made of copper. If the insulating rod sections 3*a* 3*b* and the support plate 1 are made of a material which has a larger abrasion resistance than that of the copper wire 5, and if all of the circuit wires 5, the insulating rod sections 3*a*, 3*b*, and the support plate 1 are simultaneously rubbed by moving recording papers, the electric wires 5 may be worn off faster than the rod sections and the support plate. Accordingly, the service life of the pin electrode may be comparatively short. On the other hand, if the electric wires 5 are extended beyond the edges of the insulating rod sections 3*a* and 3*b* as shown in FIG. 6, the service life of the pin electrode can be improved. The adhesive 10 filling the portion corresponding to the distance X has an abrasion resistance which is comparable with the electric wire 5, so that the presence of such adhesive 10 does not affect the aforesaid improvement of the service life of the pin electrode. Similarly, the abrasion resistance of the spacer 7, e.g., a polyester sheet, is comparable with that of the electric wire 5, and it does not affect the aforesaid improvement.

With the embodiment of FIG. 4, according to the present invention, the outer edges of the support plates 1, 1′, the insulating rod sections 3, 3′, the electric wires 5, 5′ and the spacer 7 may be aligned on a common plate at first, and then the edges of the support plates 1, 1′ and the insulating rod sections 3, 3′ may be ground so as to cause the edges of the electric wires 5, 5′ and the spacer 7 to project beyond the edges of the support plates and the insulating rod sections. Referring to FIG. 2, it is also possible to position the electric wires 5 on the row of the insulating rod sections 3 in such a manner that the edges of the electric wires 5 extend beyond the edges of the insulating rod sections 3 and the support plate 1. If only the electric wires 5 extend beyond the edges of the insulating rod sections and the support plates, the projecting portions of the electric wires 5 may be bent when they are rubbed by moving recording papers. The construction of FIG. 6 is free from such risk of being bent.

As described in the foregoing disclosure, according to the present invention, there is provided a simple method for making a pin electrode having an accurate pitch of electric wires.

It should be noted here that the scope of the present invention is not restricted to the illustrated embodiments, but numerous changes can easily be made. For example, instead of forming a groove on the support plate for receiving the insulating rod sections, a suitable jig means may be used for properly disposing the insulating rod sections on the flat surface of a support plate. Furthermore, the spacer 7 to be inserted between the two support plates may be dispensed with by using an electrically insulating adhesive for bonding the support plates while electrically isolating the individual electric wires 5 from each other.

We claim:

1. A method of making a pin electrode for electrostatic recording, comprising the steps of cutting a plurality of insulating rod sections of a given diameter at a predetermined length, juxtaposing the rod sections in contact with each other on a support plate made of an electric insulating material, bonding the rod sections to the support plate, the length of the rod sections being substantially the same as the width of the support plate, placing electric wires in recessed portions between adjacent rod sections at regular intervals, bonding the electric wires to the rod sections, similarly disposing and bonding insulating rod sections and electric wires on another support plate of a similar material and dimensions with the first-named support plate, and bonding the two support plates together while causing the electric wires of one support plate to face the wires of the other support plate, and electrically insulating the individual electric wires from each other.

2. The method according to claim 1, wherein an electrically insulating spacer is inserted between the two support plates for insulating the electric wires.

3. The method according to claim 1, wherein the electric wires of the two support plates are insulated from each other by an adhesive which bonds the two support plates.

4. The method according to claim 1, wherein the insulating rod sections are made of glass fibers, and the electric wires are made of copper.

5. The method according to claim 1, wherein a groove is formed on the support plate for receiving said insulating rod sections therein.

6. The method according to claim 1, wherein the electric wires of the two support plates are disposed in a staggered fashion when the two support plates are bonded.

7. A method of making a pin electrode for electrostatic recording, comprising the steps of cutting a plurality of insulating rod sections of a given diameter at a predetermined length, juxtaposing the rod sections in contact with each other on a support plate made of an electric insulating material, bonding the rod sections to the support plate, the length of the rod sections being substantially the same as the width of the support plate, placing electric wires in recessed portions between adjacent rod sections at regular intervals, bonding the electric wires to the rod sections, cutting the support plate into two halves along a line extending at right angles to the length direction of the rod sections and the electric wires, folding the two halves along the line so as to cause the electric wires of one half support plate to face the wires of the other half, and bonding the two havles while insulating the individual electric wires from each other.

8. The method according to claim 7, wherein an electrically insulating spacer is inserted between the two support plates for insulating the electric wires.

9. The method according to claim 7, wherein the electric wires of the two support plates are insulated

from each other by an adhesive which bonds the two support plates.

10. The method according to claim **7,** wherein the insulating rod sections are made of glass fibers, and the electric wires are made of copper.

11. The method according to claim **7,** wherein a groove is formed on the support plate for receiving said insulating rod sections therein.

12. The method according to claim **7,** wherein the electric wires of the two halves are disposed in a staggered fashion when the two halves are bonded.

13. A method of making a pin electrode for electrostatic recording, comprising the steps of cutting a plurality of insulating rod sections of a given diameter at a predetermined length, juxtaposing the rod sections in two spaced rows, the rod sections in each row being in contact with each other on a support plate made of an electric insulating material, bonding the rod sections to the support plate, the length of the rod sections being slightly shorter than one half of the width of the support plate, placing electric wires in recessed portions between adjacent rod sections at regular intervals, bonding the electric wires to the rod sections, cutting the support plate into two halves along a line bisecting the space between the two rows of rod sections at right angles to the length direction of the rod sections and the electric wires, folding the two halves along the line so as to cause the electric wires of one half support plate to face the wires of the other half, while extending cut edge portions of the electric wires beyond cut edge portions of the rod sections, and bonding the two halves while keeping the electric wire edge portions extended, and electrically insulating the individual electric wires from each other.

14. The method according to claim **13,** wherein an electrically insulating spacer is inserted between the two support plates for insulating the electric wires.

15. The method according to claim **13,** wherein the electric wires of the two support plates are insulated from each other by an adhesive which bonds the two support plates.

16. The method according to claim **13,** wherein the insulating rod sections are made of glass fibers, and the electric wires are made of copper.

17. The method according to claim **13,** wherein a groove is formed on the support plate for receiving said insulating rod sections therein.

18. The method according to claim **13,** wherein the electric wires of the two halves are disposed in a staggered fashion when the two halves are bonded.

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