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DESCRIPTION

MANUFACTURING METHOD OF CIRCUIT BOARD,
5 MANUFACTURING APPARATUS FOR IT, AND
POROUS SHEET USED IN IT

Technical Field

The present invention relates to a
10 manufacturing method of circuit board and a porous
sheet, more specifically a manufacturing method of
circuit board comprising a process of filling a
conductive material in pierced holes of the plate
for circuit board, a manufacturing apparatus and a
15 porous sheet used for it.

Background Art

A manufacturing method of circuit board has a
process of forming pierced holes (through holes)
20 in said plate serving as base material of circuit
board and a printing process for printing
conductive material on that plate. This printing
process comprises a process of forming a
conductive layer of prescribed pattern on the
25 surface of said plate, and a process of filling a
conductive material in said pierced holes



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(metallizing process) to ensure electric continuity between the both surfaces of said plate. Conventionally, for filling the conductive material sufficiently in the pierced holes in the latter metallizing process, the plate for circuit board was placed on the printing stage and, while the pierced holes in the plate were vacuum sucked, the conductive material was filled in the pierced holes. Fig. 4 indicates that conventional method.

As shown in Fig. 4, air intake ports 37 are formed on a printing stage 32, and the air intake ports 37 have holes slightly larger than the pierced holes 36. At the position where the air intake ports 37 correspond to the pierced holes 36, a plate 31 for circuit board is placed on the printing stage 32. In this state, vacuum suction is performed from under the printing stage 32. With this vacuum suction, the air in the pierced holes 36 is sucked through these air intake ports 37. In this state, the conductive material 35 put on a screen mesh 33 placed on the plate 31 for circuit board is screen printed. In the screen process printing, the conductive material 35 is printed inside the pierced holes 36 through a screen mesh 33 by means of a squeegee 34. As a result of this screen process printing, the

conductive material 35 is filled in the pierced holes 36.

However, in the conventional printing process described above, each time when the position of pierced holes 36 in the plate 31 for circuit board changes, the position of the air intake ports 37 in the printing stage 32 must also be changed. For that reason, the manufacturing cost of the printing stage 32 becomes high. Moreover, in said conventional method, part of the conductive material 35 filled in the pierced holes 36 moves into the air intake ports 37. For that reason, as the number of times of printing process increases, the conductive material 35 gradually accumulates in the air intake ports 37. When the number of times of printing process further increased, the conductive material 35 also passed to the back side of the plate 31, producing a deposit of dirt there, and the conductive material 35 was transferred to the surrounding area on the bottom face side of the pierced holes 36 and, as a result, said method caused occurrence of short-circuit in the circuit board.

The present invention provides a manufacturing method of circuit board, not requiring any change of specifications of the printing stage at each

change of specifications of the plate for circuit board nor producing any dirt on the back side of the plate for circuit board, and a porous sheet used it.

SUMMARY OF THE INVENTION

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According to one aspect of the present invention, there is provided a method of manufacturing a circuit board, comprising the steps of:

- (a) feeding a printing stage having a porous member permeable in the direction of thickness,
- 10 (b) placing a plate for circuit board having a pierced hole above said porous member, and
- (c) a process of filling a conductive material in said pierced hole from the upper side of said plate for circuit board by sucking said porous member at prescribed vacuum pressure from the back side of said porous member;

15 wherein said porous member has a porous plate permeable in the direction of thickness and a porous sheet containing cellulose in the range of approximately 90 wt% to approximately 98 wt% and permeable in the direction of thickness, and

said plate is placed on the top face side of said porous sheet.

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According to another aspect of the present invention, there is provided apparatus for manufacturing a circuit board comprising:

a printing stage having a porous member permeable in the direction of thickness, capable of placing a plate for circuit board above said porous member and,

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a suction mechanism for sucking said porous member at prescribed vacuum pressure from the back face side of said porous member, and

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a coating mechanism for coating a conductive material on said plate for circuit board placed on said printing stage, from the top face side of said printing stage, capable of coating said conductive material on the surface of said plate for circuit board from the upper side of said plate while said plate is being sucked as said porous member is subjected to vacuum suction from the back face side of said printing stage,

wherein said porous member has a porous plate permeable in the direction of thickness and a porous sheet composed of cellulose and permeable in the direction of thickness placed on said porous plate, and said plate is placeable on the top face side of said porous sheet.

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In the latter case the porous sheet may also contains cellulose in the range of approximately 90 wt% to approximately 98 wt% .

Preferably in either aspect, said porous plate plays the role of said printing stage.

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Said porous sheet may be replaceable and, moreover, a process of replacing said porous sheet is provided.

15 It is preferable that said cellulose

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contains softwood kraft pulp in the range of approximately 20 wt% to approximately 40 wt% and hardwood kraft pulp in the range of approximately 60 wt% to approximately 80 wt%.

5 With the construction described above, there is no more need of changing the specifications of porous plate and porous sheet as printing stage each time when the specifications of the plate for circuit board are changed, and it becomes possible
10 to fill a conductive material easily in pierced holes of the base material for circuit board with different specifications. Furthermore, adhesion of conductive material and dirt to the back face of the plate for circuit board is prevented.

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Brief Description of Drawings

Fig. 1 is a partial sectional view showing the manufacturing apparatus of circuit board of an embodiment of the present invention.

20 Fig. 2 indicates a sectional view showing the manufacturing process in an embodiment of the manufacturing method of circuit board according to the present invention.

Fig. 3 indicates a sectional view showing the
25 state in which a conductive material is filled in the pierced holes of a plate for circuit board.

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Fig. 4 indicates a partial side sectional view showing the conventional printing method.

Best Mode for Carrying Out the Invention

5 Various studies were made and a variety of experiments were conducted and, as a result, the present invention was completed. Namely, an idea was conceived of constituting the printing stage with a porous plate having mechanical strength and
10 a porous sheet having accurate surface, and it was also confirmed that use of specific cellulosic sheet as porous sheet is preferable.

An embodiment of the manufacturing method of circuit board according to the present invention
15 comprises a process of placing a plate for circuit board forming pierced holes on a printing stage and a process of filling a conductive material in said pierced holes from the surface side of the plate for circuit board through the printing stage
20 from the back side of the printing stage.

The manufacturing apparatus of circuit board according to the present invention comprises a printing stage having a porous member permeable in the direction of thickness, a suction mechanism
25 for sucking said porous member at prescribed vacuum pressure from the back side of said

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printing stage, and a coating mechanism for coating a conductive material on said plate for circuit board placed on said printing stage, from the upper side of said printing stage. The plate
5 for circuit board can be placed above said porous member, and said conductive material can be coated on the surface of said plate for circuit board from the upper side of said plate for circuit board.

10 Particularly preferably, said porous member plays the role of a printing stage.

Particularly preferably, the printing stage has a porous member. That porous member has a porous plate and a porous sheet, and is
15 constructed as the porous sheet is placed on the porous plate. Moreover, particularly preferably, said porous sheet contains cellulosic sheet. That cellulosic sheet contains 20 to 40 wt% of softwood kraft pulp and 60 to 80 wt% of hardwood kraft pulp.
20 Furthermore, that cellulose represents 90 to 98 wt% of the entire cellulosic sheet.

In the printing method of this embodiment, the printing stage comprises a porous plate having a strong mechanical strength sufficient for
25 holding the plate for circuit board and a porous sheet having accurate surface placed on it.

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The porous plate, obtained by working powdery material, has such property that a plurality of voids formed among the powdery material enable ventilation in the direction of thickness. For example, the porous plate is constituted, at least, with a sintered metal plate or a porous ceramic plate, etc. and has a thickness of approximately 1 mm to approximately 10 mm. That porous plate has a structure enabling passage of gas in the direction of thickness, at portions where the plate for circuit board is supported. For example, that porous plate has continuous pierced holes passing through from surface to back face. The sintered metal plate or porous ceramic plate has continuous ultrafine pores. Moreover, that porous plate has mechanical strength for protection against cracking or breaking due to suction force of vacuum suction, in the state in which the plate for circuit board is supported.

The porous sheet has a thickness of approximately 20 μm to approximately 80 μm , for example. That porous sheet is porous, at least, on the entire area of the portion at which it is in contact with the plate for circuit board, and has a structure enabling passage of gas in the direction of thickness at all positions facing the

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plate for circuit board. Namely, the porous sheet has air permeability. That porous sheet has an accurate surface and, for that reason, is finished smooth at the portion of pierced holes which gets
5 in contact with the surface of the circuit board. In that case, as degree of accuracy, a density of approximately 0.3 g/cm^3 to approximately 0.8 g/cm^3 is desirable. Furthermore, in the case where the specific gravity of the pulp is supposed to be
10 approximately 1, the porous sheet shall preferably have a porosity in the range from approximately 0.3 to approximately 0.8, considering the density. In the case where the density is no higher than 0.3 g/cm^3 , the surface roughness of the porous
15 sheet gets higher, having bad influences on the circuit board. In the case of a density no less than approximately 0.8 g/cm^3 , the air permeability of the porous sheet gets low.

The porous sheet used in this embodiment will
20 be described concretely hereafter. This porous sheet contains 90 to 98 wt% of cellulose. That cellulose contains approximately 20 to approximately 40 wt% of softwood kraft pulp and approximately 60 to approximately 80 wt% of
25 hardwood kraft pulp. In the case where the cellulose content in the porous sheet is no higher

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than 90 wt%, the tensile strength of the sheet becomes weak. On the other hand, in the case where the cellulose content is no lower than 98 wt%, the flexibility diminishes, and a
5 construction containing at least one of water content and additive as component other than cellulose in the porous sheet is also possible. As additive, polyethylene oxide, etc. may be used, for example.

10 The raw material of the cellulose in this embodiment will be described hereafter. This cellulose has an advantage of providing a porous sheet with sufficient strength and little production of fiber refuse as the proportion of
15 softwood pulp content increases. However, in the case where the proportion of softwood pulp is higher than the range mentioned above (approximately 40 wt%), the smoothness of the surface gets poorer and, for that reason, the
20 degree of contact between the pierced hole portion of the plate for circuit board and the porous sheet becomes variable. As a result, variations of suction force are produced, causing defective filling of the conductive material to be filled in
25 the pierced holes. On the other hand, as the proportion of hardwood pulp content increases, the

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absorbability of the conductive material sucked by the porous sheet improves, providing porous sheet with excellent surface smoothness. However, in the case where the proportion of hardwood pulp is higher than the range mentioned above (approximately 80 wt%), the air permeability tends to drop. As a result, the suction force becomes weaker, to eventually produce a large amount of fiber refuse. In this way, defective filling comes to be produced easily. For that reason, in the case where an ordinary toilet paper is used, for example, a large amount of dust and fiber refuse coming out of this paper clogs the pierced holes, eventually leading to frequent production of defective filling. On the other hand, in the case of use of high-quality paper, the conductive material cannot be absorbed well because of a drop of air permeability.

In the case where a printing stage having porous plate and porous sheet is sucked from its back face side, the plate for circuit board is subject to a suction force through those porous plate and porous sheet. Moreover, even in the case where the position and dimensions of pierced holes in the plate for circuit board changed with some change of product specifications, it becomes

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possible for the plate for circuit board to be submitted to a suction force, through those porous plate and porous sheet, without being influenced by such change of product specifications. Namely, 5 the printing stage used in this embodiment does not require any suction hole of prescribed shape. The printing stage used in this embodiment, which does not have any suction hole of prescribed shape, prevents accumulation of conductive material in 10 such holes and on the back face. In a printing process placed under such state of vacuum suction, there are cases where part of the conductive material filled in the pierced holes adheres to the porous sheet but, in that case, only the 15 porous sheet is replaced, at a proper point in time when the number of times of printing progressed. With this porous sheet only, it becomes possible to prevent transfer of such deposit to the plate for circuit board.

20 The manufacturing method of circuit board of this embodiment comprises a process of placing a plate for circuit board forming pierced holes on the printing stage and a process of filling a conductive material in said pierced holes from the 25 surface side of the plate for circuit board while sucking said plate for circuit board from the back

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side of that printing stage.

In this method, ceramic green sheet, organic resin base material or metal substrate, etc. are used, for example, as plate for circuit board.

5 As conductive material, an ordinary conductive material is used. For example, a conductive material is composed of a main component of metal powder such as Cu, Ag, Au, W, Mo, etc., a binder such as ethyle cellulose, etc. and a solvent such
10 as terpeneol, etc. The proportion of blending of those component elements is approximately 70 to approximately 95 wt% of metal powder and approximately 30 to approximately 5 wt% of binder and solvent components, for example.

15 As for the method of filling conductive material in the pierced holes, such method as screen printing method or metal mask printing method, etc. are used.

As suction pressure (degree of vacuum), a
20 range from approximately 100 to approximately 500 mmHg is preferable, for example. In the case where the suction pressure is no higher than approximately 100 mmHg, the conductive material may not be filled sufficiently in the pierced
25 holes. In the case of a suction pressure no lower than approximately 500 mmHg, there is a risk of

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producing a void or depression at the center of the pierced holes.

Exemplary embodiment:

5 An exemplary embodiment of the manufacturing method of circuit board according to the present invention, manufacturing apparatus for it and porous sheet used in that manufacturing method will be explained concretely hereafter with
10 reference to drawings. Fig. 1 indicates an apparatus for coating a conductive material on a plate for circuit board. Fig. 2 indicates a process of filling the conductive material in pierced holes of the plate for circuit board. Fig.
15 3 indicates the state in which the conductive material is filled in the pierced holes.

In Fig. 1 and Fig. 2, the printing stage 10 has a porous plate 8 and a porous sheet 9. The porous plate 8 has a mechanical strength
20 sufficient for holding the plate for circuit board, is made by sintering metal particles of particle size 40 μm , and is a sintered metal plate with a thickness of 2.0 mm. The porous sheet 9 is a paper containing 95 wt% of cellulose and water
25 content. Said cellulose has 30 wt% of softwood kraft pulp and 70 wt% of hardwood kraft pulp. The

surface roughness of the porous sheet 9 is 30 sec/surface (value obtained by the test method of JIS-P 8119). The thickness of the porous sheet 9 is 50 μm .

5 On this porous sheet 9 was placed a plate for circuit board 1 forming pierced holes 6 with a diameter of 0.15 mm. This plate for circuit board 1 consists of a green sheet of a thickness of 200 μm . Green sheet means sinterable sheet composed
10 of ceramic powder and a binder.

On the back side of the porous plate 8 is provided a suction mechanism 12. The suction mechanism 12 has a vacuum pump 12a and a wind tunnel 12b installed on the back face side of the
15 printing stage 2. The conductive material 5 was printed and filled in the pierced holes 6 through the screen mesh 3 by sliding the squeegee (skid) 4, while performing vacuum suction at a pressure of 300 mmHg from the back side of the plate for
20 circuit board 1. Namely, the conductive material 5 was filled in the pierced holes 6, by the screen process printing method in the state of vacuum suction. The conductive material 5 consists of a Ag paste having 80 wt% of Ag and 20 wt% of binder
25 and solvent. At that time, a suction force which passed through the porous plate 8 and the porous

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sheet 9 works on the pierced holes 6 and, by that suction force, the conductive material 5a is filled adequately into the pierced holes 6. And yet, the filled conductive material 5 no longer
5 turned to the back side of the plate for circuit board 1, and no foreign matters or dirt, etc. adhered to the back face of the plate for circuit board 1. The filled conductive material 5a does not contain any air bubbles.

10 Next, on the green sheet 1, the pierced holes 6 of which are filled with the conductive material 5a, was coated a Ag paste containing silver powder, and prescribed inner layer circuit was formed. Green sheets having various inner layer circuits
15 were prepared with repetition of such processes, and by using different green sheets. 6 green sheets 1 having this inner layer circuit are put one upon another, and hot pressed at a temperature of 100°C and a pressure of 100 kg/cm². A layered
20 product obtained this way was submitted to a binder removing treatment for 2 hours at 400°C, and then sintered for an hour at 900°C. Lastly, on the outermost layer of this sintered body was formed a prescribed outermost layer pattern with
25 Ag/Pd paste containing silver powder and lead powder, and then sintered at a temperature of 850°C.

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A circuit board was completed in this manner.

Industrial Applicability

With the construction of the present invention,
5 there is no more need of changing the
specifications of porous plate and porous sheet as
printing stage each time when the specifications
of the plate for circuit board are changed, and it
becomes possible to fill conductive material in
10 the pierced holes of plates for circuit board
having different specifications easily, by means
of a set of specifications of porous plate and
porous sheet. Moreover, adhesion of conductive
material and dirt to the back face of the plate
15 for circuit board is prevented.

CLAIMS

1. A method of manufacturing a circuit board, comprising the steps of:
 (a) feeding a printing stage having a porous member permeable in
5 the direction of thickness,
 (b) placing a plate for circuit board having a pierced hole above said
porous member, and
 (c) a process of filling a conductive material in said pierced hole from
the upper side of said plate for circuit board by sucking said porous member at
10 prescribed vacuum pressure from the back side of said porous member;
 wherein said porous member has a porous plate permeable in the
direction of thickness and a porous sheet containing cellulose in the range of
approximately 90 wt% to approximately 98 wt% and permeable in the direction
of thickness, and
15 said plate is placed on the top face side of said porous sheet.
2. The manufacturing method of Claim 1, wherein said porous sheet is
replaceable, further comprising the step of replacing said porous sheet with another
porous sheet.
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3. The manufacturing method of Claim 1, wherein said porous sheet is
composed of cellulosic sheet containing softwood kraft pulp and hardwood kraft
pulp.
- 25 4. The manufacturing method of Claim 1, wherein said porous sheet is
a cellulosic sheet containing softwood kraft pulp in the range of approximately 20
wt% to approximately 40 wt% and hardwood kraft pulp in the range of approximately
60 wt% to approximately 80 wt%.
- 30 5. The manufacturing method of Claim 1, wherein said porous plate is
obtained by working powdery material, and a plurality of voids formed among the
powdery material enable ventilation in the direction of thickness.

6. The manufacturing method of Claim 1, wherein said porous plate is a metal sintered body obtained by sintering metal powder.

7. The manufacturing method of Claim 1, wherein said porous sheet
5 has a thickness of approximately 20 μm to approximately 80 μm , and said porous plate has a thickness of approximately 1 mm to approximately 10 mm.

8. The manufacturing method of Claim 1, wherein the pressure for
10 sucking said porous member with vacuum pressure is in the range from approximately 100 mmHg to approximately 500 mmHg.

9. The manufacturing method of Claim 1, wherein said porous sheet has a density of approximately 0.3 g/cm^3 to approximately 0.8 g/cm^3 .

10. The manufacturing method of Claim 1, wherein, in said process (c),
15 said conductive material is filled in said pierced hole, at least one method of screen printing method and metal mask printing method.

11. Apparatus for manufacturing a circuit board comprising:
20 a printing stage having a porous member permeable in the direction of thickness, capable of placing a plate for circuit board above said porous member and,
a suction mechanism for sucking said porous member at prescribed vacuum pressure from the back face side of said porous member, and
25 a coating mechanism for coating a conductive material on said plate for circuit board placed on said printing stage, from the top face side of said printing stage, capable of coating said conductive material on the surface of said plate for circuit board from the upper side of said plate while said plate is being sucked as said porous member is subjected to vacuum suction from the back
30 face side of said printing stage,
wherein said porous member has a porous plate permeable in the direction of thickness and a porous sheet composed of cellulose and permeable in the direction of thickness placed on said porous plate, and

said plate is placeable on the top face side of said porous sheet.

12. The apparatus of Claim 11, wherein said porous plate plays the role of said printing stage.

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13. The apparatus of Claim 11, wherein said porous plate has a mechanical strength sufficient for holding said plate for circuit board, and said porous sheet has an accurate surface for finishing the surface of said plate for circuit board smooth.

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14. The apparatus of Claim 11, wherein said porous sheet is provided in a way to be replaceable.

15. The apparatus of Claim 11, wherein said porous plate has a pierced hole, so that said conductive material may be filled easily in said pierced hole by suction force.

16. The apparatus of Claim 11, wherein said porous sheet is composed of cellulosic sheet containing softwood kraft pulp and hardwood kraft pulp.

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17. The apparatus of Claim 11, wherein said porous sheet is a cellulosic sheet containing softwood kraft pulp in the range of approximately 20 wt% to approximately 40 wt% and hardwood kraft pulp in the range of approximately 60 wt% to approximately 80 wt%.

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18. The apparatus of Claim 11, wherein said porous plate is a worked body of powdery material and has such property that a plurality of holes formed among said powdery material enable ventilation in the direction of thickness.

19. The apparatus of Claim 11, wherein said porous plate is a metal sintered body obtained by sintering metal powder.

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21. The apparatus of Claim 11, wherein said porous sheet has a density of approximately 0.3 g/cm^3 to approximately 0.8 g/cm^3 .

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