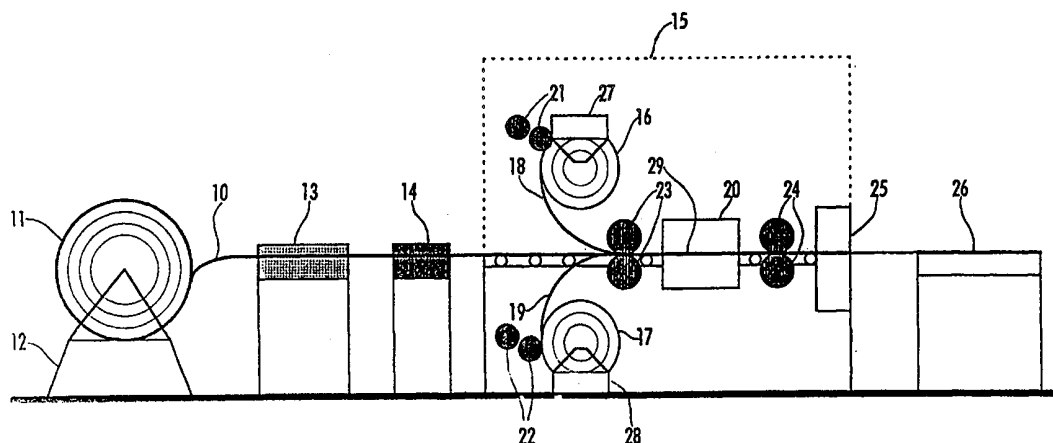




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : H05K 3/02	A1	(11) International Publication Number: WO 00/16596 (43) International Publication Date: 23 March 2000 (23.03.00)
(21) International Application Number: PCT/IT99/00283 (22) International Filing Date: 6 September 1999 (06.09.99) (30) Priority Data: TO98A000779 14 September 1998 (14.09.98) IT (71) Applicant (for all designated States except US): VIASYSTEMS S.R.L. [IT/IT]; Via Carlo Viola, 65, I-11026 Pont Saint Martin (IT). (72) Inventor; and (75) Inventor/Applicant (for US only): PEDRETTI, Giuseppe [IT/IT]; Via Carpena, 13, I-26100 Cremona (IT). (74) Agent: CASUCCIO, Carlo; Olivetti S.p.A., Via G. Jervis, 77, I-10015 Ivrea (IT).		(81) Designated States: CA, CN, JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

(54) Title: COMPONENT FOR MULTILAYER PRINTED CIRCUIT BOARD, METHOD OF PRODUCTION THEREOF AND ASSOCIATED MULTILAYER PRINTED CIRCUIT BOARD

**(57) Abstract**

A method is described for the manufacture of a Copper-Aluminium-Copper component (C-A-C "sandwich") which can be used in the production of multilayer printed circuit boards, obtained by means of joining two external sheets of copper to one internal sheet of aluminium by means of a process of electro-mechanical or mechanical joining, which does not require the use of additional material (such as, for example, an adhesive) and guarantees a consistently high level of quality. According to a first embodiment, the joining process, normally continuous, is based on the use of a sonotrode to effect ultrasonic welding, wherein a single ultrasonic weld provides two joining zones between the two external copper sheets and the one internal aluminium sheet. Alternatively, the joining process is based on the exploitation of the plasticity of the materials under the action of knurling wheels in order to effect the joining of the various sheets. At last, according to a further embodiment, the component is manufactured with at least one layer of resin deposited externally on one of the external faces of the two copper sheets, which are not into contact with the internal aluminium sheet.

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COMPONENT FOR MULTILAYER PRINTED CIRCUIT BOARD, METHOD OF PRODUCTION THEREOF AND ASSOCIATED MULTILAYER PRINTED CIRCUIT BOARD

FIELD OF THE INVENTION

5 The present invention relates to multilayer printed circuit boards, and more specifically to a component suitable for use in manufacturing multilayer printed circuit boards, and to a method used for its manufacture.

BACKGROUND OF THE INVENTION

10 Multilayer printed circuit boards are widely used in modern electronic equipment, particularly that which is used professionally, since, amongst other things, they allow the assembly of electronic components with a greater density, thus reducing the bulk of the equipment itself.

 The conventional method for manufacturing multilayer printed circuit boards is well known to those acquainted with the sector art and for this reason a detailed
15 description will not be given here; for a better understanding of the present invention, it may be useful to recall that in the step of preparing the so-called "stacks", a mirror-polished stainless steel plate is used in the hot pressing step, placed as a separator between two separate multilayer circuit boards to which it is fixed by means of a separation film. This is in order to protect the external surfaces of the circuit boards.
20 It also minimises the surface irregularities and makes the temperature distribution uniform.

 The separation film is used to prevent any infiltration of the adhesive used between the layers which make up the multilayer circuit boards, and has to be

removed at the end of the process, while the mirror-polished stainless steel plate is polished thoroughly before being used again; this procedure is complex and costly, compromising the quality and the efficiency of the manufacturing process.

The United States Patent N° US 5,153,050 proposes and describes a variation of the conventional process referred to above, in which provision is made for the use of a specific component consisting of a laminate made typically from two external copper sheets and one internal aluminium sheet, sealed at the edges. At the end of the process, the two copper sheets will each become the outermost conductive layer of two distinct multilayer circuit boards, while the aluminium sheet is a disposable element, which is eliminated at the end of the process itself.

The faces of the two copper sheets and the face of the aluminium sheet placed in reciprocal contact must not be contaminated, i.e. they must be free from all particles (e.g., resin and glass fibre dusts) and adhesive. A light strip of temporary adhesive along the perimeter fixes the non-contaminated faces to each other, thus defining two non-contaminated central zones, protected during the subsequent steps of the work. The aluminium sheet also contributes by giving the whole rigidity, facilitating handling operations.

The process for manufacturing multilayer printed circuit boards using this component is generally designated with the initials C-A-C, meaning Copper-Aluminium-Copper, or with the initials R-A-R in Italian (Rame-Alluminio-Rame).

One inconvenient aspect of the C-A-C process is the high cost of the adhesive, since very specific properties are required, as it has to remain stable and effective during the various steps of the work and it must be easily removable, without leaving any residue at the end of the process. For this reason the

manufacturers of multilayer printed circuit boards felt it was necessary to find a cheaper but highly reliable alternative.

Furthermore, in the manufacture of multilayer printed circuit boards, the technology of microdrilling using a "laser" light ray has recently been developed, also called laser microdrilling for brevity, where by this term is meant the non pass-through drilling of holes with a very small diameter, typically ranging between 0.05 mm and 0.25 mm. These non-through holes, as those acquainted with the sector art will know, are normally made on the outer surfaces of the multilayer printed circuits, and are intended to be suitably metalized in such a way as to electrically connect the circuits made on the outer conductive layer of copper to the circuits made on the inner conductive layers. As laser microdrilling is much more effective when the material to be drilled does not contain glass fibre, the solution most widely adopted recently is to use a component made from a copper sheet covered on one side by a layer of epoxy resin of variable thickness, where this component is known as RCC foil, the abbreviation RCC standing for "Resin Coated Copper". In fact, if this component is applied to the outer surfaces of the multilayer printed circuit board in place of the normal copper sheet, drilling with a laser ray is made possible with a much greater efficiency, since under the copper sheet the laser ray does not meet the glass fibre typically present in the insulating layers of the multilayer printed circuit board, but instead meets the resin.

On the other hand, the presence of the layer of resin makes this component particularly delicate to handle, to the extent that simply bending it may lead to microcracks in the layer of resin with resultant product defects.

Use of these RCC components is therefore considerably critical, as their fragility is their worst defect.

SUMMARY OF THE INVENTION

The object the present invention is to define a component for the C-A-C
5 multilayer printed circuit board manufacturing process, which is economical, can be made using known, tried and tested systems, having a high level of productivity, and which make it possible to achieve excellent quality and reliability. The component of the invention is obtained by joining the two external copper sheets to the internal aluminium sheet by means of a continuous electro-mechanical or mechanical
10 process, which does not require additional materials (such as adhesive) and guarantees a consistently high level of quality.

This process will preferably consist of ultrasonic welding, subject to appropriate regulation of the power and pressure, or of a knurling operation, subject to the definition of the properties of the imprint.

15 Another object of the invention is that of defining a method for manufacturing C-A-C type multilayer printed circuit boards based on the use of a component obtained by the joining of the two external copper sheets to the internal aluminium sheet by means of a continuous electro-mechanical or mechanical process, such as ultrasonic welding or knurling.

20 A further object of the invention is that of defining a multilayer printed circuit board, manufactured by means of a C-A-C type method based on the use of a component made by the joining of the two external copper sheets to the internal aluminium sheet by means of a continuous electro-mechanical or mechanical process, such as ultrasonic welding or knurling.

Another object of this invention is to define a component suitable for being used in a process for manufacturing multilayer printed circuits, based on use of the laser microdrilling technology, wherein the said component is capable of overcoming the drawbacks, particularly the fragility, typical of the components used at the moment. The component of the invention is obtained by joining at least one copper sheet with an aluminium sheet by means of a continuous electromechanical or mechanical process, that does not need any additional materials (such as adhesive) and guarantees a consistently high level of quality, and further by depositing a layer of resin on the outer surface of the copper sheet not in contact with the aluminium sheet.

The above mentioned objects are obtained by means of a component, a manufacturing method and a multilayer printed circuit board, characterized as defined in the main claims.

These and other objects, characteristics and advantages of the invention will become evident on the basis of the following description of a preferred embodiment, provided purely by way of an illustrative, non-restrictive example, and with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 - Is a schematic view of the equipment used for the manufacture of the component for multilayer printed circuit boards in accordance with this invention, in a first embodiment thereof.

Fig. 2 - Is a flow diagram of the operational sequence of the method for the manufacture of the component for multilayer printed circuit boards in accordance with this invention, in a first embodiment thereof.

Fig. 3 - Is a schematic view of the equipment used for the manufacture of the component for multilayer printed circuit boards in accordance with this invention, in a second embodiment thereof.

Fig. 4 - Is a flow diagram of the operational sequence of the method for the
5 manufacture of the component for multilayer printed circuit boards in accordance with this invention, in a second embodiment thereof.

DESCRIPTION OF A FIRST PREFERRED EMBODIMENT OF THE INVENTION

Fig. 1 represents a schematised lateral view of the equipment used for the manufacture of the component for multilayer printed circuit boards in accordance
10 with this invention, in a first embodiment thereof.

The equipment includes a known type unwinder 12, on which is mounted a reel 11 of an aluminium ribbon 10; a straightening device 13 and a dust remover 14, both of which known type, which act on the aluminium ribbon 10; a first joining station 15 consisting of a first pair of rectified, rubber-coated rollers 23 for feeding
15 and a second pair of rectified, rubber-coated rollers 24 for traction, a higher unwinder 27, of known type, on which is mounted an upper reel 16 of an upper copper ribbon 18, a lower unwinder 28, of known type, upon which is mounted a lower reel 17 of a lower copper ribbon 19, a first pair 21 of dust-removing rollers acting on the upper copper ribbon 18 and a second pair 22 of dust-removing rollers acting on the lower
20 copper ribbon 19, a sonotrode 20 for the ultrasonic welding of a "sandwich" 29 consisting of an aluminium ribbon 10 and the upper 18 and lower 19 copper ribbons, and finally of a cutter 25, for example of the known guillotine type; and a station 26, for example of the type with a known type automated manipulator, for offloading of the square pieces of the copper-aluminium-copper sandwich 29.

Operation of the equipment listed above will now be described, with reference to Fig. 1 and to the flow diagram represented in Fig. 2.

The continuous aluminium ribbon 10 with a thickness of several tenths of a millimetre, generally 0.2 – 0.8 mm, preferably 0.3 – 0.5 mm, and a width generally
5 between 350 and 700 mm, is unwound (step 30) by the unwinder 12, centred and fed by means of a transport system not shown in the figure, into the straightening device 13 and subsequently into the dust remover 14 in order to be straightened and dusted (step 31) on both faces; the continuous aluminium ribbon 10 is then fed, by means of a transport system not shown in the figures, into the joining station 15.

10 In parallel, the upper unwinder 27 unwinds the upper copper ribbon 18 from the upper reel 16 (step 32) and the lower unwinder 28 unwinds the lower copper ribbon 19 from the lower reel 17 (step 34); the lower face of the upper copper ribbon 18 and upper face of the lower copper ribbon 19 are dusted gradually as they are unwound, respectively by the first pair 21 of dust-removing rollers and by the second
15 pair 22 of dust-removing rollers (steps 33 and 35). The dust-removing rollers 21 and 22 consist generally of rollers with an adhesive surface, which are suitable for rotating in an idle way in contact with the respective copper ribbon. The upper 18 and lower 19 copper ribbons are essentially the same width as the aluminium ribbon 10 and are generally of a thickness between 8 and 70 μm , preferably between 15
20 and 20 μm , though the thickness is not limited to these values, and may even be 0.4 mm.

The first pair of rubber-coated rollers 23, applying a pressure generally of between 1 and 4 bar, laminates the upper copper ribbon 18 with its lower face in contact with the upper face of the aluminium ribbon 10, and the lower copper ribbon

19 with its upper face in contact with the lower face of the aluminium ribbon 10, so as to create, in a temporary join, the copper-aluminium-copper sandwich 29 (step 36).

The first pair of rubber-coated rollers 23 also has the function of feeding the sandwich 29 towards the sonotrode 20, assisted in this by the second pair of rubber-coated rollers 24 whose function is to pull.

The sonotrode 20, as is already known to those acquainted with the sector art, consists of two pairs of steel wheels, not shown in the figures, with a diameter of 40 mm for example, with a slightly knurled profile, which produce a seam weld with a typical width of between 2 and 3 mm along the edge of the sandwich 29, by means of the combined action of pressure and of the heat generated by the emission of ultrasonic frequencies of ≥ 20 kHz, which make permanent the join between the three ribbons, whereby the ultrasonic welding makes two joining zones between the central ribbon of aluminium 10 and the outer ribbons of copper, upper 18 and lower 19.

The pressure is typically between 1 and 6 bar, preferably equal to approximately 3 bar, the power absorbed by the sonotrode is regulated in relation to the thickness of the copper ribbons to be welded and is typically between 0.5 and 2 kW, for a maximum weld speed of approximately 10 m/min. The distance between the two pairs of wheels in the direction of the width of the aluminium ribbon 10 can be regulated, and is done so simultaneously for both pairs in relation to the middle line of the ribbon 10 itself.

Down from the second pair of rubber-coated rollers 24, the sandwich 29 is passed through the cutter 25 which crops the sandwich 29 itself, sub-dividing it into square pieces of the desired dimensions (step 38); the square pieces are then

conveyed to the offloading station 26 to be stacked and then taken away, either automatically or manually (step 39).

The method of the invention uses only well-known equipment, which is easy to find and capable of performing work of quality to a high level of reliability. In addition the ultrasonic welding does not require expendable materials, which are often very costly, as in the case of special adhesives, and which, being extraneous to the printed circuit board itself might produce waste or lead to re-working in the subsequent steps of the manufacturing process. In addition, the speed of the process is very high and makes it possible to join materials of variable thickness within ample limits without causing any problem.

DESCRIPTION OF A SECOND EMBODIMENT OF THE INVENTION

A second embodiment of the method for manufacture of the component for multilayer printed circuit boards in accordance with the invention will now be described, together with the relevant equipment used, with reference to Fig. 3, in which the same devices as described in the first embodiment retain the same reference numeral.

The first joining station 15 in Fig. 1 has been substituted by a second joining station 55, in which, in place of the sonotrode 20, the join between the upper 18 and lower 19 copper ribbons and the aluminium ribbon 10 is effected by means of two pairs of geared wheels 60 (knurls) with a sloping profile (in Fig. 3 only one pair is visible), made from case-hardened steel and with the distance between centres placed in such a way that the tip of the tooth on one wheel is not in contact with the corresponding space between the teeth of the other wheel.

Operation of the equipment in accordance with this second embodiment is

now described, with reference to Fig. 3 and to the flow diagram represented in Fig. 4. In the latter, steps 40-46 and 48-49 are identical to the corresponding steps 30-36 and 38-39 of the flow diagram in Fig. 2, previously illustrated. Accordingly, only step 47 will be described in detail now, i.e. that of knurling of the copper-aluminium-copper sandwich 29.

As those acquainted with the sector art well know, the pair of geared wheels 60 leaves an imprint (knurl) on the sandwich 29 generally of a width of approximately 5 mm, which serves to mechanically join the three ribbons which make up the sandwich 29, by exploiting the plasticity of the materials. The pressure on the geared wheels 60 is typically between 3 and 5 bar, depending on the distance between the centres of the gears 60 themselves, a distance which must be substantially regulated only according to the thickness of the aluminium ribbon 10, with the two upper 18 and lower 19 copper ribbons completing the sandwich 29 typically limited to a thickness of 17 – 35 μm . The speed of the knurling joining process is typically 3 m/min. The advantage of this type of join is that the life of the geared wheels 60 is practically unlimited and in addition they cost less than the sonotrodes; on the other hand, the quality of the join may be negatively affected if the aluminium ribbon 10 has not been degreased perfectly .

Naturally changes may be made to the invention described above, without departing from the scope of the invention itself.

For example, it is possible, with reference to both of the embodiments described above, to envisage a joining process for the C-A-C sandwich 29 starting, not from the continuous aluminium ribbon 10, but from aluminium panels, loaded, for example, by means of a suction pad loader and a subsequent, known type centring

device, at predetermined regular intervals in the first joining station 15 or, respectively in the second joining station 55, so the cutter 25 will only have to cut the copper ribbons.

Or else it is possible, with reference to both of the embodiments described
5 above, to envisage a further work station between either the first 15 or second 55 joining station and the offloading station 26 of the square pieces, comprising a turning device to rotate by 90° a square which has previously been welded or knurled on two sides, and a further welding station, either ultrasonic or knurling, to complete the welding on all four sides.

10 DESCRIPTION OF A THIRD EMBODIMENT OF THE INVENTION

A third embodiment of the component in accordance with the invention will now be described, together with the relevant method for manufacture. For brevity's sake this third embodiment, since having characteristics and aspects mostly similar to those of the previous embodiments already described so as to be
15 easily referable to the relative accompanying drawings, will be illustrated in the following without using specific drawings.

In particular, the component in accordance with the third embodiment comprises, similarly to what has already been described with reference to the previous embodiments, two copper sheets and one sheet or internal support of
20 aluminium arranged between the two copper sheets, wherein these three sheets are welded together by means of an ultrasonic joining or joined mechanically, for example by knurling, so that, due to the presence of the internal aluminium sheet, the component is particularly malleable and not subject to being bent with ease.

In addition, the component also comprises a layer of resin deposited externally on one or both of the copper sheets, along their surfaces that are not facing the internal aluminium sheet.

In this way, each copper sheet, being covered by an external layer of resin, acquires a rigidity and ease of handling much greater than the copper sheet alone without a layer of resin, so that the component thus comprised is not subject to the main defect, namely the fragility, which instead afflicts the RCC type components currently available on the market.

Further, as there are no problems owing to fragility, it is possible to deposit layers of resin of even greater thickness than those of the traditional RCC type components.

Typically the thicknesses of the layer of resin deposited externally on this component range from 50 μ m to 200 μ m.

Deposition of the layer of resin is effected, after the aluminium sheet has been joined with the two copper sheets as described earlier with reference to the two previous embodiments, through various well-known depositing processes widely available on the market, such as silk-screen printing, film-coating, rollercoating, or dryfilm lamination.

The resin depositing process can be implemented in continuous mode in a stage prior to the final cutting of the component, or can be implemented on the cut pieces of the component, after it has been cut.

The component can also be made of a single copper sheet and an aluminium sheet joined together, with a layer of resin deposited on the outside of the copper sheet.

Accordingly the resin can be spread on the two external surfaces in the case of a three-sheet Copper-Aluminium-Copper (CAC) component, or on a single external face in the case of a two-sheet Copper-Aluminium (CA) component.

5 In short, the component of this third embodiment may be designated R-C-A-C-R (Resin-Copper-Aluminium-Copper-Resin) in the case of two joins, or R-C-A (Resin-Copper-Aluminium) in the case of a single join.

 In short, while fully maintaining the principle of this invention, the construction details and the embodiments may be abundantly varied with respect to what has
10 been described and illustrated, without departing from the scope of the invention.

CLAIMS

1. Component provided for being used in a process for manufacturing a multilayer printed circuit board, comprising:

- a laminate having a perimeter, said laminate consisting of two copper sheets (18, 19) which, at the end of said manufacturing process, constitute a functional element of said printed circuit board, and of one aluminium sheet (10) which constitutes an element that may be eliminated in the course of said manufacturing process, one surface of each of said copper sheets (18, 19) and both surfaces of said aluminium sheet (10) being non-contaminated and provided for being super-imposed upon each other,

characterized in that said one aluminium sheet (10) and said two copper sheets (18, 19) are bonded to each other by means of a single ultrasonic weld of fixed width along at least a part of said perimeter, whereby said single ultrasonic weld provides two joining zones between said two copper sheets and said one aluminium sheet, in order to delimit two non-contaminated zones within said perimeter, on opposite sides of said aluminium sheet (10).

2. Component according to claim 1, characterized by the fact that said fixed width ultrasonic weld is carried out along all of said perimeter.

3. Component according to claim 1, characterized by the fact that said fixed width is between 2 and 3 mm.

4. Component according to claim 1, in which said copper sheets have a first thickness, characterized by the fact that said first thickness is between 8 and 70 μm .

5. Component according to claim 1, in which said aluminium sheet has a second thickness, characterized by the fact that said second thickness is between 0.2 and 0.8 mm.

6. Component according to claim 1, characterized by the fact that it further comprises at least one layer of resin deposited at the outside on one of the surfaces of said copper sheets, which cannot be super-imposed on said aluminium sheet.

7. Component according to claim 6, characterized by the fact that said layer of
5 resin has a thickness of between 50µm and 200µm.

8. Method for the manufacture of a multilayer printed circuit board, comprising the following steps:

- disposing of a laminate having a perimeter, said laminate consisting of two copper sheets which, at the end of said manufacturing process, represent a functioning
10 element of said printed circuit board, and of an aluminium sheet which represents an element that may be eliminated in the course of said manufacturing process, one surface of each of said copper sheets and both surfaces of said aluminium sheet being non-contaminated and provided for being super-imposed upon each other;
- bonding to each other of said aluminium sheet and said copper sheets by means
15 of an ultrasonic welding operation along at least a part of said perimeter, in order to delimit two non-contaminated zones within said perimeter, on opposite sides of said aluminium sheet.

9. Method for the manufacture of a multilayer printed circuit board according to claim 8, also comprising the step of removing dust from said one surface of each of said
20 copper sheets and from both said surfaces of said aluminium sheet.

10. Method for the manufacture of a multilayer printed circuit board according to claim 8, also comprising the step of feeding said copper sheets and said aluminium sheet from reels in the form of continuous sheets, and the step of cropping said laminate.

11. Method for the manufacture of a multilayer printed circuit board according to claim 8, characterized by the fact that said ultrasonic welding operation includes the use of a pressure of between 1 and 6 bar.
12. Method for the manufacture of a multilayer printed circuit board according to claim 8, characterized by the fact that said ultrasonic welding operation includes the use of a power of between 0.5 and 2 kW.
13. Method for the manufacture of a multilayer printed circuit board according to claim 8, characterized by the fact that said ultrasonic welding operation is carried out at a speed of not more than 10m/min.
- 10 14. Method for the manufacture of a multilayer printed circuit board according to claim 8, characterized by the fact that said fixed width ultrasonic weld is carried out along all of said perimeter.
- 15 15. Method for the manufacture of a multilayer printed circuit board according to claim 8, further comprising the step of externally depositing at least one layer of resin on one of the surfaces of said two copper sheets, which cannot be superimposed on said aluminium sheet.
- 20 16. Method for the manufacture of a multilayer printed circuit board according to claim 15, further comprising a cutting step to reduce said laminate into cut pieces, wherein the deposition of the layer of resin is effected as a continuous process on said laminate, prior to said cutting step, through a known technology selectable from a group comprising: silk-screen printing, film-coating, rollercoating, and dryfilm lamination.
17. Method for the manufacture of a multilayer printed circuit board according to claim 15, further comprising a cutting step to reduce said laminate into cut pieces,

wherein the deposition of the layer of resin is effected on the cut pieces of said laminate through a known technology selectable from a group comprising: silk-screen printing, film-coating, rollercoating, and dryfilm lamination.

18. Multilayer printed circuit board manufactured by means of a manufacturing
5 process comprising the step of disposing of a laminate having a perimeter, said laminate consisting of two copper sheets which, at the end of said manufacturing process, represent a functioning element of said printed circuit board, and of an aluminium sheet which represents an element that may be eliminated in the course of
10 said manufacturing process, one surface of each of said copper sheets and both surfaces of said aluminium sheet being non-contaminated and which can be superimposed upon each other, **characterized by** the fact that, in the course of said manufacturing process, said aluminium sheet and said copper sheets are bonded to each other by means of a fixed width ultrasonic weld on at least a part of said perimeter, in order to delimit two non-contaminated zones within said perimeter, on opposite sides
15 of said aluminium sheet.

19. Multilayer printed circuit board according to claim 18, characterized by the fact that said fixed width ultrasonic weld is carried out along all of said perimeter.

20. Multilayer printed circuit board according to claim 18, characterized by the fact that said fixed width is between 2 and 3 mm.

20 21. Multilayer printed circuit board according to claim 18, in which said copper sheets have a first thickness, characterized by the fact that said first thickness is between 8 and 70 μm .

22. Multilayer printed circuit board according to claim 18, in which said aluminium sheet has a second thickness, characterized by the fact that said second thickness is

between 0.2 and 0.8 mm.

23. Component which can be used in a process for manufacturing a multilayer printed circuit board, comprising:

- a laminate having a perimeter, said laminate consisting of two copper sheets which, at the end of said manufacturing process, represent a functioning element of said printed circuit board, and of an aluminium sheet which represents an element that may be eliminated in the course of said manufacturing process, one surface of each of said copper sheets and both surfaces of said aluminium sheet being non-contaminated and which can be super-imposed upon each other,
- 10 **characterized in that** said aluminium sheet and said copper sheets are bonded to each other by means of a knurling of fixed width on at least a part of said perimeter, in order to delimit two non-contaminated zones within said perimeter, on opposite sides of said aluminium sheet.

24. Component according to claim 23, characterized by the fact that it further comprises at least one layer of resin deposited externally on one of the surfaces of said two copper sheets, which cannot be super-imposed on said aluminium sheet.

25. Component according to claim 24, characterized by the fact that said layer of resin has a thickness of between 50µm and 200µm.

26. Method for the manufacture of a multilayer printed circuit board, comprising the following steps:

- disposing of a laminate having a perimeter, said laminate consisting of two copper sheets which, at the end of said manufacturing process, represent a functioning element of said printed circuit board, and of an aluminium sheet which represents an element that may be eliminated in the course of said manufacturing process, one

surface of each of said copper sheets and both surfaces of said aluminium sheet being non-contaminated and which can be super-imposed upon each other;

- bonding to each other of said aluminium sheet and said copper sheets by means of a knurling operation on at least a part of said perimeter, in order to delimit two non-contaminated zones within said perimeter, on opposite sides of said aluminium sheet.

27. Method for the manufacture of a multilayer printed circuit board according to claim 26, further comprising the step of externally depositing at least one layer of resin on one of the surfaces of said two copper sheets, which is not super-imposable on said aluminium sheet.

28. Method for the manufacture of a multilayer printed circuit board according to claim 27, further comprising a cutting step to reduce said laminate into cut pieces, wherein the deposition of the layer of resin is effected as a continuous process on said laminate and prior to said cutting step through a known technology selectable from a group comprising: silk-screen printing, film-coating, rollercoating, and dryfilm lamination.

- 29 Method for the manufacture of a multilayer printed circuit board according to claim 27, further comprising a cutting step to reduce said laminate into cut pieces, wherein the deposition of the layer of resin is effected on the cut pieces of said laminate through a known technology selectable from a group comprising: silk-screen printing, film-coating, rollercoating, and dryfilm lamination.

30. Multilayer printed circuit board manufactured by means of a manufacturing process comprising the step of disposing of a laminate having a perimeter, said laminate consisting of two copper sheets which, at the end of said manufacturing process, represent a functioning element of said printed circuit board, and an aluminium

sheet which represents an element that may be eliminated in the course of said manufacturing process, one surface of each of said copper sheets and both surfaces of said aluminium sheet being non-contaminated and which can be super-imposed upon each other, **characterized by** the fact that, in the course of said manufacturing process, said aluminium sheet and said copper sheets are bonded to each other by means of a knurling of fixed width on at least a part of said perimeter, in order to delimit two non-contaminated zones within said perimeter, on opposite sides of said aluminium sheet.

31. Method for the manufacture of a multilayer printed circuit board according to claim 30, characterized by the fact that said knurling operation includes the use of a pressure of between 3 and 5 bar.

32. Component (R-C-A; R-C-A-C-R) provided for being used in a process for manufacturing a multilayer printed circuit board, comprising:

- a laminate having a perimeter, said laminate consisting of at least one copper sheet which, at the end of said manufacturing process, constitutes a functional element of said printed circuit board, and of one aluminium sheet which constitutes an element that may be eliminated in the course of said manufacturing process, one surface of said copper sheet and one surface of said aluminium sheet being non-contaminated and provided for being super-imposed upon each other,

characterized by further comprising a layer of resin deposited externally on the face of the copper sheet which is not super-imposable on the aluminium sheet,

and in that said aluminium sheet and said copper sheet are bonded to each other along at least a part of said perimeter, in order to delimit a non-contaminated zone within said perimeter, on one side of said aluminium sheet.

33. Component according to claim 32, characterized by the fact that said

aluminium sheet and said copper sheet are bonded to each other by means of an ultrasonic weld of fixed width.

34. Component according to claim 32, characterized by the fact that said aluminium sheet and said copper sheet are bonded to each other by means of a
5 knurling of fixed width.

35. Method for the manufacture of a multilayer printed circuit board, comprising the following steps:

- disposing of a laminate having a perimeter, said laminate consisting of at least one copper sheet which, at the end of said manufacturing process, constitutes
10 a functional element of said printed circuit board, and of one aluminium sheet which constitutes an element that may be eliminated in the course of said manufacturing process, one surface of said copper sheet and one surface of said aluminium sheet being non-contaminated and provided for being super-imposed upon each other;
- bonding to each other of said aluminium sheet and said copper sheet by means
15 of an ultrasonic welding or a knurling operation along at least a part of said perimeter, in order to delimit a non-contaminated zone within said perimeter, on one side of said aluminium sheet; and
- externally depositing a layer of resin on the face of said copper sheet, which is not super-imposable on said aluminium sheet.

20 36. Method for the manufacture of a multilayer printed circuit board according to claim 35, further comprising a cutting step to reduce said laminate into cut pieces, wherein the deposition of the layer of resin is effected as a continuous process on said laminate and prior to said cutting step through a known technology selectable

from a group comprising: silk-screen printing, film-coating, rollercoating, and dryfilm lamination.

37. Method for the manufacture of a multilayer printed circuit board according to claim 35, further comprising a cutting step to reduce said laminate into cut pieces,

5 wherein the deposition of the layer of resin is effected on the cut pieces of said laminate through a known technology selectable from a group comprising: silk-screen printing, film-coating, rollercoating, and dryfilm lamination.

38. Multilayer printed circuit board manufactured by means of a manufacturing process comprising the step of disposing of a laminate having a perimeter, said

10 laminate consisting of at least one copper sheet which, at the end of said manufacturing process, constitutes a functional element of said printed circuit board, and of one aluminium sheet which constitutes an element that may be eliminated in the

course of said manufacturing process, one surface of said copper sheet and one surface of said aluminium sheet being non-contaminated and provided for being

15 super-imposed upon each other, **characterised by** the fact that, in the course of said manufacturing process, said aluminium sheet and said copper sheet are bonded

to each other by means of an ultrasonic welding or a knurling operation along at least a part of said perimeter, in order to delimit a non-contaminated zone within said perimeter,

on one side of said aluminium sheet; and moreover that a layer of resin is

20 externally deposited on the face, of said copper sheet, which is not super-imposable on said aluminium sheet.

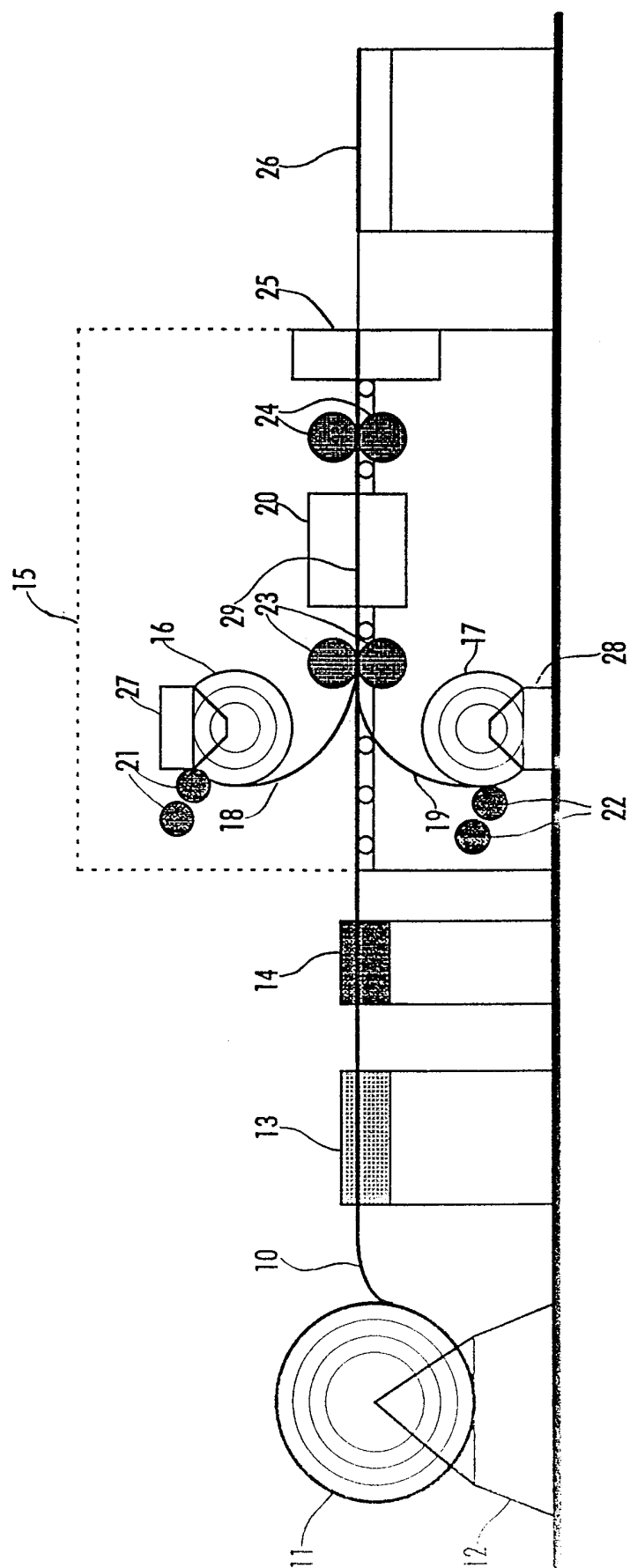


FIG. 1

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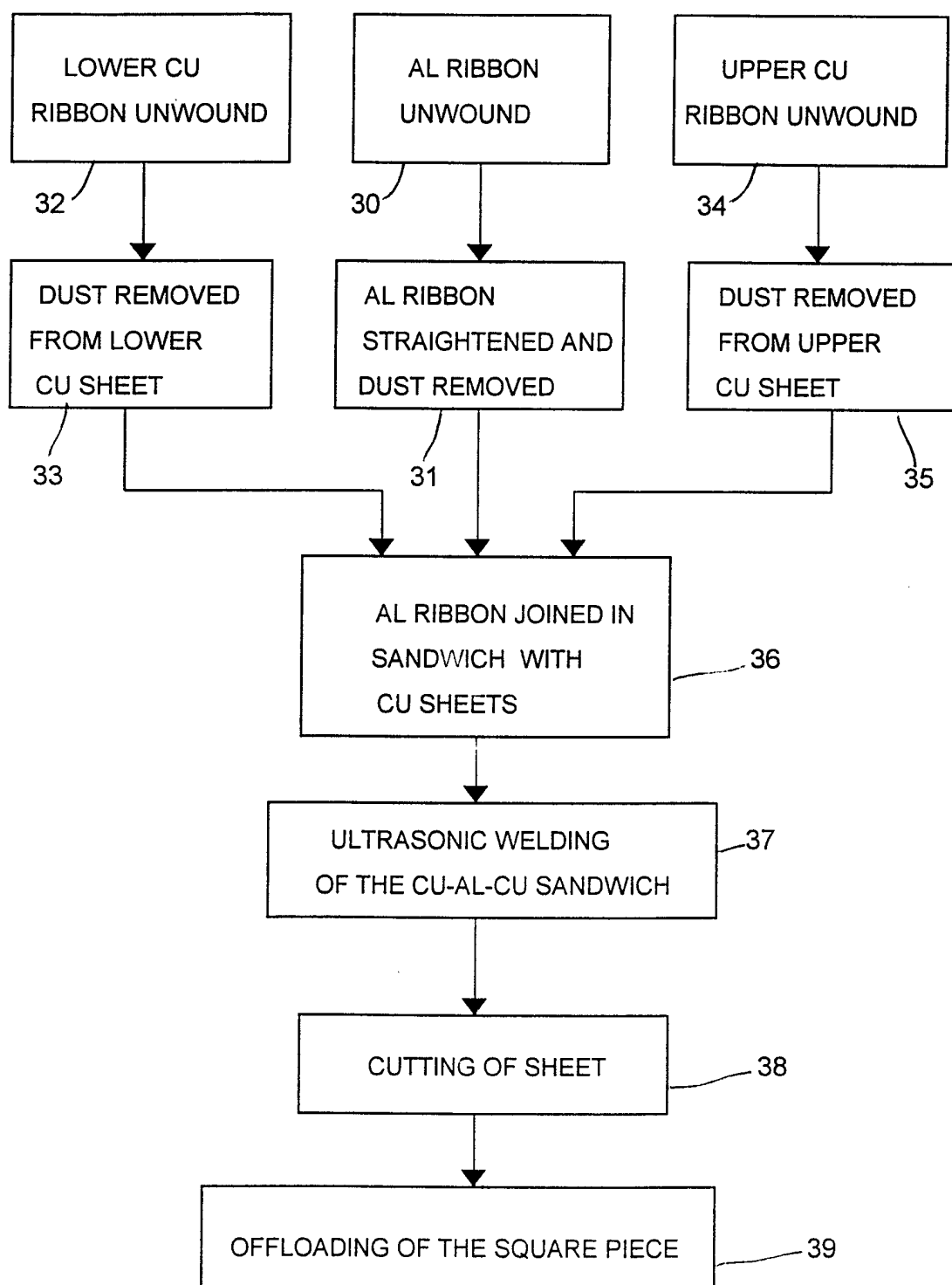
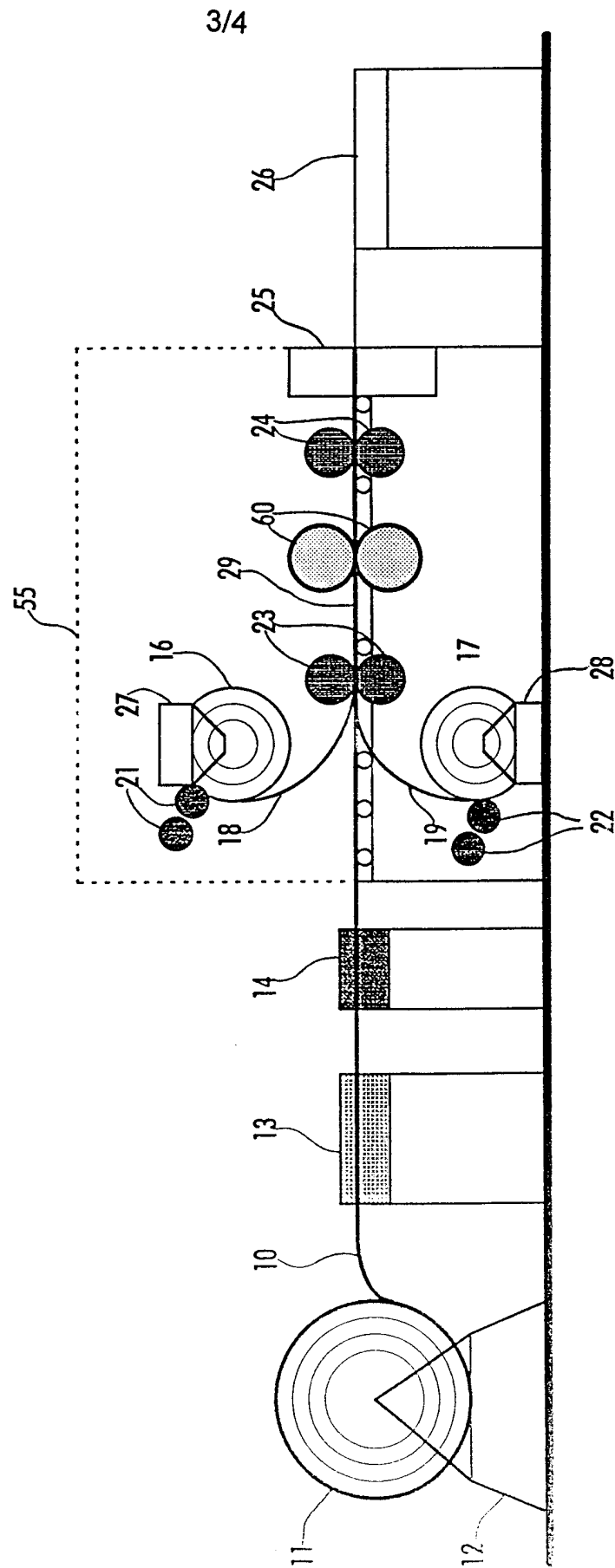


FIG. 2



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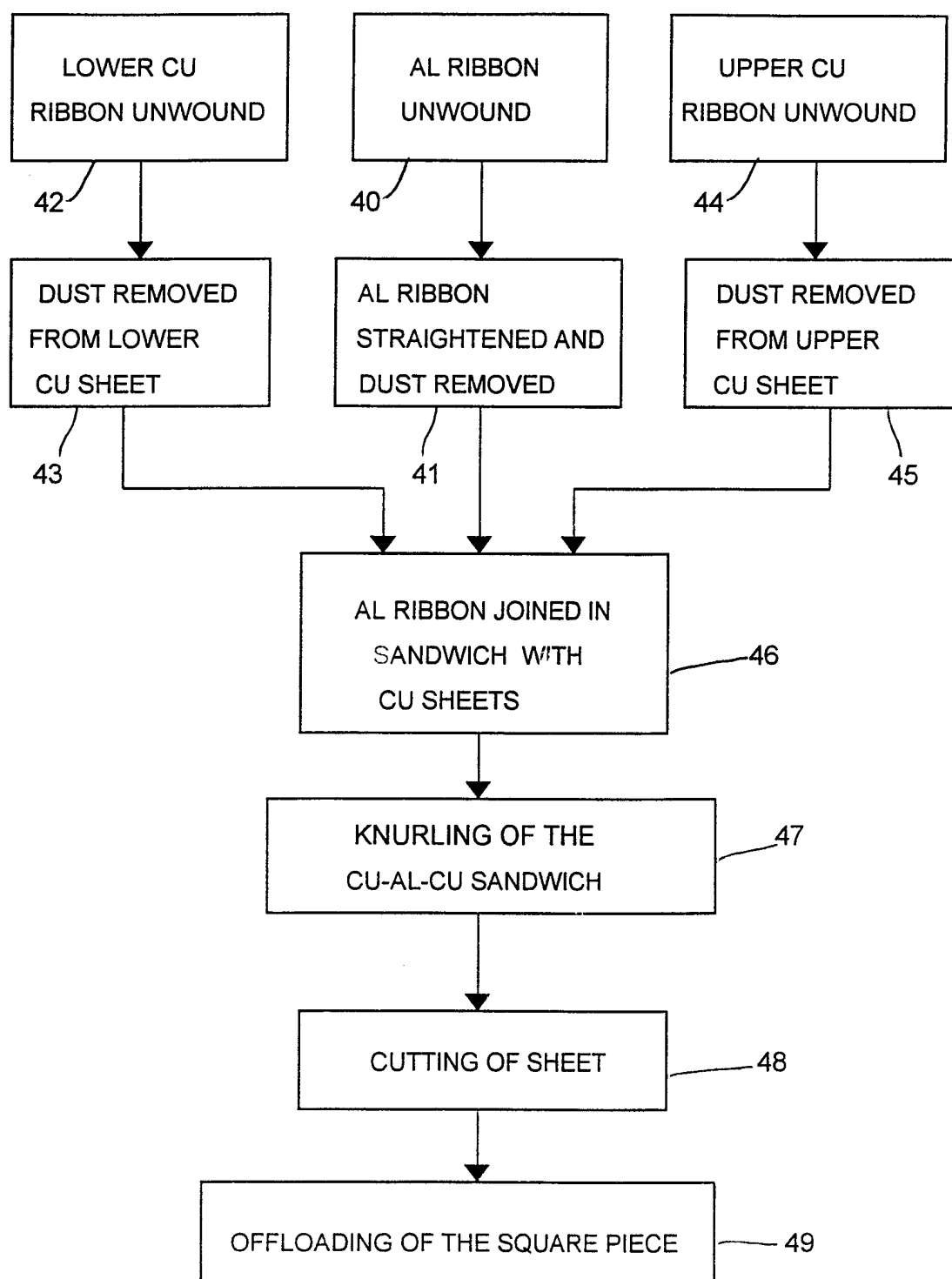


FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No

PCT/IT 99/00283

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H05K3/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H05K B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 153 050 A (JOHNSTON JAMES A) 6 October 1992 (1992-10-06) the whole document ---	1-22, 32-38
P,X	EP 0 872 301 A (MITSUI MINING & SMELTING CO) 21 October 1998 (1998-10-21) the whole document ---	1,8,18, 35
A	GB 1 217 104 A (SIEMENS AG) 31 December 1970 (1970-12-31) the whole document ---	1,8,18
X	US 4 499 152 A (GREEN ROBERT W ET AL) 12 February 1985 (1985-02-12) the whole document ---	32
A	---	33-38
	-/--	



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

19 January 2000

Date of mailing of the international search report

28/01/2000

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INTERNATIONAL SEARCH REPORT

Inter. nial Application No

PCT/IT 99/00283

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 082 160 A (LEIGH RICHARD W) 21 January 1992 (1992-01-21) the whole document -----	23-31

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IT 99/00283

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/IT 99/00283

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-22,32-38

fixing of a temporary aluminium foil between two copper foils by providing an ultrasonic welding at the border

2. Claims: 23-31

fixing a temporary aluminium foil between two copper foils by providing a knurled border

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IT 99/00283

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