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Printed-circuit board and method for the precise assembly and soldering of electronic components on the surface of the printed-circuit board

The invention relates to a printed-circuit board and a method for the precise assembly of electronic components on the surface of the printed-circuit board, said electronic components being electrically and conductively attached to the printed-circuit board by means of a reflow soldering technique. In particular, the printed-circuit board configured according to the invention is intended for use in voltage surge protection assemblies, said electronic components being voltage surge arresters, PTC's, varistors and diodes.

It is known to mount the voltage surge arresters by a reflow soldering technique on the printed-circuit board and to contact the other electronic components, such as PTC's, varistors and diodes as chip components by means of a conventional clamping technique. Therein problems exist with the precise positioning of the voltage surge arrester, when the latter is not held in the desired position during the soldering process, and therefore contact problems or difficulties during further processing or assembly of the printed-circuit board may occur.

By the various techniques of assembling different components on the printed-circuit board, several steps are required for contacting. Further, additional contact lugs are required for the assembly of the printed-circuit board with the other components (PTC's and varistors), thus increasing the material and manufacture costs.

In reflow soldering techniques it is common to apply solder material on the printed-circuit boards at positions intended for receiving an electronic component. Thereafter, the respective component is mounted on the solder material still being in a pasty condition, and





then the completely assembled printed-circuit board is heated, until the solder material melts, and after cooling down, the electronic component is held in position by the re-solidified solder material and is electrically contacted.

As long as the solder material does not yet effect an intense connection of the electronic component to the printed-circuit board, that is immediately after placing the electronic components, the respective electronic component may slip and come out of the desired position. Since the reflow soldering technique is usually performed in continuous-heating furnaces, such as they are for example known from DE 40 16 366 C2, provisions have to be taken during transportation of the printed-circuit board assembled before, such provisions preventing the electronic component from slipping away from the desired position by movements or vibrations.

In order to prevent such slipping away, there is known for example from EP 0 540 497 A2 the utilisation of a matrix which can however only determine the surface shape of the solder applied to the solder positions. Fixation of the component at least to a certain degree is not possible by this method. Positioning is to be facilitated by that the generated solder positions have a plane surface.

The utilisation of an adhesive to fix the components to an printed-circuit board is disclosed in DE 41 26 913 A1. Therein the connection of the respective component to the printed-circuit board is established by an adhesive. Thereafter the actual soldering process is performed, and the complete connection is finally accomplished. In addition to the required adhesive the supply of which necessitates higher expenditures for the printed-circuit board assembly, high requirements have to be met by the used adhesive. Since the latter is exposed to high temperatures during soldering, it may come to damages due to the solvent possibly contained in the adhesive.

It is therefore the object of the present invention to provide a printed-circuit board and a method for the assembly of such a printed-circuit board wherein in a simple manner the electronic components to be applied to the surface of the printed-circuit board can precisely be positioned and thereafter be soldered in this position.

According to the invention, this object is achieved for the printed-circuit board configured according to the invention by the features of claim 1 and for the method for the assembly of such a printed-circuit board by the features of claim 20. Advantageous embodiments and improvements of the invention are defined by the features of the sub-claims.

There are provided sections in the surface of a printed-circuit board according to the invention that are configured in such a manner that they define recesses adapted at least partially in their contours to the planar outside contours of the respective electronic components to be mounted on the printed-circuit board. Preferably grooves or slotted contours are provided into which the electronic components to be mounted can be fitted. The contours of the grooves or slots are configured such that they can hold the respective electronic components to be mounted in the desired position on the printed-circuit board by their selected shapes.

Further, during automated assembly there are problems when base plates or printed-circuit boards already assembled are to be connected to a housing. When using connection technologies such as gluing, there are high expenditures due to high installation costs caused by the required glue supply and a normally also required suction device for solvent vapours and also due to the control and monitoring of the joining process, since it is to be avoided that a certain portion of the glue will come to the bottom side of the printed-circuit board or even into the automatic machine or installation.

Connections that seem to be possible by latch lugs or other elements configured in a similar manner have the disadvantage that, on one hand, correspondingly configured elements require complicated shapes for the manufacture thereof, and that, on the other hand, they are subject to interferences due to the small sizes made necessary by the limited space available, since they will easily break under the rough manufacturing conditions and will thus not be operable anymore. Since printed-circuit boards of relatively small thickness are used, it is difficult or even impossible to configure the latch elements such that a projection over the bottom side of the printed-circuit board can be avoided.

A protection circuit for telecommunication installations for protecting a user from overvoltage and overcur-

rent is disclosed for example in DE 40 26 004 C2, by means of which a voltage surge arrester can also be protected from thermal overloads after response of a thermal protection element (fail-safe contact). For this purpose, a sheet-metal part is in contact with the voltage surge arrester, and to the sheet-metal part is connected a solder position with a slider against which a spring acts. When the voltage surge arrester heats up in an inadmissible way, and thus also the sheet-metal part, the solder position will melt away, and the slider is moved by the force of the spring and the voltage surge arrester is shorted. A thus configured thermal protection device needs quite a number of individual parts, resulting in high expenditures for production and assembly. Further, the necessary space requirement is relatively high. In particular the use of springs is critical with regard to an automatic assembly, since therefor special requirements exist.

In the solution disclosed in DE 40 26 004 C2 additional elements are required for the establishment of a connection to earth potential.

Further, from DE 33 23 687 C2 is known a voltage surge arrester magazine for terminal blocks of the telecommunication technique, wherein for the thermal protection an S-shaped bracket spring can be inserted from above for each spark gap of a two-way arrester, said bracket spring having a solder element at its one leg and a latch device at its other leg. This thermal protection, too, is expensive to manufacture and subject to interferences due to the additional bracket spring.

By the printed-circuit board according to the invention it is thus possible to mount all components commonly in one step and to finally complete the printed-circuit board already assembled by means of a reflow soldering technique, and to establish the fixation of the electronic components and the required electrical connection and to provide it in a simple manner with a housing.

By the sections provided on the surface of the printed-circuit board wherein the electronic components are mounted, it is possible, by the recessed configuration, to reduce the overall height or to prevent, with thicker printed-circuit boards, an increase of the required height. The utilisation of printed-circuit boards having a higher overall height is also favourable due to

the higher heat resistance during soldering. If for example the printed-circuit boards according to the invention are provided with voltage surge arresters, these will determine the overall required height that cannot be increased or even reduced, as explained above. Terminal blocks or disconnect blocks with two lines of insulation displacement contacts are known in the art. To the insulation displacement contacts are connected cable wires. If the assembled printed-circuit board is used as a protection plug and inserted into a disconnect block, at least the two insulation displacement contacts of the first line are covered by the protection plug. Due to the small height of the protection plug it is secured that the second line of insulation displacement contacts is freely accessible and connectable with mounted protection plug.

Instead of the printed-circuit board, a simpler base plate can be used that can be assembled or also covered with a housing.

There are provided terminals on the surface of the printed-circuit board that can be connected to the electrodes of the voltage surge arrester and to the complete layout of the printed-circuit board.

As electronic components (PTC's, varistors) can be used low-cost components in chip form that have at least one solderable surface, contacting of the respective components on the printed-circuit board being performed by a slotted contour preferably used for such elements. Positioning of the components during assembly preferably is to be made vertically to the printed-circuit board, the actual solder connection being established over the front faces of the respective components up to the connection surfaces (pads) disposed adjacent to the slotted contour or the groove.

The sections on the printed-circuit board configured to receive the respective components are dimensioned such that the depth of the printed-circuit board can nearly completely be used, and thus a relatively large soldering surface is achieved.

For increasing the wetting capability of the components, the slotted contours or grooves can be at least partially be metallised at their borders. The metallised portion of the sections configured to receive the components are preferably provided at the longitudinal sur-

faces. Metallisation can be performed by a galvanic process, such as known for through-contacts.

Prior to the actual assembly of the printed-circuit board with the electronic components, the solder paste to be used is applied for all components either by means of a template printing or a dispense process. Thereby it can be achieved that only those sections definitely required for the establishment of a connection are provided with solder paste, and therefore in spite of a safe provision of the required connection between printed-circuit board and components, no re-work is necessary.

The printed-circuit board according to the invention and the method according to the invention furthermore have the advantage over the solutions described above that the number of required individual parts is reduced and in particular no additional contact surfaces are required.

A foil to be applied to the bottom side of the printed-circuit board covers the printed-circuit board in this direction, and if a suitable foil material is selected, a voltage-resistant embodiment (contact protection) of the complete assembly is possible on this side. Further, by means of a dispense process, an isolator can be applied to the bottom side of the printed-circuit board also allowing a voltage-resistant embodiment. When using a printed-circuit board according to the invention with the sequences also suggested, manufacture can be optimised with regard to costs, since the expenditures can be reduced in particular by the option of automating the process. Another advantage is that the failure rate can be reduced, since the positioning accuracy can be improved by simple measures and faults can therefore be avoided.

The printed-circuit board according to the invention can be covered with a housing and provided with electronic components as a voltage surge protection module. Several, however at least two dome-type extensions of an at least partly deformable material are arranged at the housing. Said extensions extend at the housing towards the base plate to be connected and engage into cutouts provided therein. The size of the dome-type is such that they can be guided without any problems during assembly into the cutouts and are deformed by exposure to energy and/or force such that a positive-linkage and/or fric-

tional connection between housing and base plate is established. Said extensions are to be dimensioned, further, that after the deformation achieved by energy and/or force exposure they do not project over the plane given by the bottom side of the base plate and thus guarantee that these modules can be connected in the required way.

By the embodiment according to the invention can further in an advantageous manner be secured that the modules are pluggable without problems as protection plugs, with a simultaneous reduction of the required space and without any interferences between adjacent modules or other circuit elements.

Manufacture can advantageously be performed in two steps by an automatic machine, in the first step the housing being placed on or in the base plate, resp., and held there, and in the second step the deformation of the extensions being activated. This can be achieved in an advantageous manner by pressure with heated pins against the front faces of the dome-type extensions. Heating causes a softening of the extensions material, and by the pressure of the pins the desired shape can be produced, thus being secured that base plate and housing are connected to each other free from play.

Heating of the pins can for example be achieved by resistance heating. There is also the possibility, however, to use other forms of energy, such as electromagnetic radiation, in order to make possible a temperature increase and thus softening of the extensions material, a suitable plastic material, preferably a thermoplastic material.

With corresponding configuration, an overvoltage protection plug combining the two functions "earthing contact" and "fail-safe contact" in one part can be made by punching and subsequent bending. This configuration has the advantage that the expenses for assembly are considerably reduced and linear joining movements only are to be performed for the insertion into the housing, those movements being particularly favourable for automatic assembly machines.

Another advantage is that the number of transition positions loaded by surge currents can be removed.

The second contact bracket has in the assembled condition a permanent biasing force against the external

electrodes disposed at the voltage surge arrester. During normal operation, the thermal element acts against the biasing force of the second contact bracket and insulates the second contact bracket from the external electrodes and prevents thus that an electrically conductive connection between the contact element and the external electrodes of the voltage surge arrester exists. The thermal element can be configured as a solder element attached at the second contact bracket, or can be snap-fitted in a cutout provided in the contact bracket. In this latter solution, the contact element is first positioned without the thermal element in the housing of the protection plug. After connecting the housing to the printed-circuit board of the protection plug, the thermal element is then latched in the second contact bracket, and the fail-safe contact is completely biased and made operable.

The thermal element can be a moulded part made from a material, such as metal that melts when heated up and releases the movement of the second contact bracket towards the external electrodes of the voltage surge arrester, so that a conductive connection between the telecommunication wires and the earthing bar exists. The melt temperature of the material is selected such that damages to the installation or even fire risks can be excluded.

The thermal element can also be made of a material that will only become soft when correspondingly heated up, and will yield under the biasing force of the second contact bracket such that the latter will come into contact with the external electrodes and can establish the conductive connection to said electrodes.

Further possibilities are the utilisation of bi-metals or known memory alloys that are capable when heated up to release the second contact bracket for the connection to the external electrodes of the voltage surge arrester.

Moreover, the thermal element can be composed of an insulating paint or an insulating foil disposed between the external electrodes of the voltage surge arrester and the second contact bracket resiliently resting there-against and insulating them from each other. The paint or the foil will melt when heated up, thus the conductive connection being established.

Preferably the contact element is configured as at least one resilient holding leg serving as a counter-bearing on the side of the voltage surge arrester opposite to the first holding bracket at the insulating surface thereof. Thereby an unbalanced load of the solder connection between the voltage surge arrester and the printed-circuit board carrying the latter is prevented.

In the following, the invention will be described in more detail, based on embodiments shown in the drawings. There are:

Fig. 1 a printed-circuit board according to the invention prior to assembly,

Fig. 2 a printed-circuit board provided with components according to Fig. 1,

Fig. 3 a printed-circuit board with a housing mounted already, prior to the final connection,

Fig. 4 a diagrammatical representation of a dome-type extension at the housing,

Fig. 5 several embodiments for cutouts to be used in the printed-circuit board,

Fig. 6 an example of a contact element for voltage surge protection plug,

Fig. 7 the contact element of Fig. 6 mounted on a voltage surge arrester,

Fig. 8 a protection plug for use in telecommunication installations under application of the contact element of Fig. 6, and

Fig. 9 a second example of a contact element.

Fig. 1 shows a printed-circuit board 1 configured according to the invention, said printed-circuit board having various sections 2, 3 machined in the material of printed-circuit board 1. A transverse groove 2 is provided on surface 12 of printed-circuit board 1, said transverse groove being intended for receiving a not shown voltage surge arrester. Printed-circuit board 1 has, different from printed-circuit boards of 0.8 mm thickness used up to now, a thickness of 1.2 mm, such that a groove 2 can be provided in printed-circuit board 1 with sufficient depth. The width of groove 2 should be so selected under consideration of its depth and the outside dimensions that the mounted voltage surge arrester

is held by the shape only of groove 2 in the desired position, and displacement or slipping-away is prevented even when moved through a continuous-heating furnace.

In addition to groove 2, slotted contours 3 are provided on the surface of printed-circuit board 1, wherein other electronic components also not shown here can be accommodated.

The machined sections (groove 2, slotted contours 3) can be provided during the manufacture of the printed-circuit board for example by milling or punching.

The slotted contours are preferably metallised at the inner faces 9 only, said faces being provided with termination surfaces 7, wherein copper can for example be deposited galvanically.

After solder paste has been applied by suitable methods at the respective positions in the area of the provided structures, assembly with the various electronic components can be performed in an automated manner and one process step.

Printed-circuit board 1 shown in Fig. 2 is provided with a voltage surge arrester 4 mounted in groove 2 and two varistors 5 and two PTC's 6 mounted in slotted contours 3. It can be seen that used components 4, 5 and 6 are selected with regard to their dimensions to match the sections configured as groove 2 or slotted contours 3, such that the shape only of sections 2 and 3 prevents a slipping-away and electronic components 4, 5 and 6 are precisely held in the desired position. If at least some of the surfaces surrounding sections 2 and 3 are inclined, this will have a positive effect during assembly of printed-circuit board 1, since insertion of components 4, 5 and 6 is facilitated.

Printed-circuit board 1 assembled according to Fig. 2 can now be forwarded to a reflow soldering process, in order to establish a permanent connection of components 4, 5 and 6 to printed-circuit board 1, and during the movements occurring therewith of printed-circuit board 1, a displacement of components 4, 5 and 6 is avoided.

Grooves 2 and slotted contours 3 provided in printed-circuit board 1 additionally increase the strength of the connection established by the soldering process, since by the adaptation of the respective contours under



consideration of the outside contours of the respectively used component, also the selected shape has a positive effect with regard to the finally achieved strength of the connection.

Fig. 3 shows a module wherein housing 13 is placed on a base plate configured as a printed-circuit board 3 and already provided with various electronic components, such as a voltage surge arrester 4, varistor 5 and PCT's 6. Dome-type extensions 14 pass through cutouts 15, 16 or 17 provided therein, so that cutouts 15, 16 and 17 are at least partly filled up with extension material. In the example shown in Fig. 1, dome-type extensions 14 extend past printed-circuit board 1 and its bottom side 18. In some cases it is however not necessary to dimension extensions 14 so large, but they can also be smaller.

In a preferred embodiment extensions 14 provided at housing 13 are cylindrical or polygonal, as shown in Fig. 4, and have at their front face a depression or notch 19 suitable to hold a not shown pin during the hot-pressing procedure, that is during heating and simultaneous pressure, on extension 14 and bring the extension material during the flow process occurring by the pressure and temperature increase to the desired shape and prevent a slipping-away.

From Fig. 5 can be taken possible shapes for the cutouts to be provided in the printed-circuit board 1. In Fig. 5, in the leftmost representation, can be seen a blind hole 15, in the two representations of cutouts in the centre of Fig. 5 depressions 16 with widths decreasing towards top side 20 of printed-circuit board 1, and in the rightmost representation a borehole or a polygonal break-through portion 17.

The cutouts configured as blind holes 15 or depressions 16 have the advantage over the third possibility that the finally accomplished connection has a higher positive-linkage fraction, and is therefore safer.

If however cutouts are configured as boreholes or break-through portions 17 having a rectangular cross-section, the accomplished connection forces are lower, but a disconnection later possibly required can be achieved in this variant considerably simpler and without destruction.

The contact element 21 shown in Fig. 6 comprises a resilient first contact bracket 22 that is angled towards

a central electrode 23 of a voltage surge arrester 4 not shown in this representation. Contact bracket 22 contacts central electrode 23 being connected in case of an over-voltage within voltage surge arrester 4 to external electrodes 25 and 26 thereof. External electrodes 25 and 26 in turn are connected in the inserted condition of the protection plug to one telecommunication wire each. Contact element 21 comprises a receiving portion in the form of two bent-off resilient lugs 27, into said receiving portion being inserted a contact lug 28 connected to the earthing bar. Thus, in case of an overvoltage, an earth connection is established from the telecommunication wires a or b, resp., over external electrodes 25 or 26, resp., voltage surge arrester 4, central electrode 23, contact bracket 22 and lugs 27 of contact element 21 and contact lug 28 to the earthing bar.

One-piece contact element 21 comprises further a second resilient contact bracket 29 being transformed at its free end into a transverse web 30. The two ends of transverse web 30 are opposite to external electrodes 25 or 26, resp., of voltage surge arrester 4. Between the ends of transverse web 30 is attached a solder element 31 on the side of contact bracket 29 directed towards voltage surge arrester 4, said solder element resting under the spring force of contact bracket 29 against the insulating outer surface or central electrode 23 of voltage surge arrester 4 and thereby holds the ends of transverse web 30 spaced to external electrodes 25 or 26, resp. When voltage surge arrester 4 is excessively heated up, for example when an increased voltage exists for a longer time between the telecommunication wires a, b, but without leading to a response of voltage surge arrester 4, solder element 31 will melt. It cannot prevent therefore anymore that transverse web 30 comes by the spring force of contact bracket 29 to rest against external electrodes 25 and 26 of voltage surge arrester 4, so that now an earth connection between those and the earthing bar exists over contact element 21 with transverse web 30, contact bracket 29 and lugs 27 and contact lug 28.

In Fig. 6 are further disposed two holding legs 32 of contact element 21 with respect to contact bracket 22 on the other side of voltage surge arrester 4 so that they serve as a counter-bearing and prevent an unbalanced load of the solder connection between voltage surge ar-

rester 4 and the printed-circuit board carrying the latter.

In Fig. 7 is shown the contact element of Fig. 1 mounted on voltage surge arrester 4, and it can further be seen that holding legs 32 rest against the insulated outer surface of voltage surge arrester 4 on both sides of central electrode 23.

In Fig. 8 is shown the protection plug in inserted condition, with several electronic components, such as PCT's, and voltage surge arrester 4 being mounted on a printed-circuit board 1 within a housing 13. Contact element 21 is herein mounted on voltage surge arrester 4, as in the representation of Fig. 7. Simultaneously it is held by housing 13.

In Fig. 9 is shown another embodiment of a contact element 21. Second contact bracket 9 is opposite to first contact bracket 22, and solder element 31 is adapted to the external periphery of voltage surge arrester 4 such that said solder element is the counter-bearing for contact bracket 22, and holding legs 32 are therefore not required. Solder element 31 has an inner rest surface 33 in the form of an arc section, the radius of which is identical to the radius of cylindrical voltage surge arrester 4. In the central section of transverse web 30 is provided a cutout into which solder element 31 can be inserted and snap-fitted.



Patent Claims

1. A printed-circuit board for the precise assembly and soldering of electronic in particular being soldered to the surface of the printed-circuit board by means of a reflow soldering technique, characterised in that sections (2, 3) for receiving electronic components (4, 5, 6) are provided on surface (12) of printed-circuit board (1), said sections being at least partially adapted to the outside contours of respective electronic components (4, 5, 6).

2. A printed-circuit board according to claim 1, characterised in that the provided sections are configured in the form of a groove (2).

3. A printed-circuit board according to claim 1, characterised in that the provided sections are configured in the form of a slotted contour (3).

4. A printed-circuit board according to one of claims 1 to 3, characterised in that terminals or termination surfaces (7) are arranged adjacent to provided sections (2, 3).

5. A printed-circuit board according to claim 4, characterised in that terminals or termination surfaces (7) are arranged at the borders (8) of provided sections (2, 3).

6. A printed-circuit board according to one of claims 1 to 5, characterised in that inner faces (9) of provided sections (2, 3) are at least partially metalised at their borders.

7. A printed-circuit board according to one of claims 1 to 6, characterised in that an insulating cover can be brought on bottom side (10) of printed-circuit board (1).

8. A printed-circuit board according to one of claims 1 to 7, characterised in that a housing (13) for covering printed-circuit board (1) comprises dome-type extensions (14) of an at least partly deformable material in the direction of printed-circuit board (1) to be connected, said extensions engaging in cutouts (4, 5 or 6) provided in printed-circuit board (1) and passing through the latter, and being dimensioned so to meet the shape and size of cutouts (4, 5 or 6) such that a positive-linkage and/or frictional housing/printed-circuit board





connection is established by deformation of extensions (14) by exposure to energy and/or force, such that dome-type extensions (14) do not project over the bottom side of printed-circuit board (1), when the housing/printed-circuit board connection is established.

9. A printed-circuit board according to claim 8, characterised in that said cutouts are configured as blind holes (15).

10. A printed-circuit board according to claim 8 or 9, characterised in that said extensions are recesses (16) reducing their width from bottom side (18) of printed-circuit board (1) towards top side (20) of printed-circuit board (1).

11. A printed-circuit board according to one of claims 8 to 10, characterised in that said cutouts are configured as uniform boreholes over the complete width of printed-circuit board (1) or as break-through portions (17) having a polygonal cross-section.

12. A printed-circuit board according to one of claims 8 to 11, characterised in that dome-type extensions (14) are made of a thermoplastic material.

13. A printed-circuit board according to one of claims 8 to 12, characterised in that extensions (14) comprise at their front face directed towards bottom side (18) of printed-circuit board (1) a recess or notch (19).

14. A printed-circuit board according to claim 1 or 8, characterised in that an overvoltage protection plug for terminal blocks of the telecommunication technique, comprising a pluggable plastic material housing with a voltage surge arrester (4) and two external electrodes (22) each connected to a telecommunication wire and a central electrode (23) connected to the earthing bar, and comprising a thermal overload protection device by means of which the telecommunication wires are connected to the earthing bar in case of excessive heating of voltage surge arrester (4) is provided, a one-piece contact element (21) to be inserted into the housing being provided, said contact element comprising a first contact bracket (22) being in contact with central electrode (23) of mounted voltage surge arrester (4), in the inserted condition, a receiving portion (27) for a contact lug (28) rigidly connected to the earthing bar, and a resilient second contact bracket (29) that is held spaced to external electrodes (25, 26) by a thermal element (31) and can





be brought, by a change of shape of thermal element (31) due to its resilient properties in case of excessive heating, to rest against both external electrodes (25, 26).

15. A printed-circuit board according to claim 14, characterised in that second contact bracket (29) is transformed at its free end into a transverse web (30) the free ends of which can each be brought into contact with one of external electrodes (25, 26) and between the ends of which thermal element (31) is arranged.

16. A printed-circuit board according to claim 14 or 15, characterised in that thermal element (31) is a moulded part melting when heated or a bi-metal, is made of a material becoming soft when heated or of a memory alloy.

17. A printed-circuit board according to one of claims 14 to 16, characterised in that thermal element (31) is rigidly connected to second contact bracket (29).

18. A printed-circuit board according to one of claims 14 to 16, characterised in that thermal element (31) is snap-fitted in second contact bracket (29).

19. A printed-circuit board according to one of claims 14 to 18, characterised in that contact element (21) comprises at the side of voltage surge arrester (4) opposite to first holding bracket (22) at least one holding leg (23) resiliently resting against its insulating surface.

20. A method for the precise assembly and soldering of electronic components on the surface of the printed-circuit board by means of a reflow soldering technique, wherein solder paste is applied in a dosed manner on termination surfaces (7) to be soldered of printed-circuit board (1), said termination surfaces being located in sections (2, 3) provided on surface (12) of printed-circuit board (1) and adapted to the outside contours of respective electronic components (4, 5, 6), electronic components (4, 5, 6) being precisely placed in provided sections (2, 3), and then the solder paste being heated to a temperature above its melting point.

21. A method according to claim 20, characterised in that electronic components (4, 5, 6) are directed, with their solderable surfaces (11), vertically to printed-





circuit board (1) and are placed in provided sections (2, 3).

22. A method according to claim 20 or 21, characterised in that the solder paste is applied in a dosed manner by template printing.

23. A method according to claim 20 or 21, characterised in that the solder paste is applied in a dosed manner by a dispense process.



Abstract:

Printed-circuit board and method for the precise assembly and soldering of electronic components on the surface of the printed-circuit board

The invention relates to a printed-circuit board (1) and a method for the precise assembly of electronic components on surface (12) of printed-circuit board (1), said electronic components being electrically and conductively attached to printed-circuit board (1) by means of a reflow soldering technique. For this purpose, a printed-circuit board (1) is used that has sections (2, 3) for receiving electronic components on its surface (12), said sections being at least partially adapted to the outside contour of respective electronic components. Said sections configured as slotted contours (3) or grooves (2) secure that the electronic components mounted after the application of solder paste are held in their desired positions prior to the actual soldering process.

In addition, the assembled printed-circuit board can be connected to a housing (1) composed of dome-type extensions (14) of an at least partly deformable material. Said extensions engage in cutouts (15, 16 or 17) provided in the printed-circuit board and pass through the latter, and a positive-linkage and/or frictional housing/printed-circuit board connection is established by deformation of said extensions (14). Further, an overvoltage protection plug for terminal blocks of the telecommunication technique with a voltage surge arrester (4) can be mounted that combines the two functions "earthing contact" and "fail-safe contact" in one part, and an assembly can be achieved with little expenses for assembly.

(Fig. 2)

FIG.1

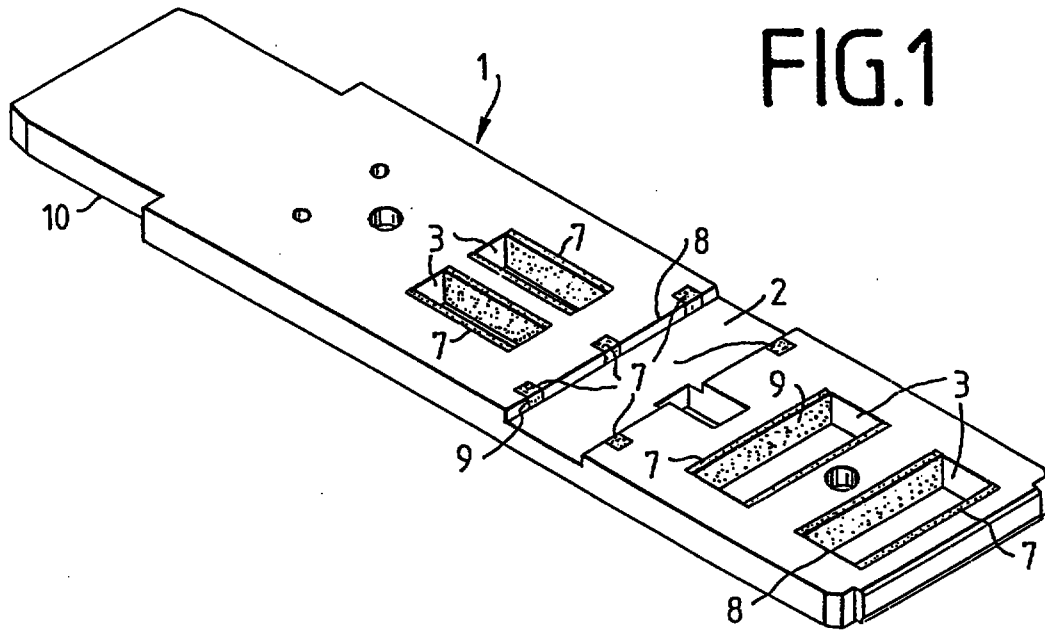
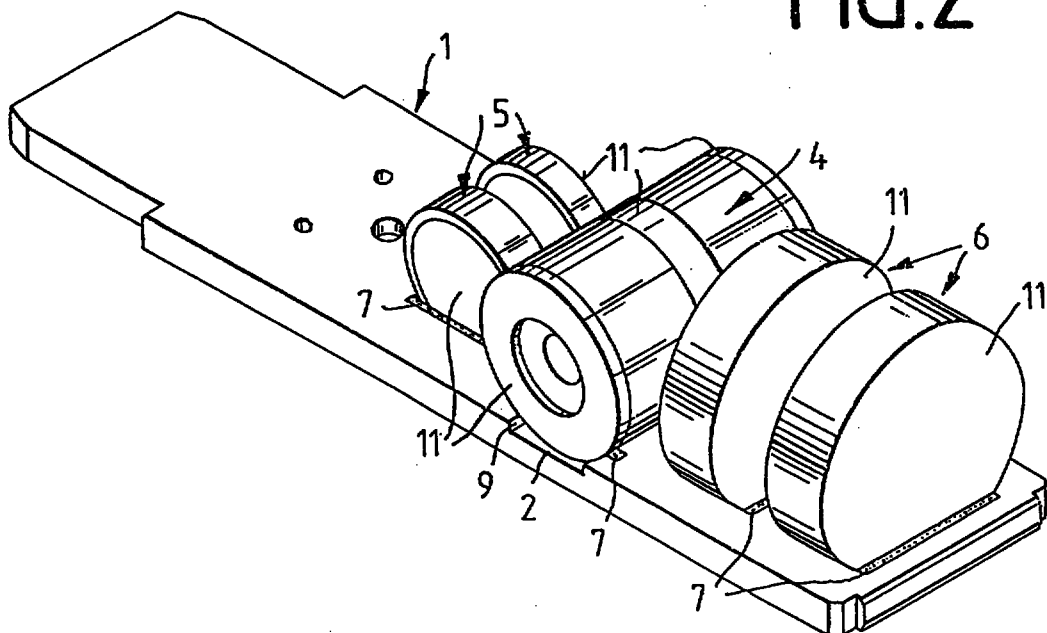


FIG.2



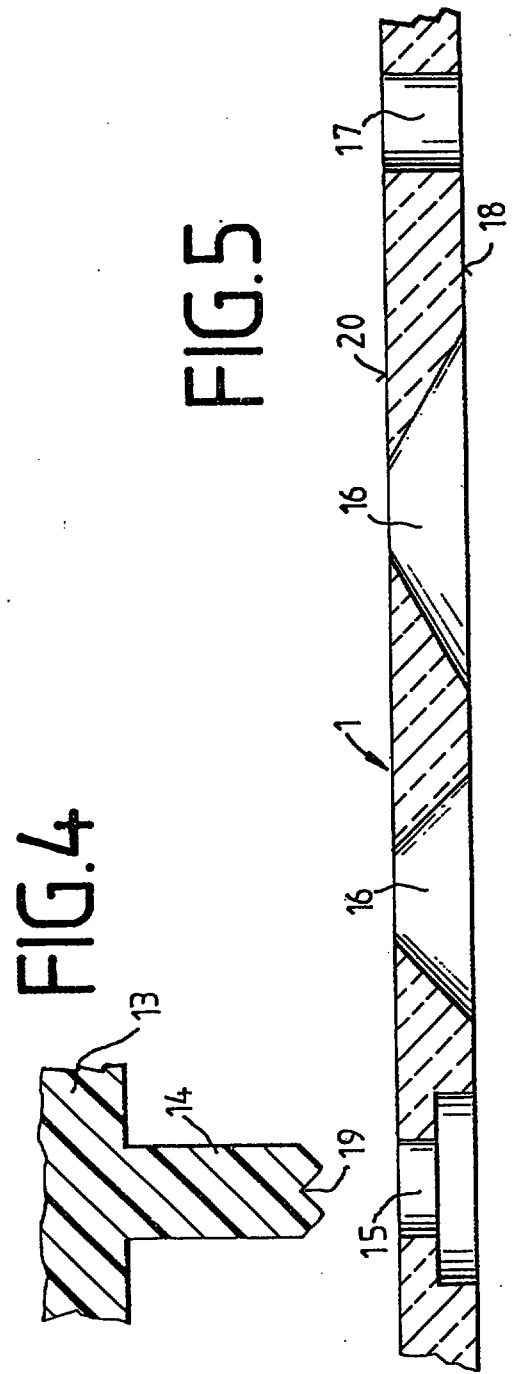
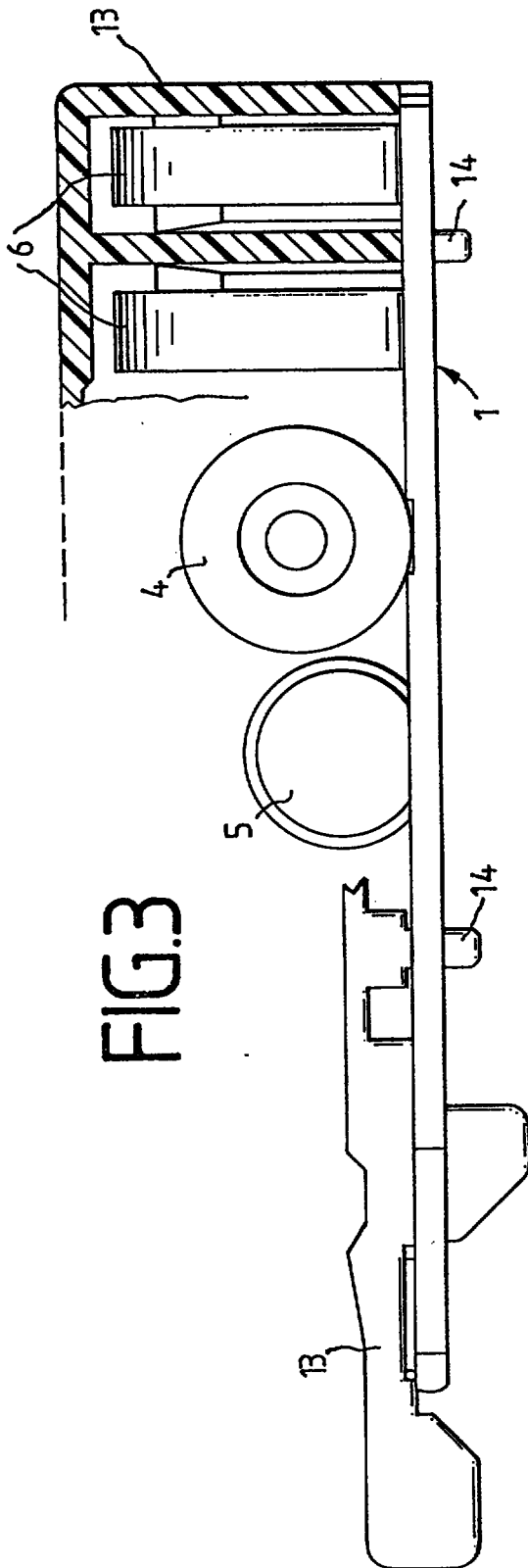


FIG.6

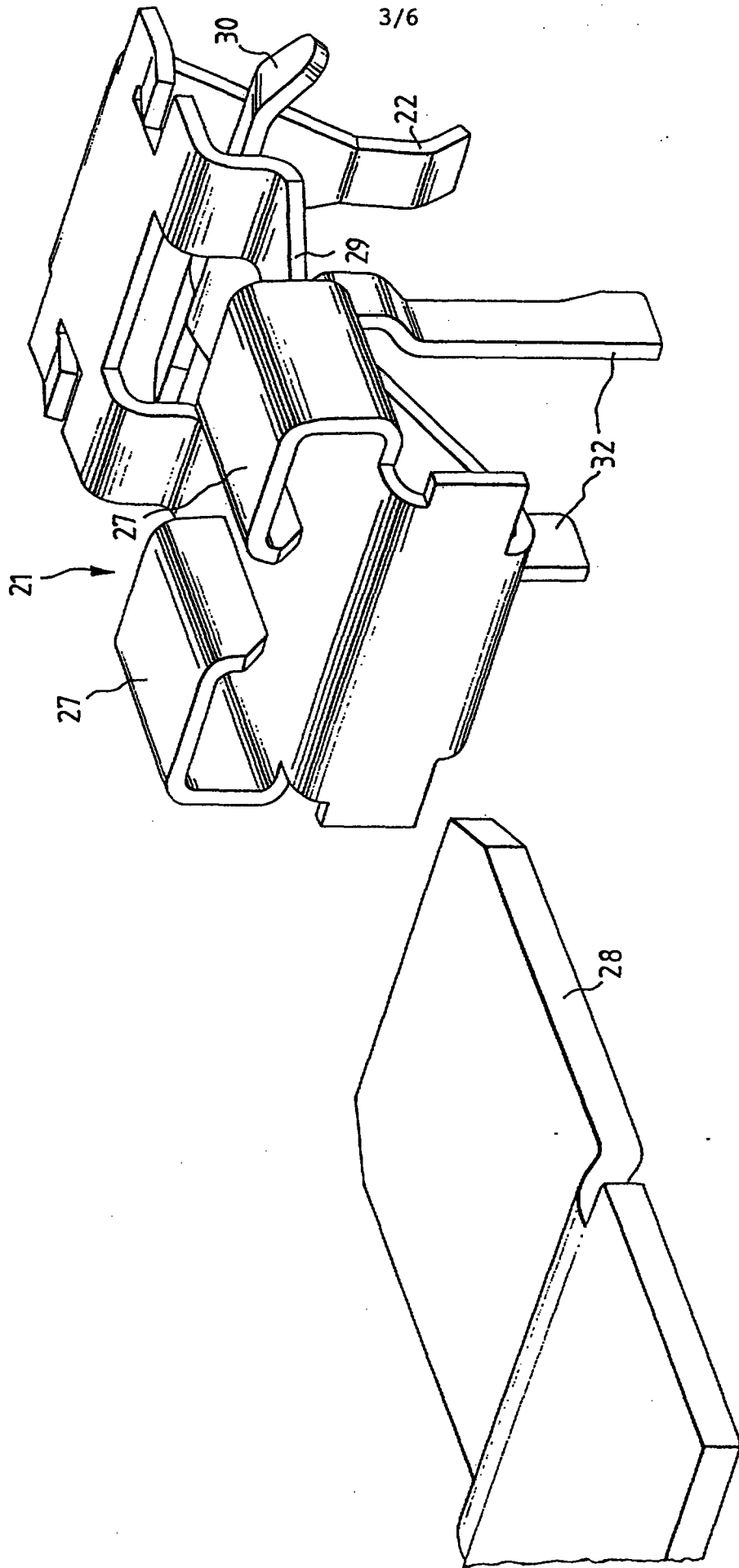


FIG.8

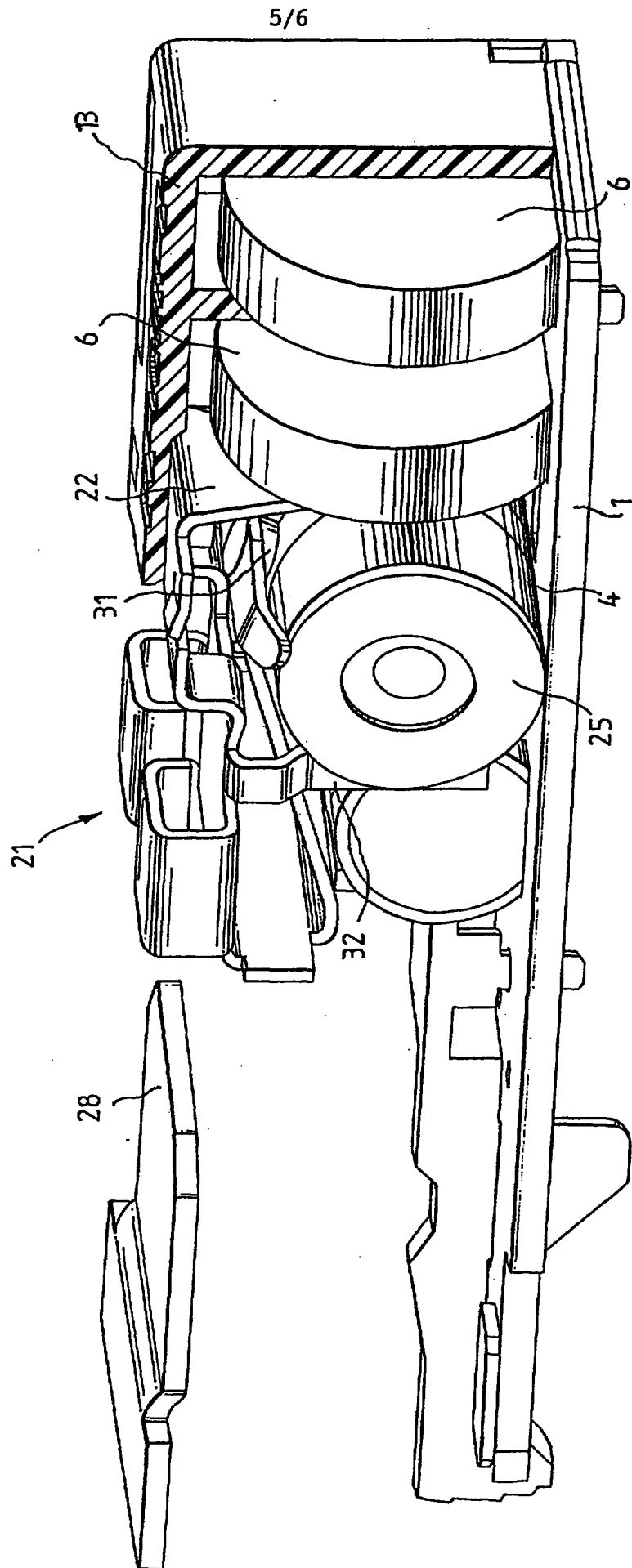
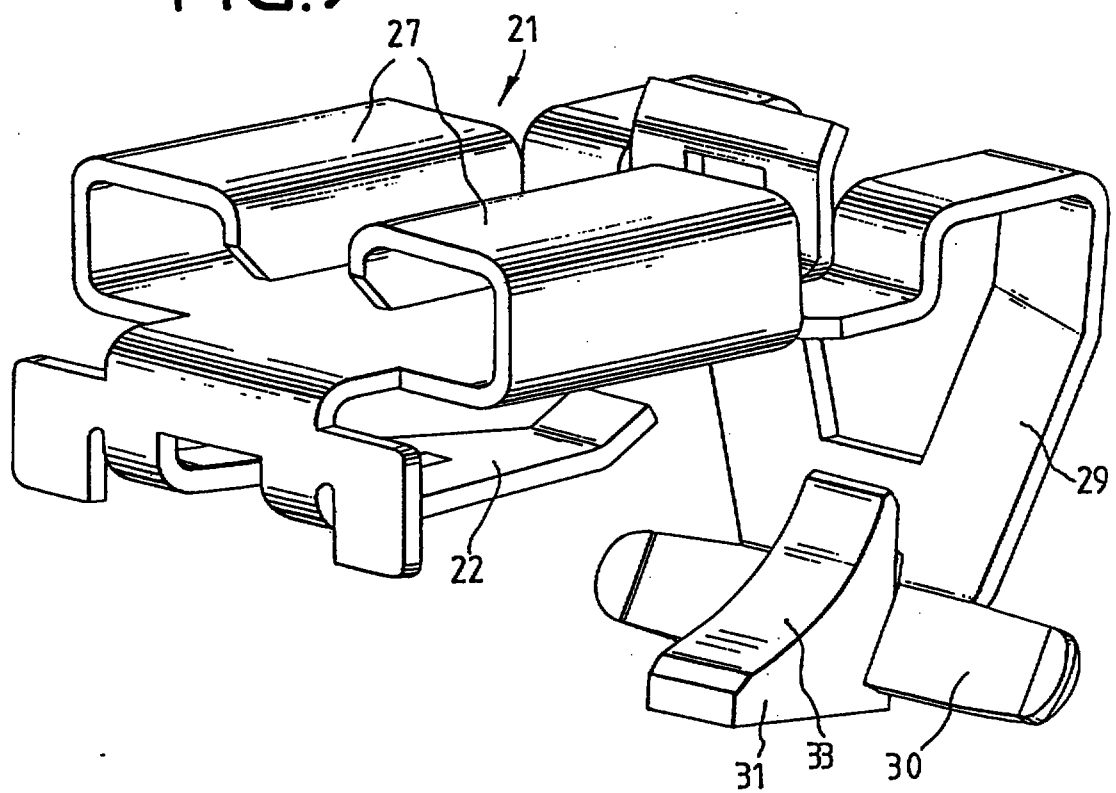


FIG. 9



REPLACEMENT SHEETS SG
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Printed-circuit board and method for the precise assembly and soldering of electronic components on the surface of the printed-circuit board

The invention relates to a printed-circuit board and a method for the precise assembly of electronic components on the surface of the printed-circuit board.

It is known to mount the voltage surge arresters by a reflow soldering technique on the printed-circuit board and to contact the other electronic components, such as PTC's, varistors and diodes as chip components by means of a conventional clamping technique. Therein problems exist with the precise positioning of the voltage surge arrester, when the latter is not held in the desired position during the soldering process, and therefore contact problems or difficulties during further processing or assembly of the printed-circuit board may occur.

By the various techniques of assembling different components on the printed-circuit board, several steps are required for contacting. Further, additional contact lugs are required for the assembly of the printed-circuit board with the other components (PTC's and varistors), thus increasing the material and manufacture costs.

In reflow soldering techniques it is common to apply solder material on the printed-circuit boards at positions intended for receiving an electronic component. Thereafter, the respective component is mounted on the solder material still being in a pasty condition, and

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then the completely assembled printed-circuit board is heated, until the solder material melts, and after cooling down, the electronic component is held in position by the re-solidified solder material and is electrically contacted.

As long as the solder material does not yet effect an intense connection of the electronic component to the printed-circuit board, that is immediately after placing the electronic components, the respective electronic component may slip and come out of the desired position. Since the reflow soldering technique is usually performed in continuous-heating furnaces, such as they are for example known from DE 40 16 366 C2, provisions have to be taken during transportation of the printed-circuit board assembled before, such provisions preventing the electronic component from slipping away from the desired position by movements or vibrations.

In order to prevent such slipping away, there is known for example from EP 0 540 497 A2 the utilisation of a matrix which can however only determine the surface shape of the solder applied to the solder positions. Fixation of the component at least to a certain degree is not possible by this method. Positioning is to be facilitated by that the generated solder positions have a plane surface.

The utilisation of an adhesive to fix the components to an printed-circuit board is disclosed in DE 41 26 913 A1. Therein the connection of the respective component to the printed-circuit board is established by an adhesive. Thereafter the actual soldering process is performed, and the complete connection is finally accomplished. In addition to the required adhesive the supply of which necessitates higher expenditures for the printed-circuit board assembly, high requirements have to be met by the used adhesive. Since the latter is exposed to high temperatures during soldering, it may be damaged due to the solvent possibly contained in the adhesive.

It is therefore the object of the present invention to provide a printed-circuit board and a method for the assembly of such a printed-circuit board wherein in a simple manner the electronic components to be applied to the surface of the printed-circuit board can precisely be positioned and thereafter be soldered in this position.

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consideration of the outside contours of the respectively used component, also the selected shape has a positive effect with regard to the finally achieved strength of the connection.

Fig. 3 shows a module wherein housing 13 is placed on a base plate configured as a printed-circuit board 3 and already provided with various electronic components, such as a voltage surge arrester 4, varistor 5 and PCT's 6. Dome-type extensions 14 pass through cutouts 15, 16 or 17 provided therein, so that cutouts 15, 16 and 17 are at least partly filled up with extension material. In the example shown in Fig. 1, dome-type extensions 14 extend past printed-circuit board 1 and its bottom side 18. In some cases it is however not necessary to dimension extensions 14 so large, but they can also be smaller.

In a preferred embodiment extensions 14 provided at housing 13 are cylindrical or polygonal, as shown in Fig. 4, and have at their front face a depression or notch 19 suitable to hold a not shown pin during the hot-pressing procedure, that is during heating and simultaneous pressure, on extension 14 and bring the extension material during the flow process occurring by the pressure and temperature increase to the desired shape and prevent a slipping-away.

From Fig. 5 can be taken possible shapes for the cutouts to be provided in the printed-circuit board 1. In Fig. 5, in the leftmost representation, can be seen a hole 15 having a shoulder, in the two representations of cutouts in the centre of Fig. 5 depressions 16 with widths decreasing towards top side 20 of printed-circuit board 1, and in the rightmost representation a borehole or a polygonal break-through portion 17.

The cutouts configured as holes 15 or depressions 16 have the advantage over the third possibility that the finally accomplished connection has a higher positive-linkage fraction, and is therefore safer.

If however cutouts are configured as boreholes or break-through portions 17 having a rectangular cross-section, the accomplished connection forces are lower, but a disconnection later possibly required can be achieved in this variant considerably simpler and without destruction.

The contact element 21 shown in Fig. 6 comprises a resilient first contact bracket 22 that is angled towards

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1. A printed-circuit board for the precise assembly and soldering of electronic components in particular those soldered to the surface of the printed-circuit board by means of a reflow soldering technique, characterised in that sections for receiving electronic components are provided on a surface of the printed-circuit board, said sections being at least partially adapted to the outside contours of respective electronic components, the inner faces of the sections being provided with at least one terminal or termination surface.
2. A printed-circuit board according to claim 1, characterised in that the provided sections are configured in the form of a groove.
3. A printed-circuit board according to claim 1, characterised in that the provided sections are configured in the form of a slotted contour.
4. A printed-circuit board according to any of claim 1, 2 or 3 characterised in that terminals or termination surfaces are arranged at the borders of the sections.
5. A printed-circuit board according to one of claims 1 to 4, further comprising an insulating cover disposed on the under side of the printed-circuit board.
6. A printed-circuit board according to one of claims 1 to 5, characterised in that a housing for covering the printed-circuit board comprises a plurality of dome-type extensions of an at least partly deformable material engaging in cutouts provided in the printed-circuit board and passing through the latter, and being dimensioned so to be received by the cutouts such that a positive linkage and/or frictional housing/printed-circuit board connection is established by



deformation of extensions by exposure to energy and/or force, such that the dome-type extensions do not project over the bottom side of printed-circuit board, when the housing/printed circuit board connection is established.

7. A printed-circuit board according to claim 6, characterised in that said cutouts are configured as holes having a shoulder.

8. A printed-circuit board according to claim 6 or 7, characterised in that said cutouts are recesses reducing their width from bottom side of printed-circuit board towards top side of printed-circuit board.

9. A printed-circuit board according to one of claims 6 to 8, characterised in that said cutouts are configured as uniform boreholes through the complete thickness of the printed-circuit board or as break-through portions having a polygonal cross-section.

10. A printed-circuit board according to one of claims 6 to 9, characterised in that dome-type extensions are made of a thermoplastic material.

11. A printed-circuit board according to one of claims 6 to 10, characterised in that extensions comprise at their front face directed towards the under side of printed-circuit board a recess or notch.

12. A printed-circuit board according to claim 1 or 8, further comprising

(a) an overvoltage protection plug comprises a pluggable plastic material housing with a voltage surge arrester and two external electrodes each connected to a telecommunication wire and a central electrode connected to an earthing bar, and

(b) a thermal overload protection device by means of which the telecommunication wires are connected to the earthing bar in case of excessive heating of voltage surge arrester,

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(c) a one-piece contact element to be inserted into the housing, said contact element comprising a first contact bracket being in contact with central electrode of mounted voltage surge arrester, in the inserted condition, a receiving portion for a contact lug rigidly connected to the earthing bar, and a resilient second contact bracket that is held spaced to external electrodes by a thermal element and can be brought, by a change of shape of thermal element due to its resilient properties in case of excessive heating, to rest against both external electrodes.

13. A printed-circuit board according to claim 12, characterised in that second contact bracket forms at its free end a transverse web the free ends of which can each be brought into contact with one of external electrodes and between the ends of which thermal element is arranged.

14. A printed-circuit board according to claim 12 or 13, characterised in that thermal element is a moulded part melting when heated or a bi-metal or is made of a material becoming soft when heated or of a memory alloy.

15. A printed-circuit board according to one of claims 12 to 14, characterised in that the thermal element is rigidly connected to the second contact bracket.

16. A printed-circuit board according to one of claims 12 to 14, characterised in that the thermal element is connected to the second contact bracket by a snap-fit arrangement.

17. A printed-circuit board according to one of claims 12 to 16, characterised in that the contact element comprises, at the side of voltage surge arrester opposite to first holding bracket, at least one holding leg resiliently resting against an insulated surface of the voltage arrestor.

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18. A method for the precise assembly and soldering of electronic components on the surface of a printed-circuit board by means of a reflow soldering technique, wherein solder paste is applied in a dosed manner on termination surfaces to be soldered of printed-circuit board, said termination surfaces being located in sections provided on surface of printed-circuit board and adapted to the outside contours of respective electronic components, electronic components being precisely placed in provided sections, and then the solder paste being heated to a temperature above its melting point.

19. A method according to claim 18, characterised in that the electronic components are directed, with their solderable surfaces, perpendicular to the printed-circuit board.

20. A method according to claim 18 or 19, characterised in that the solder paste is applied in a dosed manner by template printing.

21. A method according to claim 18 or 19, characterised in that the solder paste is applied in a dosed manner by a dispensing process.

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