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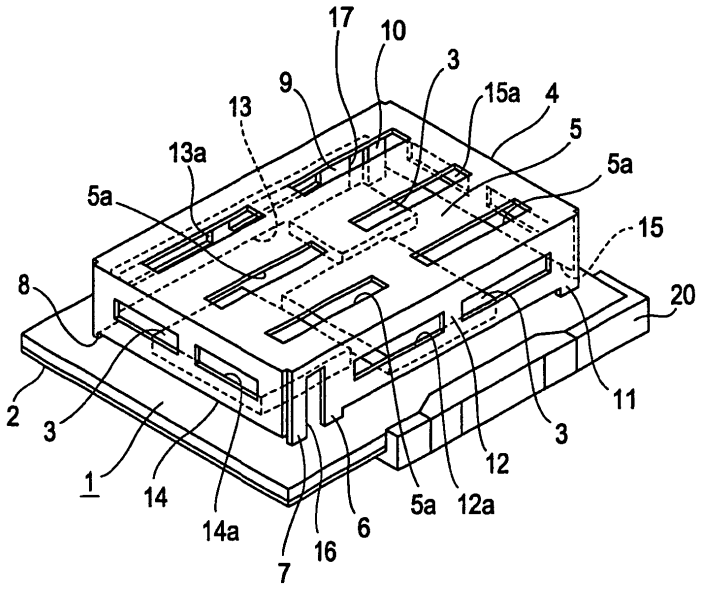
(54) Antenna-integrated module

(57) A circuit board (1) provided with a wiring pattern and an earth conductor layer (2) is mounted with a group of circuit components (3), and the group of circuit components (3) is covered by a cover and antenna element (4), which is formed by a metal plate and mounted on the circuit board (1). The cover and antenna element (4) includes a rectangular top board (5) having openings (5a), a feed leg piece 6 connected to a feeding line of the wiring pattern, short leg pieces (7) and (8) connected to the earth conductor layer (2), electrically open holding leg pieces (9) to (11), and side plates (12) to (15) having openings (12a) to (15a). The respective leg pieces (6) to (11) are solder-joined to the circuit board 1.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an antenna-integrated module suitable as a small-sized transmitting and receiving unit or the like used in communication and broadcasting.

2. Description of the Related Art

[0002] In recent years, along with the development of the wireless communication technique, there have been proposed a variety of electronic devices and wireless cards including therein a small-sized transmitting and receiving unit. A transmitting and receiving unit of this type is an antenna-integrated high frequency module including an antenna element on a circuit board provided with a high frequency circuit. A conventional general antenna-integrated module is configured such that a shield case formed by a metal plate covers a predetermined region on a circuit board provided with a major portion of a high frequency circuit, and that an antenna element such as a chip antenna and a pattern antenna is provided in another region on the circuit board (see Pages 4 to 6 and Fig. 1 of Japanese Unexamined Patent Application Publication No. 2002-232221, for example).

[0003] In such a configuration that the antenna element and the shield case are juxtaposed in different regions on the circuit board, however, the entire module is increased in planar size. Thus, it is difficult to facilitate size reduction of the module. Further, if such a configuration is adopted that a chip antenna is used as the antenna element to be connected to the high frequency circuit via a coaxial cable, component cost is significantly increased.

[0004] In recent years, therefore, there has been proposed an antenna-integrated module configured such that the shield case for covering and electromagnetically shielding a group of circuit components of the high frequency circuit can be used also as the antenna element of an inverted-F antenna (see Pages 4 and 5 and Fig. 1 of Japanese Unexamined Patent Application Publication No. 2005-5866, for example). The conventional proposal uses a cover and antenna element formed by a metal plate, in which a plurality of bent leg pieces hang from the periphery of a rectangular top board (i.e., a flat metal plate). The cover and antenna element is mounted on the circuit board provided with the high frequency circuit, and a predetermined one of the bent leg pieces is connected to a wiring pattern or an earth conductor layer of the high frequency circuit to operate as a feed pin or a short pin, while the remaining bent leg pieces are connected to electrically isolated solder lands. Further, the top board stably supported by the respective bent leg pieces is disposed to face the circuit board, with a predetermined interval formed therebetween, at such a position to cover the group of circuit components of the high frequency circuit. Therefore, the top board connected to the bent leg piece corresponding to the short pin can electromagnetically shield the group of circuit components of the high frequency circuit. The top board is also connected to the bent leg piece corresponding to the feed pin, and thus can operate as a radiating conductor of the inverted-F antenna. If the cover and antenna element formed by a metal plate is thus adopted, it is possible to obtain an antenna-integrated module which is more easily reduced in size and cost than the module according to the above-described conventional technique of planarly juxtaposing the separate components of the antenna element and the shield case.

[0005] As described above, in the antenna-integrated module of the conventional proposal disclosed in Japanese Unexamined Patent Application Publication No. 2005-5866, the reduction in size and cost of the module is attempted by employing the cover and antenna element. In the cover and antenna element, however, the top board formed by the flat metal plate is disposed at the position to cover the group of circuit components. Thus, if reflow soldering is performed at one time on the cover and antenna element and on the group of circuit components mounted on the circuit board, the heat from a reflow furnace is not sufficiently transmitted to the region covered by the top board. As a result, the reliability of solder joining of the group of circuit components is significantly deteriorated. In this antenna-integrated module, therefore, it is required that the group of circuit components is mounted on the circuit board to be subjected to the first reflow soldering and thereafter the cover and antenna element is mounted on the circuit board to be subjected to the reflow soldering, which is performed again at a lower melting temperature than in the first reflow soldering. Accordingly, the reflow process cannot be effectively performed.

[0006] Further, in the cover and antenna element used in the antenna-integrated module of the above conventional proposal, the plurality of bent leg pieces simply hang from the periphery of the top board. Thus, the space covered by the top board (i.e., the region mounted with the group of circuit components) is widely exposed, as viewed from a lateral side. Therefore, there is a possibility that a solder trowel or the like is inserted into the space from the lateral side for illegal alteration of the major portion of the high frequency circuit.

SUMMARY OF THE INVENTION

[0007] The present invention has been made in view of the above-described circumferences of the conventional techniques, and an object of the present invention is to provide an antenna-integrated module which enables easy size reduction thereof, easy prevention of illegal alteration of a circuit thereof, effective performance of a reflow process thereon, and inexpensive manufac-

ture thereof.

[0008] To achieve the above-described object, an antenna-integrated module according to the present invention includes a circuit board provided with a wiring pattern and an earth conductor layer of a high frequency circuit, a group of circuit components mounted on a surface of the circuit board, and a cover and antenna element formed by a metal plate and mounted on the circuit board to cover the group of circuit components. The cover and antenna element includes a top board facing the circuit board with a predetermined interval therebetween and operating as a radiating conductor, a feed leg piece hanging toward the circuit board from a feeding point of the top board and connected to the wiring pattern, short leg pieces hanging toward the circuit board from the periphery of one side of the top board and connected to the earth conductor layer, electrically open holding leg pieces hanging toward the circuit board from the periphery of the other side of the top board and fixed to the circuit board, and side plates hanging toward the circuit board from other positions than the positions of the feed leg piece, the short leg pieces, and the holding leg pieces on the periphery of the top board such that the leading ends of the side plates face the circuit board with a clearance therebetween. The top board is pierced with openings in the form of slits or small holes at a plurality of positions apart from the periphery thereof.

[0009] In the thus configured antenna-integrated module according to the present invention, the cover and antenna element formed by a metal plate can be operated as a shield case for electromagnetically shielding the group of circuit components of the high frequency circuit, and also as an antenna element of an inverted-F antenna formed by a metal plate, in which the top board acts as a radiating conductor. Therefore, the entirety of the module is more easily reduced in size and cost than the module configured such that separate components of an antenna element and a shield case are planarly juxtaposed. Further, the top board is pierced with the openings at a plurality of positions, and thus air can be smoothly flowed through the openings. In a reflow process, therefore, the heat is easily transmitted to the region on the circuit board covered by the cover and antenna element. Thus, reflow soldering can be performed at one time on the cover and antenna element and on the group of circuit components mounted on the circuit board. Therefore, manufacturing cost can be further reduced. Furthermore, since the openings are formed into slits or small holes, it is difficult to insert a solder trowel or the like into the openings. Further, since the side plates hang toward the circuit board from the periphery of the top board, it is also difficult to insert the solder trowel or the like from a lateral side into the space covered by the cover and antenna element. Accordingly, the present antenna-integrated module has little risk of illegal alteration of a major portion of the high frequency circuit.

[0010] In the above-described configuration, the openings in the form of slits or small holes may be also pierced in each of the side plates of the cover and antenna element at a plurality of positions apart from the periphery of the side plate. This configuration is preferable in that the heat is further easily transmitted to the region on the circuit board covered by the cover and antenna element in the reflow process.

[0011] Further, in the above-described configuration, the top board of the cover and antenna element may be rectangular, and the respective short leg pieces may hang from two positions on one side in the longer direction of the top board, while the respective holding leg pieces may hang from two positions on the other side in the longer direction of the top board. This configuration is preferable in that the cover and antenna element can be simplified in shape and thus easily manufactured. In this case, the third holding leg piece having the same shape as the shape of the feed leg piece may be provided at a position point-symmetrical to the feed leg piece such that the cover and antenna element has an exterior of a symmetrical shape that does not change even if the opposite sides in the longer direction of the cover and antenna element are reversed in direction. Thus configured, there is no need to check the direction of the cover and antenna element in the assembly process of mounting the cover and antenna element on the circuit board. Accordingly, the workability can be improved.

[0012] Furthermore, in the above-described configuration, the width of the openings pierced in the top board and the side plates and the opposed interval (i.e., the size of the clearance) between the leading ends of the side plates and the circuit board may be both set to be equal to or less than 1 millimeter. This configuration is preferable in that the illegal alteration of the major portion of the high frequency circuit can be further reliably prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a perspective view of an antenna-integrated module according to a first embodiment of the present invention;

Fig. 2 is an exploded perspective view of the module and a connector illustrated in Fig. 1; and

Fig. 3 is a perspective view of an antenna-integrated module according to a second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Embodiments of the present invention will now be described with reference to the drawings. Fig. 1 is a perspective view of an antenna-integrated module according to a first embodiment of the present invention, and Fig. 2 is an exploded perspective view of the module and a connector illustrated in Fig. 1.

[0015] The antenna-integrated module illustrated in

the above drawings mainly includes a rectangular circuit board 1, a group of circuit components 3, and a cover and antenna element 4. The circuit board 1 has an upper surface provided with a wiring pattern (not illustrated) of a high frequency circuit, and a lower surface, nearly the entirety of which is provided with an earth conductor layer 2. The group of circuit components 3 includes chip components, integrated circuits, and the like mounted on the upper surface of the circuit board 1 and connected to the wiring pattern. The cover and antenna element 4 is formed by a metal plate and mounted on the circuit board 1 to cover the group of circuit components 3. The circuit board 1 is electrically and mechanically connected onto a not-illustrated mother board via a connector 20.

[0016] The cover and antenna element 4 includes a top board 5, a feed leg piece 6, short leg pieces 7 and 8, holding leg pieces 9 to 11, and side plates 12 to 15. The top board 5 is a flat rectangular metal plate for covering the group of circuit components 3, and operates as a radiating conductor. The feed leg piece 6, the short leg pieces 7 and 8, and the holding leg pieces 9 to 11 hang toward the circuit board 1 from the periphery of the top board 5. The side plates 12 to 15 hang toward the circuit board 1 from other positions than the positions of the above respective leg pieces 6 to 11 on the periphery (i.e., the four sides) of the top board 5. The feed leg piece 6 is connected to the wiring pattern, and the short leg pieces 7 and 8 are connected to the earth conductor layer 2. Meanwhile, the holding leg pieces 9 to 11 are fixed to the circuit board 1 in an electrically open state. Further, the top board 5 is pierced with slit-shaped openings 5a at six positions apart from the periphery thereof, and the respective side plates 12 to 15 are pierced with slit-shaped openings 12a to 15a, with each of the side plates having the corresponding openings at two positions apart from the periphery thereof.

[0017] That is, the side plate 12 extending along one of the long sides of the top board 5 is a bent piece, one side of which in the longer direction of the top board 5 continues to the feed leg piece 6, and the other side of which in the longer direction of the top board 5 continues to the holding leg piece 11. The side plate 12 is pierced with the openings 12a, which extend along the long side of the top board 5, at two positions in a line. Further, the short leg piece 7 is provided at a position adjacent to the side plate 12 with the interposition of the feed leg piece 6 and a cutout portion 16. Similarly, the side plate 13 extending along the other long side of the top board 5 is a bent piece, one side of which in the longer direction of the top board 5 continues to the short leg piece 8, and the other side of which in the longer direction of the top board 5 continues to the holding leg piece 9. The side plate 13 is pierced with the openings 13a, which extend along the long side of the top board 5, at two positions in a line. Further, the holding leg piece 10 is provided at a position adjacent to the side plate 13 with the interposition of the holding leg piece 9 and a cutout portion 17. Furthermore, the side plate 14 extending over the entire length of one of the short sides of the top board 5 is pierced with the openings 14a, which extend along the short side, at two positions in a line. Similarly, the side plate 15 extending over the entire length of the other short side of the top board 5 is pierced with the openings 15a, which extend along the short side, at two positions in a line. The width (i.e., the slit width) of each of the slit-shaped openings 12a to 15a pierced in the respective side plates 12 to 15 is set to be equal to or less than 1 millimeter. Further, each of the leading ends (i.e., the lower ends) of the respective side plates 12 to 15 faces the circuit board 1 with a clearance therebetween, and the opposed interval therebetween is also set to be equal to or less than 1 millimeter.

[0018] The respective leg pieces 6 to 11 of the cover and antenna element 4 will now be described in detail. A lower portion of the feed leg piece 6 is connected to a feed line of the above-described wiring pattern so that a predetermined high frequency signal is supplied to a feeding point of the top board 5 (i.e., an upper bent end portion of the feed leg piece 6) via the feed leg piece 6. The short leg pieces 7 and 8 are connected to the earth conductor layer 2 through holes formed in the circuit board 1. The holding leg pieces 9 to 11 are respectively connected to electrically isolated solder lands on the circuit board 1 so that an electrostatic capacitance is loaded between each of the solder lands and the earth conductor layer 2. That is, with the respective leg pieces 6 to 11 solder-joined to the corresponding solder lands, the cover and antenna element 4 is attached onto the circuit board 1 in a stable posture, and the top board 5 faces the circuit board 1 with a predetermined interval therebetween. Further, as illustrated in the drawings, the four corners of the cover and antenna element 4 are provided with the short leg pieces 7 and 8 and the holding leg pieces 10 and 11, and the holding leg piece 9 having the same shape as the shape of the feed leg piece 6 is provided at a position point-symmetrical to the feed leg piece 6. Accordingly, the cover and antenna element 4 is designed to have an exterior of a symmetrical shape that does not change even if the opposite sides in the longer direction of the cover and antenna element 4 are reversed in direction.

[0019] In the thus configured antenna-integrated module, the cover and antenna element 4 formed by a metal plate for covering the group of circuit components 3 is connected to the earth conductor layer 2. Thus, the cover and antenna element 4 can be operated as a shield case. Further, the rectangular top board 5 of the cover and antenna element 4 is provided with the short leg pieces 7 and 8 on one side in the longer direction thereof, and is kept in an electrically open state on the other side in the longer direction thereof. Also, the top board 5 can be excited by power feeding from the feed leg piece 6. Accordingly, the top board 5 can be operated as a radiating conductor of an inverted-F antenna formed by a metal plate.

[0020] That is, in the antenna-integrated module ac-

cording to the present embodiment, the cover and antenna element 4 for covering the major portion of the high frequency circuit is designed to operate not only as the shield case but also as the antenna element of the inverted-F antenna. Thus, the present antenna-integrated module is more easily reduced in size and cost than the module configured such that the separate components of the antenna element and the shield case are planarly juxtaposed. Further, the cover and antenna element 4 is designed to load the electrostatic capacitance on the electrically open side on which the holding leg pieces 9 to 11 concentrate, i.e., the side on which an electric field is formed at the time of power feeding. Accordingly, the size reduction of the entire module is further easily facilitated.

[0021] Furthermore, in the present antenna-integrated module, a plurality of the openings 5a and 12a to 15a are respectively pierced in the top board 5 and the respective side plates 12 to 15 of the cover and antenna element 4, and thus air can be smoothly flowed through the openings 5a and 12a to 15a. In a reflow process, therefore, the heat is easily transmitted to the region on the circuit board 1 covered by the cover and antenna element 4, and thus reflow soldering can be performed at one time on the cover and antenna element 4 and on the group of circuit components 3 mounted on the circuit board 1. That is, there is no need to repeat the reflow process. Accordingly, the module can be further inexpensively manufactured.

[0022] In addition, in the present antenna-integrated module, the side plates 12 to 15 hang toward the circuit board 1 from the periphery of the top board 5, and the opposed interval between the leading end of each of the side plates 12 to 15 and the circuit board 1 is set to be equal to or less than 1 millimeter. It is therefore difficult to insert a solder trowel or the like from a lateral side into the space covered by the cover and antenna element 4. Further, each of the openings 5a and 12a to 15a is formed into a slit shape having a width of equal to or less than 1 millimeter. Thus, it is also difficult to insert the solder trowel or the like into the openings 5a and 12a to 15a. According to the present antenna-integrated module, therefore, there is little risk that the major portion of the high frequency circuit is illegally altered.

[0023] Furthermore, in the antenna-integrated module according to the present embodiment, the cover and antenna element 4 formed by a metal plate is simple in shape and thus easy to be manufactured. Further, the cover and antenna element 4 is designed to have an exterior of a symmetrical shape that does not change even if the opposite sides in the longer direction of the cover and antenna element 4 are reversed in direction. Accordingly, the antenna-integrated module according to the present embodiment has an advantage in that there is no need to take trouble to check the direction of the cover and antenna element 4 in the assembly process of mounting the cover and antenna element 4 on the circuit board 1, and thus that the workability is improved.

[0024] Fig. 3 is a perspective view of an antenna-integrated module according to a second embodiment of the present invention. Components corresponding to the components illustrated in Figs. 1 and 2 are assigned with the same reference numerals so that redundant description thereof will be omitted.

[0025] The present embodiment is different from the above-described first embodiment in the positions formed with the feed leg piece 6, the short leg pieces 7 and 8, and the holding leg pieces 9 to 11, which hang from the periphery of the top board 5, and is basically similar to the first embodiment in the other configurations, operations, and effects. That is, the side plate 14 extending along one of the short sides of the top board 5 is a bent piece, one side of which in the shorter direction of the top board 5 continues to the feed leg piece 6, and a central portion and the other side of which in the shorter direction of the top board 5 continue to the short leg pieces 7 and 8. Similarly, the side plate 15 extending along the other short side of the top board 5 is a bent piece, a central portion and the opposite sides of which in the shorter direction of the top board 5 continue to the holding leg pieces 9, 10, and 11. Further, the side plate 12 extending over the entire length of one of the long sides of the top board 5 is pierced with the openings 12a, which extend along the long side, at two positions in a line. Similarly, the side plate 13 extending over the entire length of the other long side of the top board 5 is pierced with the openings 13a, which extend along the long side, at two positions in a line.

[0026] In the respective embodiments as described above, the respective openings 5a of the top board 5 extend along the longer direction of the top board 5. However, the respective openings 5a may extend along the shorter direction of the top board 5. Further, each of the openings 5a and the openings 12a to 15a may be shaped into a small hole instead of a slit. In such a case, if a multitude of small holes are pierced, repetition of the reflow process can be prevented.

Claims

1. An antenna-integrated module comprising:

a circuit board provided with a wiring pattern and an earth conductor layer of a high frequency circuit;
a group of circuit components mounted on a surface of the circuit board; and
a cover and antenna element formed by a metal plate and mounted on the circuit board to cover the group of circuit components,
wherein the cover and antenna element includes

a top board facing the circuit board with a predetermined interval therebetween, and

operating as a radiating conductor,
a feed leg piece hanging toward the circuit board from a feeding point of the top board, and connected to the wiring pattern,
short leg pieces hanging toward the circuit board from the periphery of one side of the top board, and connected to the earth conductor layer,
electrically open holding leg pieces hanging toward the circuit board from the periphery of the other side of the top board, and fixed to the circuit board, and
side plates hanging toward the circuit board from other positions than the positions of the feed leg piece, the short leg pieces, and the holding leg pieces on the periphery of the top board such that the leading ends of the side plates face the circuit board with a clearance therebetween, and

wherein the top board is pierced with openings in the form of slits or small holes at a plurality of positions apart from the periphery thereof.

2. The antenna-integrated module according to Claim 1,
wherein the openings in the form of slits or small holes are also pierced in each of the side plates at a plurality of positions apart from the periphery of the side plate.

3. The antenna-integrated module according to either one of Claims 1 and 2,
wherein the top board is rectangular, and
wherein the respective short leg pieces hang from two positions on one side in the longer direction of the top board, and the respective holding leg pieces hang from two positions on the other side in the longer direction of the top board.

4. The antenna-integrated module according to Claim 3,
wherein a third holding leg piece having the same shape as the shape of the feed leg piece is provided at a position point-symmetrical to the feed leg piece such that the cover and antenna element has an exterior of a symmetrical shape that does not change even if the opposite sides in the longer direction of the cover and antenna element are reversed in direction.

5. The antenna-integrated module according to any one of Claims 1 to 4,
wherein the width of the openings and the opposed interval between the leading ends of the side plates and the circuit board are both set to be equal to or less than 1 millimeter.

FIG. 1

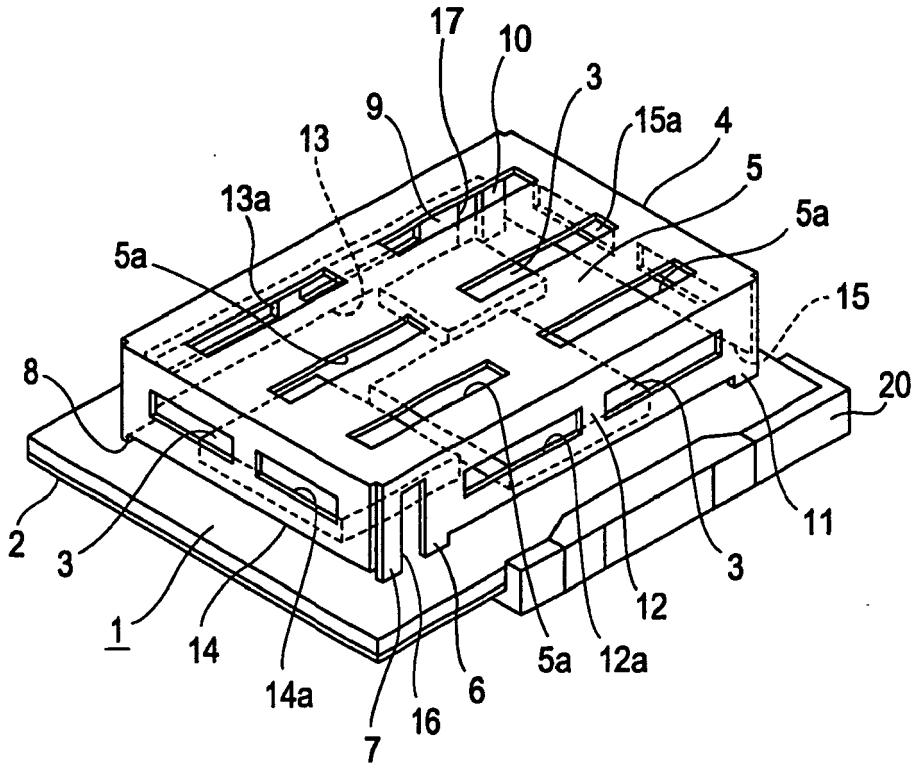


FIG. 2

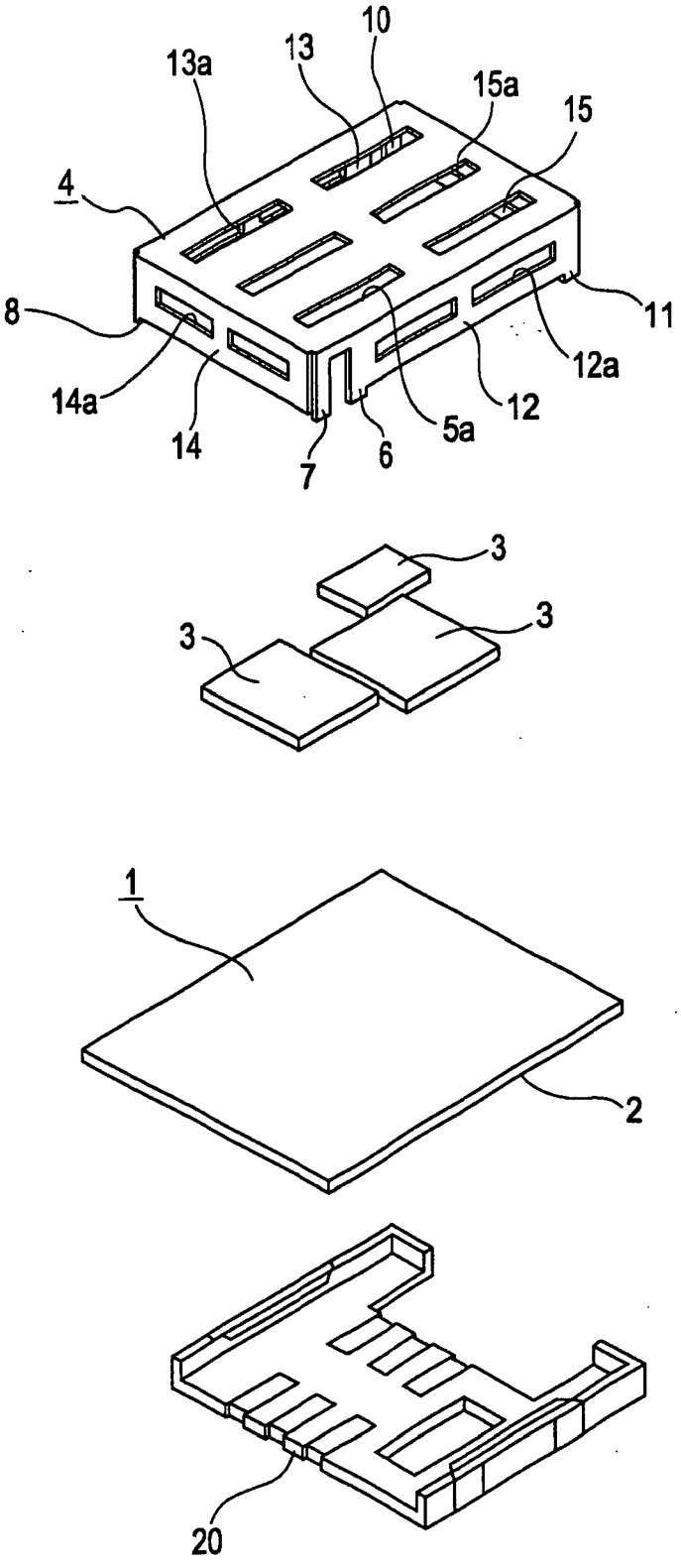
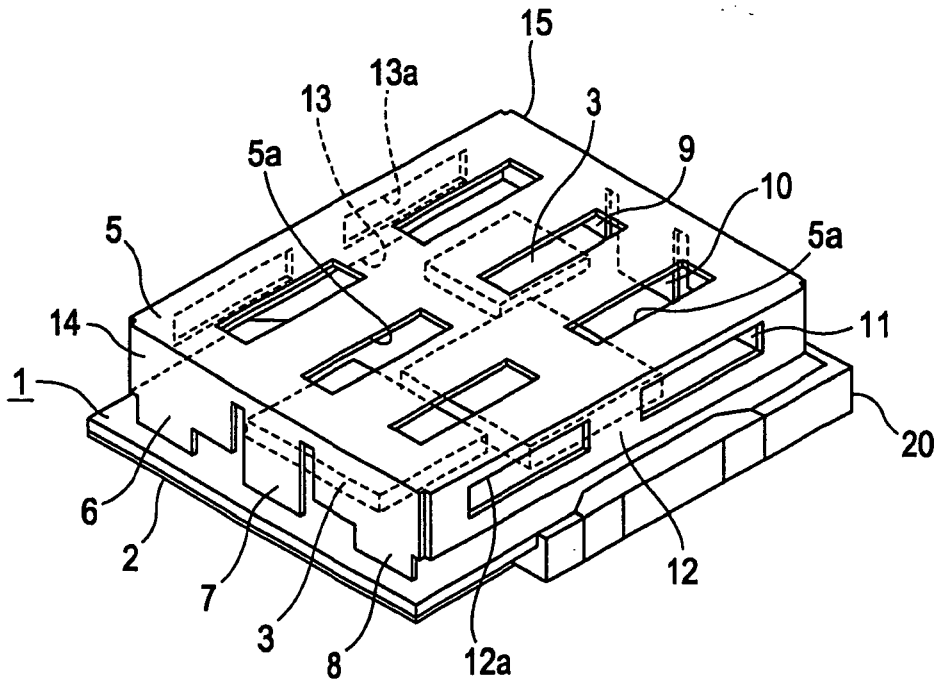


FIG. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 07 00 3436

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 May 2007	Fredj, Aziz

CATEGORY OF CITED DOCUMENTS

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