



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.07.2009 Bulletin 2009/31

(51) Int Cl.:
H01R 13/658 (2006.01)

(21) Application number: **08001349.3**

(22) Date of filing: **24.01.2008**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT
RO SE SI SK TR**
Designated Extension States:
AL BA MK RS

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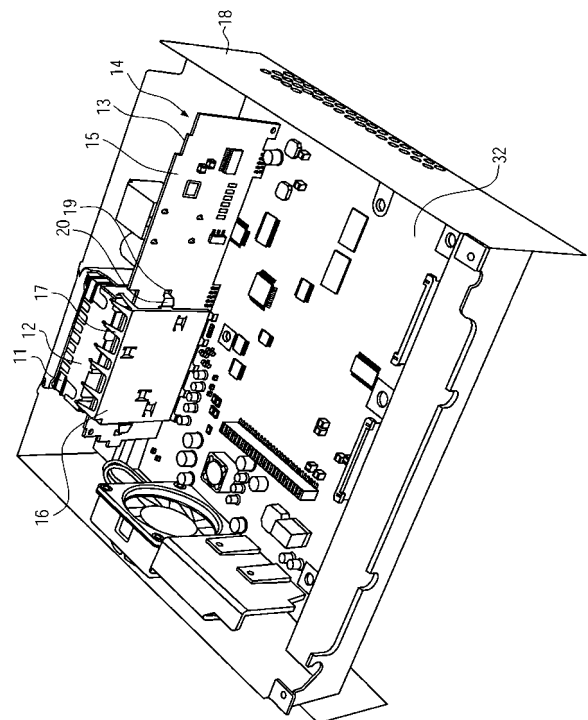
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(54) **Electromagnetic shielding of a connector arrangement**

(57) The invention relates to the improvement of electromagnetic shielding properties of a connector arrangement. To meet the high demands on electromagnetic shielding properties for connectors, an electromagnetic shielding element (16) in a connector arrangement is provided that together with a shielding frame (12) of a connector or alternatively with a device housing is providing an improved electromagnetic shielding of the connector. Thereby, the design of the shielding element and its use in the connector arrangement provides a Faraday cage in the area of connection between the connector and a circuit board so that electromagnetic interference of components on the circuit board or from outside the connector arrangement may be significantly reduced. The electromagnetic shielding element itself is provided as a separate element with a plurality of protrusions (17) that can be resiliently and/or detachably engaged to a shielding frame of the connector or the device housing of the connector arrangement.

Fig.1



Description

FIELD OF THE INVENTION

[0001] The invention relates to a connector arrangement and a system incorporating the connector arrangement. The connector arrangement is equipped with a shielding element for reducing the interference in the area of the connection of the arrangement.

TECHNICAL BACKGROUND

[0002] These days there exists a high demand on high speed networks with high data rates. Also the number of electronic devices grows and thus also the required bandwidth increases, which is necessary for serving all devices with a high speed network access.

[0003] Due to the high clock rates of today's networks and electronic devices, electromagnetic interference is one of the common problems encountered. Generally, parasitic radiation is generated from electrical components or circuits during operation which may influence the electrical performance of other electronic components. Equally important is a parasitic radiation which frequently occurs at the interface where an electronic device is attached to a high speed network. In such a case, electromagnetic interference may occur between the network cable and the electronic components of, for instance, the circuit board of the electronic device, in both directions.

[0004] Therefore, it is important to shield the electronic devices against electromagnetic interference.

[0005] In vehicle appliances, for example, the number of devices more and more increases due to the need of more sensors, actors, etc. Since that time the car entertainment plays an important role, also the number of multimedia devices has increased. In today's cars, for instance, a navigation system, DVD player, sound system and many advanced driver assistance systems almost belongs to the standard configuration and are operating simultaneously in many cases. To meet the high demands on bandwidth, for example, the MOST network has been developed for car appliances, whereby high data rates are used on optical/electrical bus systems to interconnect different components in the vehicle.

[0006] However, due to the high data rates, electromagnetic interference becomes an issue. Especially, the interference from devices coupled to the bus are of concern. To couple devices to a bus system, connector arrangements are used, whereby in many cases interference occurs which may be caused by either the device itself or by the bus.

[0007] As the requirement of the MOST bus system, for instance, are very strictly, a suitable electromagnetic shielding of such connector arrangements is inevitable.

[0008] However, shielding of the electronic devices, in particular the interface where an electronic device is attached to a high speed network has not been satisfactory

solved in the prior art. Solving these shortcomings would be a great benefit for increasing the robustness against electromagnetic interference of electronic devices.

SUMMARY OF THE INVENTION

[0009] One object of the invention is to improve the electromagnetic shielding properties of a connector arrangement. Another object is to improve the properties of a connector arrangement so as to meet the high demands on electromagnetic shielding properties for connectors in car applications.

[0010] At least one of these objects is solved by the subject matter of the independent claims. Advantageous embodiments are subject to the dependent claims.

[0011] One aspect of the invention is the utilization of an electromagnetic shielding element in a connector arrangement that together a shielding frame of a connector or alternatively with a device housing (of a device comprising the connector arrangement) is providing an improved electromagnetic shielding of the connector. The design of the shielding element and its use in the connector arrangement may provide a Faraday cage in the area of connection between the connector and a circuit board (the so-called mounting area) so that electromagnetic interference of components on the circuit board or from outside the connector arrangement may be significantly reduced. The electromagnetic shielding element may be provided as a separate element that can be resiliently and/or detachably engaged to a shielding frame of the connector or the housing of a device housing the connector arrangement.

[0012] In one embodiment of the invention, the connector arrangement comprises a connector element for receiving a plug or receivable by a socket. The connector element is equipped with an electromagnetic shielding frame. Further, the connector arrangement comprises a circuit board having a front surface and a rear surface. The connector element is mountable on the front surface of the circuit board, and - when being mounted - covers a certain area of the circuit board, which is referred to as the mounting area.

[0013] The connector arrangement also comprises an electromagnetic shielding element covering at least the rear surface of the circuit board in the circumference of the mounting area of the connector element. The electromagnetic shielding element comprises at least one protrusion for resiliently and/or detachably engaging the shielding frame of the connector and for electrically coupling the shielding element to the shielding frame of the connector element.

[0014] As indicated above, the electromagnetic shielding element may also be engaged directly with the housing of a device housing the connector arrangement. For example, the device housing is at least partly made out of conductive material, so that a Faraday cage may be provided in the space surrounded by the shielding element and the device housing. This alternative connector

arrangement according to another embodiment of the invention is for incorporation in a housing and comprises a connector element for receiving a plug or receivable by a socket and a circuit board having a front surface and a rear surface. The connector element can be mounted on the front surface of the circuit board thereby covering a mounting area of the circuit board. An electromagnetic shielding element is further provided for covering at least the rear surface of the circuit board in the circumference of the mounting area of the connector element. The electromagnetic shielding element comprises at least one protrusion for resiliently and/or detachably engaging the device housing thereby electrically coupling the shielding element to the device housing.

[0015] As indicated above, the electric coupling of the electromagnetic shielding element of the connector arrangement with the at least one protrusion to a shielding frame of the connector element or a device housing is intended to provide a Faraday cage in the mounting area of the connector element on the circuit board.

[0016] In a variation, the electromagnetic shielding element is provided with plural protrusions for resiliently and/or detachably clipping the electromagnetic shielding element to the connector element and/or the device housing. For example, the protrusions may be spring clips.

[0017] Furthermore, in another embodiment of the invention, the circuit board is provided with a plurality of through holes in a circumference of the mounting area of the connector element on the circuit board. When having mounted the shielding element, its protrusions may reach through the through holes for electrically coupling the shielding element to the shielding frame of the connector element or the device housing.

[0018] In a variation of this embodiment, the protrusions provide a resilient and/or detachable electric coupling of the electromagnetic shielding element to the ground potential of the circuit board. The through holes may be for example coated by an electrically conductive material electrically coupled to the ground potential of the circuit board.

[0019] In another embodiment, the shielding of the connections between connector and circuit board may be further improved by further using filter elements. For example, the circuit board may comprise at least one filter mounted in the circumference of the intersection of the circuit board and an area being formed by at least two of the protrusions of the shielding element. The filter element(s) may be for example realized by means of a T-filter or a II-filter.

[0020] In another variation, the filter has a grounding terminal, and the component housing of the filter is mounted on the circuit board within the mounting area of the connector element, whereby the grounding terminal of the filter is located in the circumference of the before mentioned intersection of the circuit board and an area being formed by at least two of the protrusions of the shielding element.

[0021] In another embodiment, the electromagnetic

shielding may further comprise a spring clip for resiliently and/or detachably fixing the electromagnetic shielding element to the circuit board.

[0022] Moreover, in another embodiment of the invention, the electromagnetic shielding element comprises at least one heat sink for providing a thermal connection between a circuit element on the circuit board, when mounting the connector arrangement. This may for example allow for not only using the electromagnetic shielding element for reducing electromagnetic interference but also for a regulation of the temperature.

[0023] As previously mentioned, the connector arrangement may be mounted within a housing of a device. This housing may be for example conductive so that the shielding frame of the connector element can be electrically coupled to the housing. Thus, the electromagnetic shielding frame can be for example connected to the ground potential of the housing of the device via the shielding frame of the connector element.

[0024] Another embodiment of the invention relates to a system comprising a connector arrangement according to one of the different embodiments described herein, and a second circuit board mounted across to the circuit board of the connector arrangement (referred to as the first circuit board). This second circuit board may be further electrically coupled to said circuit board of the connector arrangement (i.e. the first circuit board).

[0025] In a variation, the electromagnetic shielding element of this system is electrically coupled to the ground potential of the second circuit board by at least one protrusion of the electromagnetic shielding element.

[0026] The system may for example further comprise at least one filter (element) mounted in the circumference of the intersection of the second circuit board and a fictitious elongation of the part of the shielding element covering at least the rear surface of the circuit board in the circumference of the mounting area of the connector element, which may allow for further improving the shielding of interference.

[0027] In another example, the system may comprise at least one filter (element) mounted on the second circuit board within the circumference of the intersection of the second circuit board and a fictitious elongation of the part of the shielding element that, when the system is mounted, is essentially parallel to the first circuit board.

[0028] The electromagnetic shielding element may be further provided with plural protrusions for resiliently and/or detachably fixing the electromagnetic shielding element to the connector element or the device housing. Moreover, the second circuit board may comprise a plurality of through holes through which, when having mounted the shielding element, at least some of the plurality of protrusions of the electromagnetic shielding element reach through the through holes of the second circuit board for electrically coupling the shielding element to the shielding frame of the connector element or the device housing. In this example, the protrusions of the second circuit board may provide a resilient and/or

detachable electric coupling of the electromagnetic shielding element to the ground potential of the second circuit board. In addition, the through holes of the second circuit board may be for example coated by an electrically conductive material electrically coupled to the ground potential of the second circuit board.

[0029] Another embodiment of the invention provides a vehicle entertainment and information processing device that is comprising a connector arrangement according to one of the different embodiments described herein or a system according to one of the different embodiments described herein.

[0030] According to another embodiment, the invention also relates to a method for mounting a connector arrangement comprising a connector element, a circuit board and an electromagnetic shielding element. The terminals of the connector element may be connected to the circuit board, to thereby mount the connector element within a mounting area on a front surface of the circuit board, and the electromagnetic shielding element may be further mounted to thereby cover at least the rear surface of the circuit board in the circumference of the mounting area of the connector element. At least one protrusion of the shielding element may be resiliently and/or detachably engaged to and electrically coupled to the shielding frame of the connector.

[0031] Alternatively, in another embodiment, the method comprises connecting terminals of the connector element to the circuit board, to thereby mount the connector element within a mounting area on a front surface of the circuit board, mounting the circuit board and the connector element within the device housing and mounting the electromagnetic shielding element to thereby cover at least the rear surface of the circuit board in the circumference of the mounting area of the connector element, wherein at least one protrusion of the shielding element is resiliently and/or detachably engaged to and electrically coupled to the device housing.

[0032] In both methods, a second circuit board may be mounted cross to said circuit board, and the electromagnetic shielding element may be and electrically connected to the ground potential of the second circuit board.

BRIEF DESCRIPTION OF THE FIGURES

[0033] In the following, the invention is described in more detail in reference to the attached figures and drawings. Similar or corresponding details in the figures are marked with the same reference numerals.

Fig. 1 illustrates a housing device comprising electrical components and a connector arrangement according to an exemplary embodiment of the invention,

Fig. 2 illustrates the resilient and detachably mounting of the electromagnetic shielding element at the connector element according to an exem-

plary embodiment of the invention,

Fig. 3 illustrates a detailed view of the connector arrangement according to an exemplary embodiment of the invention,

Fig. 4 illustrates the rear side of the connector element together with pins for attaching plugs according to an exemplary embodiment of the invention,

Fig. 5 illustrates the connector arrangement comprising the electromagnetic shielding element together with elongated protrusions according to an exemplary embodiment of the invention,

Fig. 6 illustrates a top view on the connector element together with the electromagnetic shielding element mounted on the electromagnetic shielding frame according to an exemplary embodiment of the invention,

Fig. 7 illustrates the connector arrangement mechanically implemented in the device housing according to an exemplary embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0034] To solve the above mentioned problem, the invention provides a shielding part for a connector element which may be clipped on the sides of the connector element on a conductive frame which is provided around the connector element. Together with the conductive frame, the shielding part forms a Faraday cage so as to electromagnetically shield the certain area of the circuit board which is located underneath the shielding frame respectively shielding element. The certain area is also called the mounting area.

[0035] Alternatively, the shielding element may also be clipped directly to the device which comprises the connector arrangement in order to improve the electromagnetic shielding of the connector.

[0036] As a result, electromagnetic interference of components on the circuit board or from outside the connector arrangement may be significantly reduced.

[0037] Fig. 1 illustrates a housing device 18 together with a plurality of circuit boards, a cooling unit and, in particular, a connector arrangement. Generally, such a device may be, for instance, an operating unit of a navigation system in a vehicle or any other multimedia device for being used in an automotive environment. For instance, the housing may be incorporated in a specific bay of a dashboard of a car. The device may be attached to, for instance, a network of a vehicle. The network may be an optical or electrical high speed data network for exchanging data between the various devices within the vehicle. It may be a bus system, like a CAN bus or a

network with ring topology, like token ring network, for example. Such an optical high speed ring network may be for example an optical MOST network.

[0038] When devices are operated in a network, necessarily, each device must comprise an interface for connecting to the main network, for instance, of a car. Such an interface is also required for converting any signal between the main network and the device.

[0039] In Fig. 1, such an interface is shown by a connector arrangement, which comprises a circuit board 13 with a front surface 14 and a rear surface 15 and a connector element 11, which is mounted on the front surface 14 of the circuit board 13. The area of the front surface 14, which is covered by the connector element 11 denotes the mounting area of the connector element 11.

[0040] In case of being an optical network, the connector arrangement may also comprise signal converting means for converting the optical signals of the network to electrical signals and vice versa. The interface connection may be realized by an optical or electrical plug-and-socket connection.

[0041] In order to shield the parasitic radiation caused by the conversion of signals respectively reception and transmission of signals from or to the main network, or any other parasitic radiation from the inside or outside of the device. An electromagnetic shielding frame 12 may be provided that is typically enclosing a part of the connector element 11. According to one embodiment of the invention, an additional electromagnetic shielding element 16 is provided, which allows to further reduce the electromagnetic interference between the components on the circuit board 32 and the network connector arrangement and vice versa.

[0042] The shielding element 16 may also, for instance, significantly reduce the electromagnetic interference on the electronic components located within the mounting area, caused from outside the connector arrangement and vice versa.

[0043] The shielding element 16 may also, for instance, significantly reduce the electromagnetic interference on the electronic components located within the mounting area, caused from electronic components located outside the mounting area on the circuit board 13 and vice versa.

[0044] Using the electromagnetic shielding element 16 as shown in Fig. 1, it may also be prevented that electromagnetic interference occurs between the connector element 11 together with the electronic components located on the circuit board within the mounting area and for instance another circuit board or any other electronic element or device inside the device housing 18.

[0045] As shown in Fig. 1, the electromagnetic shielding element 16 is mounted parallel to the circuit board 13 and covers the mounting area of the rear surface 15 of the circuit board 13. Also shown are protrusions 17 of the electromagnetic shielding element 16, which may be vertical to the surface of the electromagnetic shielding element 16 that covers the mounting area. In one em-

bodiment, the protrusions 17 are in contact with the shielding frame 12 of the connector element 11. Such arrangement of the electromagnetic shielding element 16 being attached to the electromagnetic shielding frame 12 provides a Faraday cage, whereby the mounting area is within the area of the Faraday cage so that electromagnetic isolation is provided. The protrusions 17 shown in Fig. 1 have a predetermined spacing, whereby the distance between the protrusions may for example be indirectly proportional to the highest parasitic frequency to be filtered. Preferably, the highest parasitic frequency to be filtered is located in the GHz-range which results in a spacing for the protrusions 17 of the electromagnetic shielding element 16 of approximately 1 cm.

[0046] As a further embodiment of the invention, the electromagnetic shielding element 16 may be either mounted to the electromagnetic shielding frame 12 of the connector element 11 or to the device housing 18 directly. In both cases, a Faraday cage is provided respectively the mounting area of the circuit board 13.

[0047] When using the protrusions 17 for mounting the electromagnetic shielding element 16 to the connector element 11, the protrusions provide a resilient and detachable connection to the connector element 11 respectively the electromagnetic shielding frame 12. The electromagnetic shielding element 16 may be additionally held and fixed or prevented from slipping by an optional, separate spring clip 20, as shown in Fig. 1. The separate spring clip 20 may be attached to a hole 19 of the circuit board 13 so as to prevent the electromagnetic shielding element 16 from slipping from its position.

[0048] In a conventional manner, the electromagnetic shielding element 16 may be fixed at the connector element 11, at the electromagnetic shielding frame 12 or at the circuit board 13 by soldering the protrusions thereto. Such a conventional fixation by soldering during the manufacturing procedure may however lead to a destruction of the electronic components of the circuit board 13 due to the impact of soldering heat. In order to prevent such a damage, a certain distance between the soldering point and the closest electronic component must be adhered. This may however, lead to an ineffective arrangement of electronic components or to a waste of space on the circuit board 13. Thus, by using the resilient and detachable connection of the shielding element 16 and connector element 11, more electrical components or filter may be placed within the mounting area of the circuit board 13, and the layout of such elements for providing an optimal electromagnetic shielding may be optimized.

[0049] Therefore, an advantage of using resilient and detachable protrusions 17 is that no soldering has to be carried out for the attachment of the electromagnetic shielding element 16 to the connector element 11 or to the electromagnetic shielding frame 12. Also, by using spring clips 20 for attaching the electromagnetic shielding element 16 to the holes 19 of the circuit board 13, soldering is prevented.

[0050] A further advantage of using resilient and de-

tachable protrusions 17 is that it may be mounted during manufacturing fast and is thus more cost effective compared to conventional ways of mounting such a electromagnetic shielding element 16 to the connector element, i.e. by soldering.

[0051] According to another embodiment, by means of the spring clip 20 which may be provided on each vertical edge of the electromagnetic shielding element 16 and mounted on a hole 19 on the circuit board 13, it may be ensured that the electromagnetic shielding element 16 also may not slip in the direction of the circuit board 13, which possibly may result in a short circuit on between the electronic components of the mounting area due to the conductive material of the electromagnetic shielding element 16. As shown in Fig. 1, the spring clip 20 may comprise a bent shape so as to ensure a predetermined distance between the electromagnetic shielding element 16 and the circuit board 13.

[0052] In another embodiment, the surface of the electromagnetic shielding element 16 may not be plated as shown in Fig. 1, but rather a lattice. In such a case, the lattice space may be indirectly proportional to the highest parasitic frequency to be filtered, as also valid for the calculation of the distance of the protrusions 17. Another possible structure for use as an electromagnetic shielding element may be a conductive punched plate. An advantage of the electromagnetic shielding element 16 made of a lattice may be the reduction of material needed for manufacturing which leads to more cost effectiveness. Also, a weight reduction comes along with such an implementation of the electromagnetic shielding element 16 made of a lattice.

[0053] In another embodiment, further filter elements may be provided on the circuit board 13, which may be located in the circumference of the intersection of the circuit board 13 and an area being formed by at least two of the protrusions 17 of the electromagnetic shielding element 16. By additionally using filter elements, the electromagnetic shielding may be further improved. Such a filter may be for instance a T-filter or a Π -filter. In another embodiment, the filter may have a grounding terminal which may be located in the circumference of the intersection of the circuit board 13 and an area being formed by at least two of the protrusions 17 of the electromagnetic shielding element 16. The filters further may be provided on both surfaces of the circuit board 13.

[0054] In another embodiment, at least one filter may also or alternatively mounted in the circumference of the intersection of the second circuit board 32 and a fictitious elongation of the part of the electromagnetic shielding element 16 covering at least the rear surface 15 of the circuit board 13 in the circumference of the mounting area of the connector element 11. The part of the electromagnetic shielding element 16 that covers at least the rear surface 15 of the circuit board 13 may be parallel to the circuit board 13. In order to distinguish between the two circuit boards 13 and 32, the circuit board 13 may also be denoted as the first circuit board 13, whereby the cir-

cuit board 32 may be denoted as the second circuit board 32.

[0055] In a further embodiment, the surface of the electromagnetic shielding element 16 may be used as a heat sink for dissipating the heat produced by the electronic elements of the mounting area underneath the electromagnetic shielding element 16. In addition, a cooler may be mounted on the surface of the electromagnetic shielding element 16 to further assist in dissipating the heat. In case of the electromagnetic shielding element 16 being realized as a lattice, a heat sink may also be provided and cooling fins may be supplied as well in order to improve the air convection.

[0056] In another embodiment of the invention, the holes 19 on the circuit board 13 may be coated with an electrically conductive material (for example gold plated) and may be coupled to the ground potential of the circuit board 13. If the spring clips 20 are soldered to the coated holes 19, the electrical ground potential of the circuit board is also provided to the electromagnetic shielding element 16. Also, any other hole in the circuit board 13 through which the protrusions 17 are mounted may be coated by an electrically conductive material for soldering the protrusions 17 thereto.

[0057] Fig. 2 shows another, more detailed partial view of a connector arrangement according to one embodiment of the invention and in particular, the mounting of the electromagnetic shielding element 16 to the electromagnetic shielding frame 12 by resiliently and detachably clipping the protrusions 17 of the electromagnetic shielding element 16 to the electromagnetic shielding frame 12. In order to provide a more efficient shielding, the circuit board 13 may comprise through holes 31 through which the protrusions reach to the electromagnetic shielding frame 12. As a result, all four sides of the connector element 11 are shielded so as to provide a complete Faraday cage. Thereby, the distance between the protrusions may be indirectly proportional to the highest parasitic frequency to be filtered.

[0058] Fig. 3 shows another partial view of the connector arrangement according to one embodiment of the invention, wherein the circuit board 13 has a plurality of through holes 31 in the circumference of the mounting area of the connector element on the circuit board 13. In this embodiment, the protrusions 17 may reach through the shown through holes 31 so as to electrically couple the electromagnetic shielding element 16 to the shielding frame 12 of the connector element 11.

[0059] Protrusions 33 of the electromagnetic shielding element 16 that may be soldered to the second circuit board 32. The distance between each of the protrusions 33 may correlate to that of the protrusions 17 and is also indirectly proportional to the highest parasitic frequency to be filtered. In one further embodiment, protrusions 17 may be realized by spring clips. According to a further embodiment, the second circuit 32 board may also comprise through holes through which protrusions may reach so as to electrically couple the electromagnetic shielding

element 16 to the electromagnetic shielding frame 12 or device housing 18. Alternatively, the through holes of the second circuit board 32 may be coated so as to electrically couple the electromagnetic shielding element 16 to the ground potential of the second circuit board 32 by soldering the protrusions 17 to the coated through holes.

[0060] Fig. 4 shows the front surface 14 of the circuit board 13 and the rear side of the connector element 11 together with the pins for attaching a plug. The plug system may be either of electrical or optical nature. The plug system may also comprise both, electrical plug connectors and optical ones. For instance, the upper half of the pin arrangement at the rear side of the connector element 11 may be a plug system for electrically coupling the plug to the socket of the connector element 11, whereby, for example, the lower half may be a plug system for optically coupling the plug to the socket of the connector element 11.

[0061] Also shown is the electromagnetic shielding frame 12 that comprises conductive nooses, which are slightly bent upwards and which are called resilient springs 41. If the connector element is attached to the device housing 18, the springs 41 get in contact with the conductive material of the device housing 18 and thereby electrically couples the electromagnetic shielding element 16 and the electromagnetic shielding frame 12 to the device housing 18 and thereby to the ground potential of the device housing 18. By means of the spring clips 41, the Faraday cage comprising the electromagnetic shielding element 16, the protrusions 17 and the shielding element 12 is electrically connected to the ground potential of the device housing 18 to ensure a sufficient level of electrical shielding.

[0062] Fig. 5 illustrates another connector arrangement according to a further embodiment of the invention comprising the electromagnetic shielding element 16 together with elongated protrusions 17, being provided on all four sides of the electromagnetic shielding element 16, and that reach from the electromagnetic shielding element 16 to the device housing 18 so as to electrically couple the electromagnetic shielding element 16 to the device housing 18 directly and to form a Faraday cage. As a consequence, the electromagnetic shielding frame may not be required to obtain the shielding effect due to a Faraday cage being formed without the shielding frame 12.

[0063] In another embodiment of the invention, a certain number of protrusions 17 may be elongated as shown in Fig. 5 and reach to the device housing 18 directly, whereby also a certain number of protrusions may be shorter than the ones shown in Fig. 5 and may be coupled to the electromagnetic shielding frame 12. In such a constellation, the electromagnetic shielding frame 12 together with the short protrusions 17 may form an inner Faraday cage, whereby additionally the elongated protrusions 17 may form an outer Faraday cage. All protrusions 17 may then be electrically coupled to the ground potential of the first circuit board 13, the second circuit

board 32 and the device housing 18.

[0064] In a further embodiment, the electromagnetic shielding element 16 may be provided with protrusion means for ensuring that a certain distance does not fall below a predetermined safety distance between the electromagnetic shielding element 16 and the electronic elements of the mounting area so as to avoid a short circuit due to the conductive material of the electromagnetic shielding element 16. Although not shown, such a protrusion means may be different to the spring clips 20 which are mounted on the edges of the electromagnetic shielding element 16. For instance, such protrusion means may consist of non-conductive material which are fixed on the electromagnetic shielding element 16 and which do not have to be fixed on the circuit board 13.

[0065] According to another embodiment, in order to enhance the filtering/shielding effect, the shielding frame 12 may be made of a block out of ferrite, wherein its form determines the filtering properties. Thereby, the ferrite block may further enhance the electromagnetic filtering of the plug connection of the connector arrangement. Advantageously, in this embodiment, the protrusions 17 of the electromagnetic shielding element 16 reach to the device housing 18, as illustrated in Fig. 5.

[0066] In a further embodiment, instead of or in addition to implementing filter elements like T-filters or Π -filters, the shielding element 16 may comprise openings (not shown) through which a flexible conductor foil including a plurality of electrical conductors electrically connecting the circuit board 13 or 32 and a further circuit board with each other can be at least partially led, thereby electromagnetically filtering the plurality of electrical conductors.

[0067] According to another embodiment, the area surrounding the circumference of the intersection of the circuit boards 32 and 13 may also be provided with a block out of ferrite so as to enhance the electromagnetic shielding of the electrical connection of the circuit boards 13 and 32.

[0068] Details concerning the implementation of such ferrite shielding elements as mentioned in the above embodiments, can be found in the non-laid open European patent application 07 016 293.8.

[0069] Fig. 6 illustrates a top view on the connector element 11 together with the electromagnetic shielding element 16 mounted on the electromagnetic shielding frame 12 by using resilient protrusions 17, in particular spring clips. The spring clips may be formed in a right angle relative to the electromagnetic shielding element 16 which may be mounted parallel to the surface of the first circuit board 13.

[0070] The figure also shows that the electromagnetic shielding element 16 is electrically coupled to the resilient springs 41 of the electromagnetic shielding frame 12 via the protrusions 17. The resilient springs 41 may then be electrically coupled to the device housing 18 upon physically implementing the connector arrangement to the device housing.

[0071] Fig. 7 shows the connector arrangement mechanically implemented in the device housing 18. Also shown are the elongated protrusions 17 which electrically couple the electromagnetic shielding element 16 to the device housing and thereby form a Faraday cage which is coupled to the ground potential of the device housing 18 and provides therewith electromagnetic shielding for the mounting area of the first circuit board 13.

[0072] Fig. 7 further shows a partial view of T-filters mounted on the circuit board 13. As can be seen, the filters 72 may be located in the circumference of the intersection of the circuit board 13 and an area being formed by at least two of the protrusions 17 of the electromagnetic shielding element 16. The area, which is formed by for instance two protrusions 17 is indicated by the line 71 in Fig. 7. Arranging the filter elements, for example the shown T-filters 72 in that area, which is marked by line 71, the shielding effect is further significantly enhanced.

[0073] In a further embodiment, stranded filter elements may be implemented in addition to the T-filters and/or II-filters on the printed circuit boards 13 or 32. These stranded filter elements may also be implemented instead of T-filters or II-filters. Thereby, the stranded filter elements may be placed inside the area formed by, for instance, two protrusions 17 as indicated by the line 71 in Fig. 7. The stranded filter elements further may be placed on the printed circuit board inside or outside the Faraday cage provided in the mounting area of the connector element. If they are provided on the mounting area of the printed circuit board, they may also reach through holes of the shielding element 16 without having electrical contact thereto (not shown).

[0074] It should be further noted that the individual features of the different embodiments of the invention may individually or in arbitrary combination be subject matter to another invention.

[0075] It would be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

Claims

1. A connector arrangement comprising:

a connector element (11) for receiving a plug or receivable by a socket, wherein the connector element comprises an electromagnetic shielding frame (12),
a circuit board (13) having a front surface (14) and a rear surface (15),
wherein the connector element (11) is mountable on the front surface (14) of the circuit board

(13) thereby covering a mounting area of the circuit board (13),
an electromagnetic shielding element (16) for covering at least the rear surface (15) of the circuit board (13) in the circumference of the mounting area of the connector element (11), wherein the electromagnetic shielding element (16) comprises at least one protrusion (17) for resiliently and/or detachably engaging the shielding frame (12) of the connector (11) and electrically coupling the shielding element (16) to the shielding frame (12) of the connector element (11).

2. A connector arrangement for incorporation in a device housing (18), the connector arrangement comprising:

a connector element (11) for receiving a plug or receivable by a socket,
a circuit board (13) having a front surface (14) and a rear surface (15), wherein the connector element (11) is mountable on the front surface (14) of the circuit board (13) thereby covering a mounting area of the circuit board (13),
an electromagnetic shielding element (16) for covering at least the rear surface (15) of the circuit board (13) in the circumference of the mounting area of the connector element (11), wherein the electromagnetic shielding element (16) comprises at least one protrusion (17) for resiliently and/or detachably engaging the device housing (18) thereby electrically coupling the shielding element (16) to the device housing (18).

3. The connector arrangement according to claim 1 or 2, wherein the electric coupling of the electromagnetic shielding element (16) with the at least one protrusion (17) to a shielding frame (12) of the connector element (11) or a device housing (18) provides a Faraday cage in the mounting area of the connector element (11) on the circuit board (13).

4. The connector arrangement according to one of claims 1 to 3, wherein the electromagnetic shielding element (16) is provided with plural protrusions (17) for resiliently and/or detachably clipping the electromagnetic shielding element (16) to the connector element (11) and/or the device housing (18).

5. The connector arrangement according to claim 4, wherein the protrusions (17) are spring clips.

6. The connector arrangement according to claim 4 or 5, wherein the circuit board (13) has a plurality of through holes (31) in a circumference of the mounting area of the connector element (11) on the circuit

board (13), wherein, when having mounted the electromagnetic shielding element (16), the protrusions (17) reach through the through holes (31) for electrically coupling the shielding element (16) to the shielding frame (12) of the connector element (11) or the device housing (18).

7. The connector arrangement according to claim 6, wherein the protrusions (17) provide a resilient and/or detachable electric coupling of the electromagnetic shielding element (16) to the ground potential of the circuit board (13).
8. The connector arrangement according to claim 7, wherein the through holes (31) are coated by an electrically conductive material electrically coupled to the ground potential of the circuit board (13).
9. The connector arrangement according to one of claims 4 to 8, wherein the circuit board (13) comprises at least one filter mounted in the circumference of the intersection of the circuit board (13) and an area being formed by at least two of the protrusions (17) of the shielding element (16).
10. The connector arrangement according to claim 9, wherein the at least one filter element is a T-filter or a Π -filter.
11. The connector arrangement according to claim 9 or 10, wherein the filter has a grounding terminal, and wherein the component housing of the filter is mounted on the circuit board (13) within the mounting area of the connector element (11) and whereby the grounding terminal of the filter is located in the circumference of said intersection.
12. The connector arrangement according to one of claims 1 to 11, wherein the electromagnetic shielding element (16) comprises a spring clip for resiliently and/or detachably fixing the electromagnetic shielding element (16) to the circuit board (13).
13. The connector arrangement according to one of claims 1 to 12, wherein the electromagnetic shielding element (16) comprises at least one heat sink for providing a thermal connection between a circuit element on the circuit board (13), when mounting the connector arrangement.
14. The connector arrangement according to one of claims 1 to 13, wherein the connector arrangement is mounted within a conductive housing, and wherein the shielding frame (12) of the connector element (11) is electrically coupled to the housing.
15. The connector arrangement according to claim 14, wherein the electromagnetic shielding frame (12) is

connected to the ground potential of the housing of the device via the shielding frame (12) of the connector element.

16. A system comprising a connector arrangement according to one of claims 1 to 15, and a second circuit board (32) mounted across to the circuit board (13) of the connector arrangement, denoted by a first circuit board (13), and being electrically coupled to said circuit board (13) of the connector arrangement.
17. The system according to claim 16, wherein the electromagnetic shielding element (16) is electrically coupled to the ground potential of the second circuit board (32) by at least one protrusion (17) of the electromagnetic shielding element (16).
18. The system according to claim 16 or 17, further comprising at least one filter mounted in the circumference of the intersection of the second circuit board (32) and a fictitious elongation of the part of the shielding element (16) covering at least the rear surface (15) of the circuit board (13) in the circumference of the mounting area of the connector element (11).
19. The system according to one of claims 16 to 18, further comprising at least one filter mounted on the second circuit board (32) within the circumference of the intersection of the second circuit board (32) and a fictitious elongation of the part of the shielding element (16) that, when the system is mounted, is essentially parallel to the first circuit board (13).
20. The system according to one of claims 16 to 19, wherein the electromagnetic shielding element (16) is provided with plural protrusions for resiliently and/or detachably fixing the electromagnetic shielding element (16) to the connector element (11) or the device housing (18), and wherein the second circuit board (32) comprises a plurality of through holes through which, when having mounted the system, at least some of the plurality of protrusions (17) of the electromagnetic shielding element (16) reach through the through holes of the second circuit board (32) for electrically coupling the shielding element (16) to the shielding frame (12) of the connector element (11) or the device housing (18).
21. The system according to claim 20, wherein the protrusions (17) of the second circuit board (32) provide a resilient and/or detachable electric coupling of the electromagnetic shielding element (16) to the ground potential of the second circuit board (32).
22. The system according to claim 21, wherein the through holes of the second circuit board (32) are coated by an electrically conductive material electrically

cally coupled to the ground potential of the second circuit board (32).

- 23.** A vehicle entertainment and information processing device comprising a connector arrangement according to one of claims 1 to 15 or a system according to one of claims 16 to 22. 5
- 24.** A method for mounting a connector arrangement comprising a connector element (11), a circuit board (13) and an electromagnetic shielding element (16), the method comprising: 10
- connecting terminals of the connector element (11) to the circuit board (13), to thereby mount the connector element (11) within a mounting area on a front surface (14) of the circuit board (13), and 15
- mounting the electromagnetic shielding element (16) to thereby cover at least the rear surface (15) of the circuit board (13) in the circumference of the mounting area of the connector element (11), wherein at least one protrusion (17) of the shielding element (16) is resiliently and/or detachably engaged to and electrically coupled to the shielding frame (12) of the connector (11). 20 25
- 25.** A method for mounting a connector arrangement comprising a connector element (11), a circuit board (13) and an electromagnetic shielding element (16) within a device housing (18), the method comprising: 30
- connecting terminals of the connector element (11) to the circuit board (13), to thereby mount the connector element (11) within a mounting area on a front surface (14) of the circuit board (13), 35
- mounting the circuit board (13) and the connector element (11) within the device housing (18) and 40
- mounting the electromagnetic shielding element (16) to thereby cover at least the rear surface (15) of the circuit board (13) in the circumference of the mounting area of the connector element (11), wherein at least one protrusion (17) of the shielding element (16) is resiliently and/or detachably engaged to and electrically coupled to the device housing (18). 45
- 26.** The method according to claim 25 or 26, further comprising the steps of mounting a second circuit board (32) across to said circuit board (13), and electrically connecting the electromagnetic shielding element (16) to the ground potential of the second circuit board (32). 50 55

Fig.1

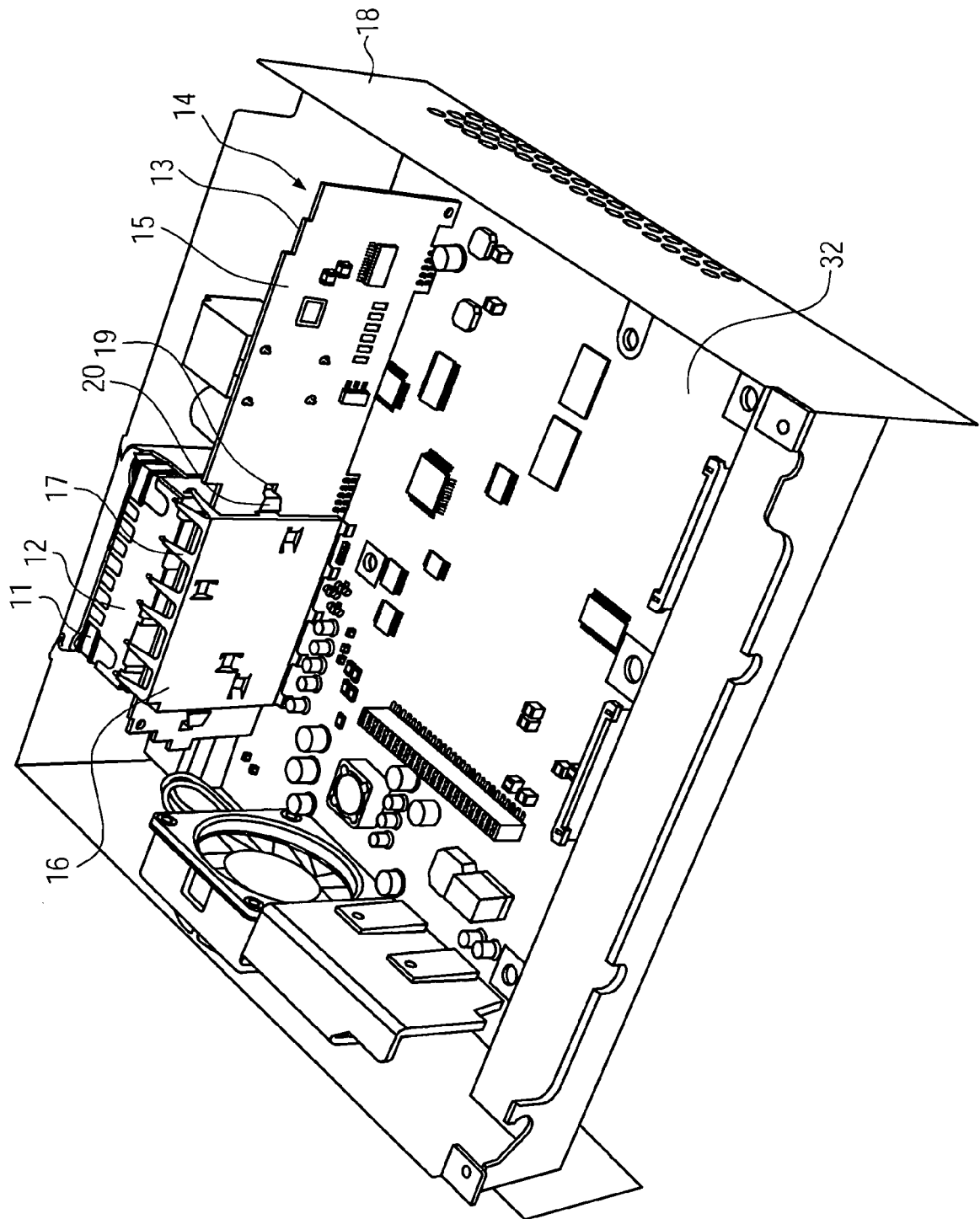


Fig.2

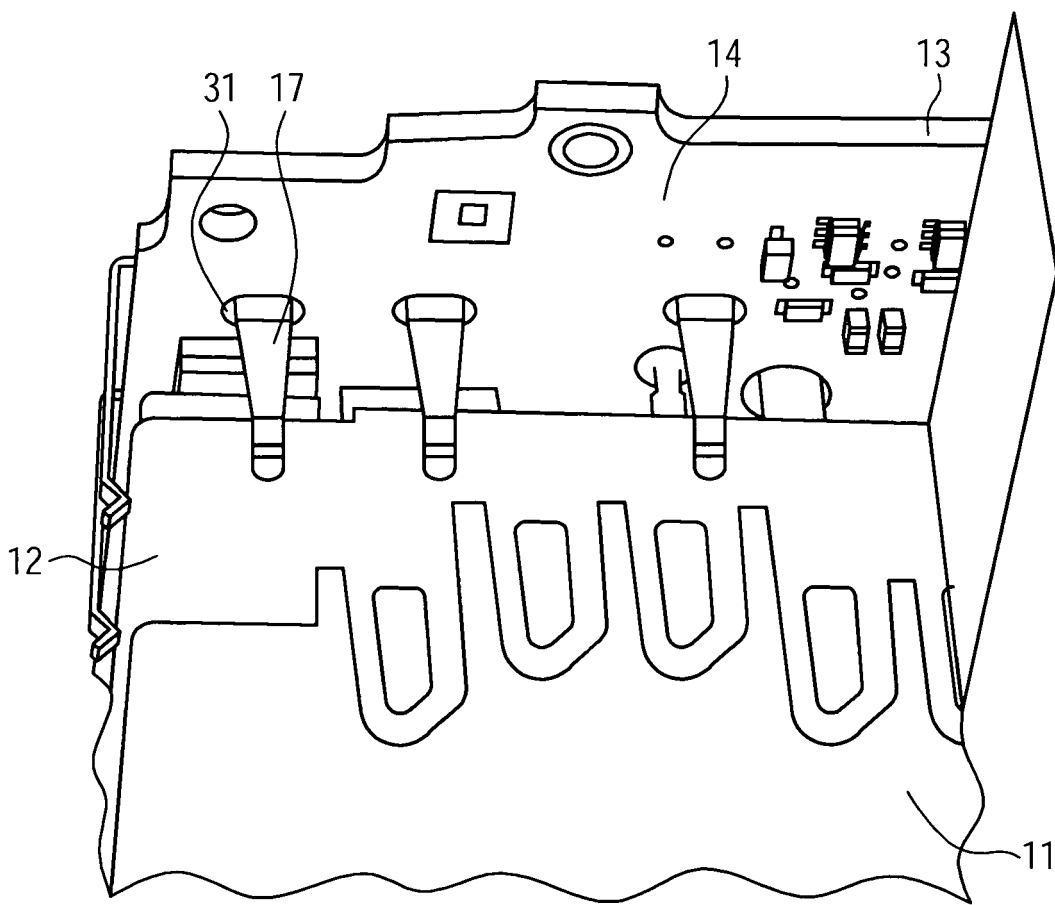


Fig.3

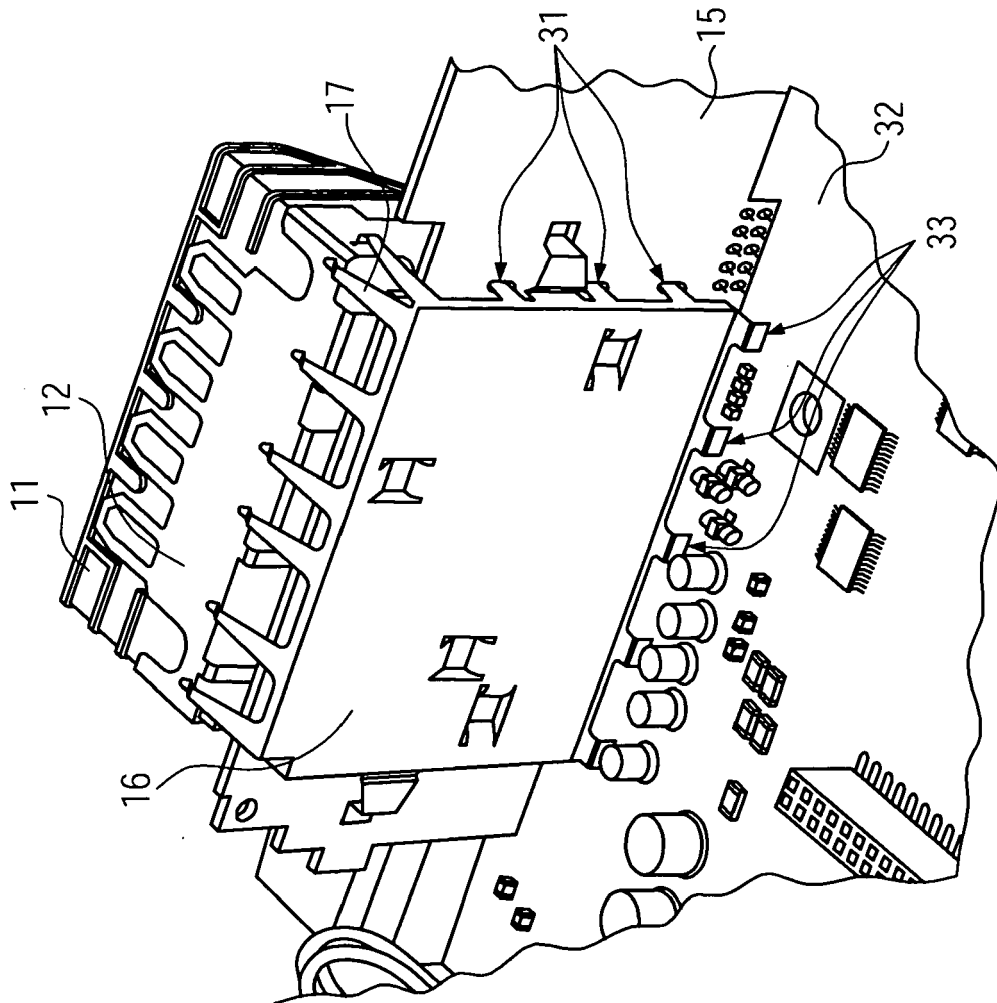


Fig.4

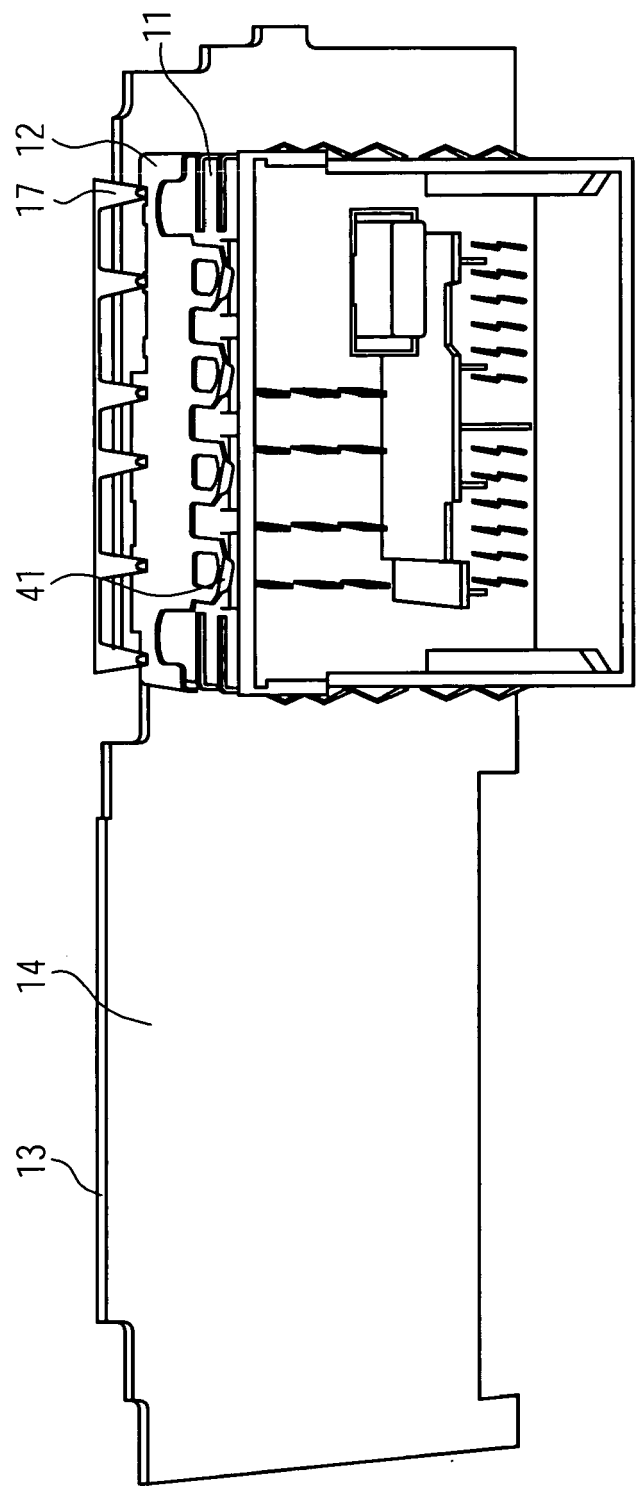


Fig.5

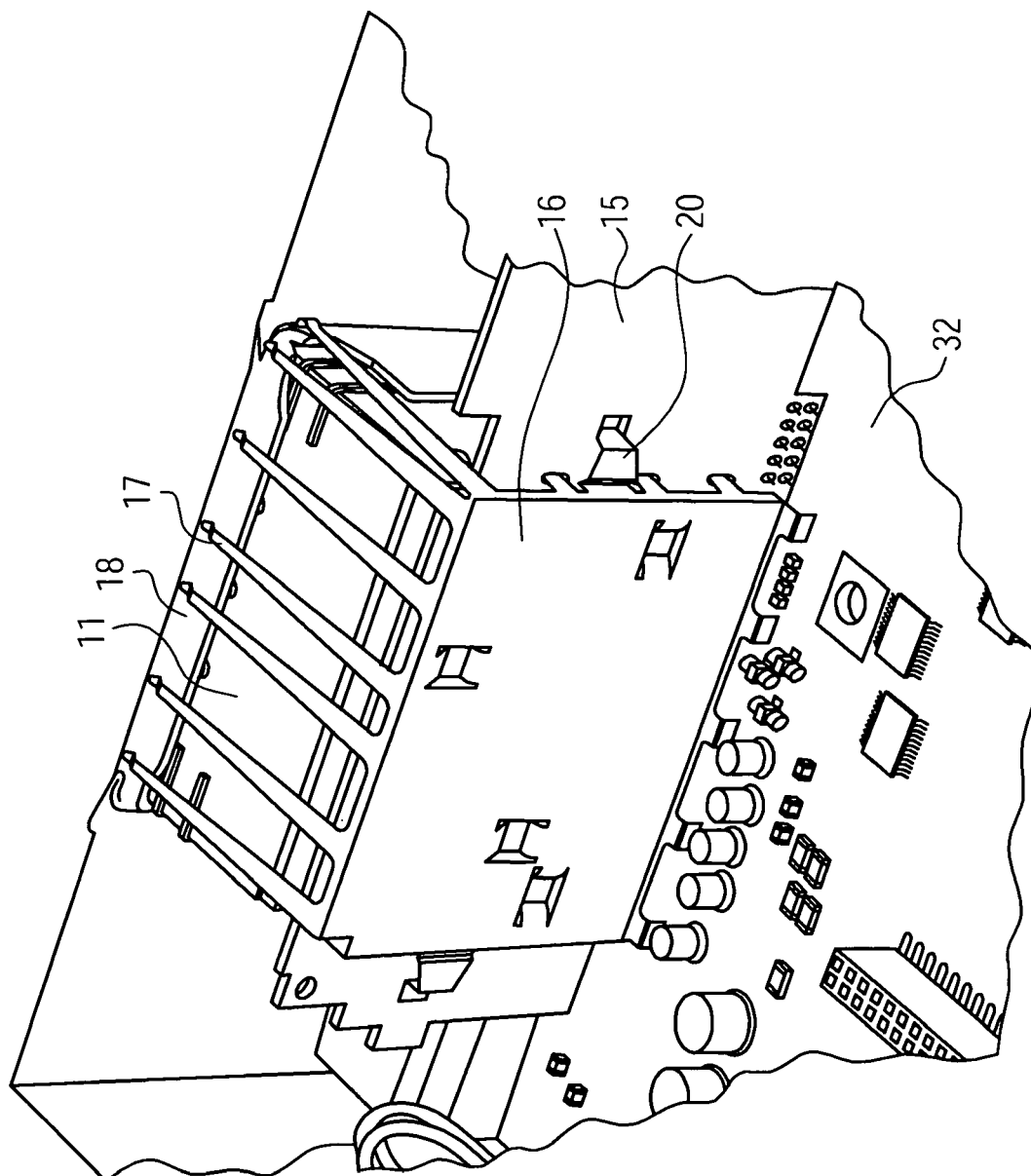


Fig.6

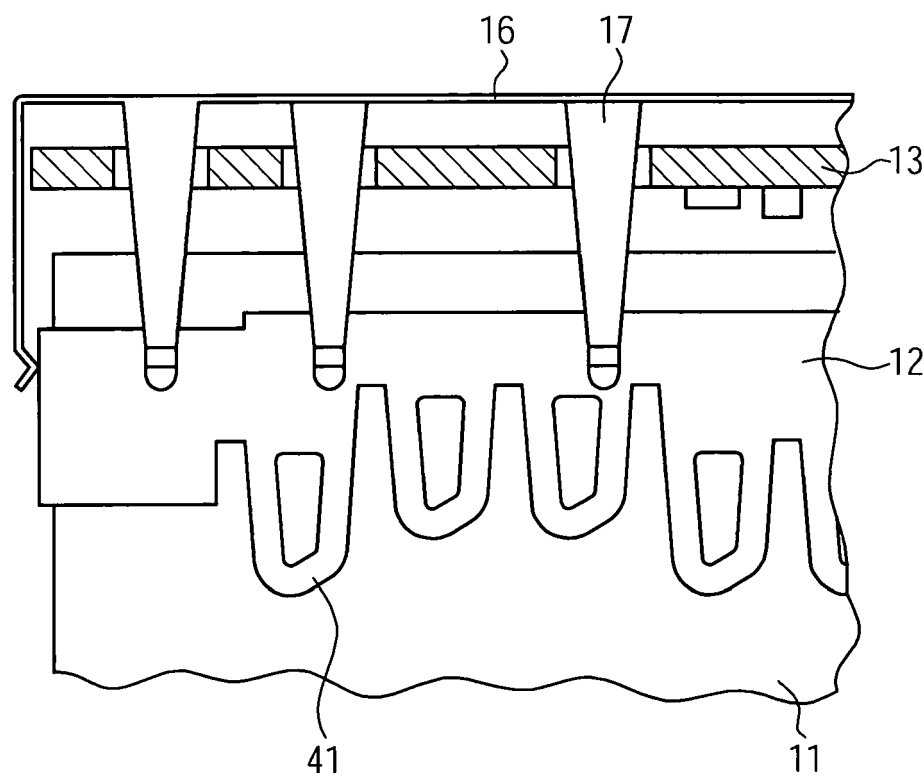
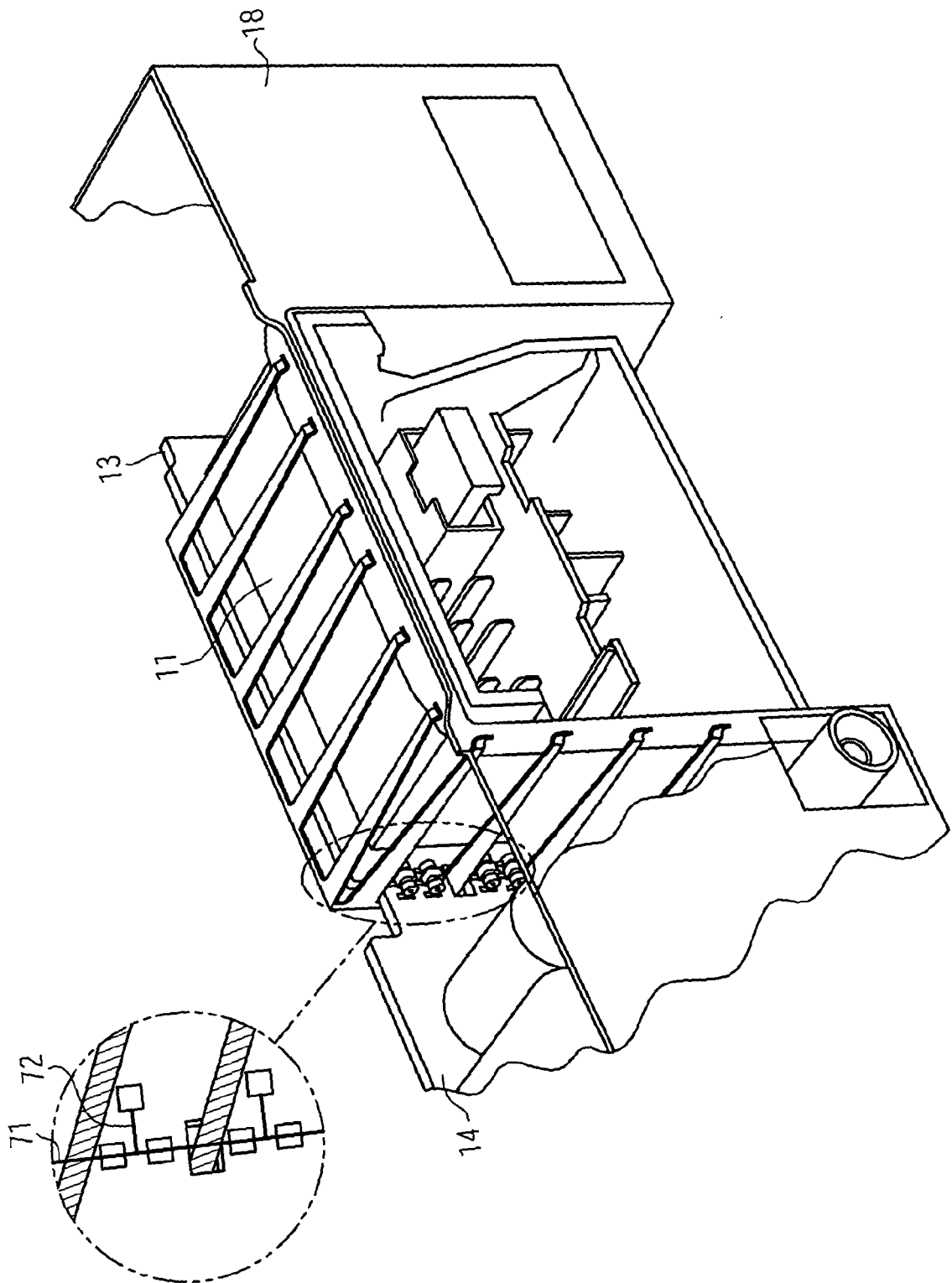


Fig.7





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 08 00 1349

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 032 090 A (MOLEX INC [US]) 30 August 2000 (2000-08-30)	1-3, 13-16, 23-26	INV. H01R13/658
Y	* paragraphs [0010], [0011], [0015]; figures 1,2 *	4-8,12	
Y	----- US 5 014 160 A (MCCOY JR JOHN F [US]) 7 May 1991 (1991-05-07) * column 6, line 37 - line 44; figure 1 * -----	4-8,12	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01R
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 June 2008	Examiner Langbroek, Arjen
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

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17-06-2008

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REFERENCES CITED IN THE DESCRIPTION

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