Title: CONNECTING DEVICE FOR CONNECTING AN ELECTRICAL CONDUCTOR TO A SOLAR MODULE AND METHOD FOR THE PRODUCTION THEREOF, AND SOLAR MODULE WITH SUCH A CONNECTING DEVICE

Abstract: A connecting device (1) for connecting at least one external electrical conductor (2) to an electrical connecting system (3, 104) of a photovoltaic solar module (100) comprises a connector housing (10) for arranging on the solar module, and an intermediate connecting arrangement (4) arranged in the connector housing and having a first contact region (5) for connection to the electrical conductor (2) and having a second contact region (6), connected to the first contact region, for connection to the connecting system (3) of the solar module (100). A first row (21) of contacts (20) arranged in the first contact region (5) connects to the electrical conductor (2) and is produced from a first metal component (40). A second row (31) of contacts (30) arranged in the second contact region (6) connects the connecting system (3) of the solar module (100) and is produced from a second metal component (50). The first and second rows (21, 31) of contacts (20, 30) are provided in a common housing (80) which surrounds the first and second rows of contacts, at least in part, and is mounted in the connector housing (10).
CONNECTING DEVICE FOR CONNECTING AN ELECTRICAL CONDUCTOR TO A SOLAR MODULE AND METHOD FOR THE PRODUCTION THEREOF, AND SOLAR MODULE WITH SUCH A CONNECTING DEVICE

The present invention relates to a connecting device for connecting at least one external electrical conductor to an electrical connecting system of a photovoltaic solar module, with a connector housing for arranging on the solar module, and an intermediate connecting arrangement arranged in the connector housing for connecting the electrical conductor(s) to the connecting system of the solar module. The invention also relates to a method for producing a connecting device of this type. The invention also relates to a solar module, to which a connecting device of this type is attached.

A photovoltaic solar module typically comprises a panel-like layer arrangement with solar cells, which generate electrical energy by a photovoltaic effect, arranged between the layers. For example, a layer arrangement of such a solar module comprises a planar, radiation-side layer, for example in the form of a glass cover with a low degree of absorption, and a planar second layer, which is arranged on the back of the solar module and, for example, is implemented in the form of a back glass cover. The solar cells are arranged between these layers in an appropriate intermediate space, and are connected to each other within the layer arrangement by an electrical connecting system. Solar module embodiments are known, in which the electrical connecting system of the solar cells is connected outwards, for example to a load, on the back of the solar module, remote from the radiation side, by means of electrical conductors, for example in the form of connecting foils. These connecting foils are connected in a connecting device in the form of a connection box or junction box to one or more electrical conductors of a connecting line, also called a solar connecting line. For this purpose, such a connecting device has an intermediate connecting arrangement arranged in a connector housing, with a plurality of contacts, to which on the one hand one or more connecting foils of the solar module and on the other hand one or more electrical conductors of the connecting cable are connected. Additionally, such a connecting device in the form of a junction box usually contains one or more diodes, which are provided to prevent equalising currents between solar cells in sunlight and solar cells in shade, which supply different solar currents and solar voltages. With the aid of such so-called bypass diodes, the module can continue to work, even in partial shade and with correspondingly reduced power.

In a known embodiment, such a connecting device in the form of a junction box includes for example four metallic modules in the form of so-called conductor rails, to connect a solar connecting cable to the electrical connecting system of a solar module. These metallic modules are usually inserted and fitted manually, individually and in succession into a housing lower part of the junction box. Following this operation, appropriate bypass diodes (three in this case) are also usually fitted manually. For this purpose, the conductor rails are each provided with tension springs, by which the diode
connecting wires are connected electrically and mechanically to the conductor rail body. The two connecting wires of the respective diodes are thus connected electrically and mechanically to the conductor rails, with the aid of metal clamps in the form of tension springs, which are placed on the conductor rails by machine. Additionally, larger tension springs, by means of which corresponding electrical conductors of outward-leading solar connecting cables are contacted, are fitted on a number of conductor rails, in this case, for example, two conductor rails. The electrical connecting system of the solar module is connected to the conductor rails by means of film conductors, the contacting being carried out by means of foil springs, with which the film conductors of the solar cells are connected to corresponding conductor rails or contacts. A plastics material cover is latched onto the metallic modules thus produced and contacted, and which are usually inserted manually, individually and in succession into the housing lower part of the junction box. At the points at which the solar connecting cables are positioned, the conductor rails are fitted with the additional large tension springs, which are in the centre of the housing for example, whereas conductor rails on the outside are fitted only with the tension springs which are necessary for connecting the diode connecting wires. Producing a connecting device for connecting a photovoltaic solar module in this way is relatively time-consuming and cost-intensive owing to the assembly steps which must mostly be carried out manually.

The object of the present invention is to provide a connecting device for connecting at least one external electrical conductor to an electrical connecting system of a photovoltaic solar module, which connecting device can be produced comparatively simply and inexpensively.

The invention relates to a connecting device according to the features of claim 1. The invention also relates to a solar module with a connecting device of this type, according to the features of claim 13. The invention also relates to a method for producing a connecting device, according to the features of claim 14.

The connecting device of the invention for connecting at least one external electrical conductor to an electrical connecting system of a photovoltaic solar module has a connector housing for arranging on the solar module, and an intermediate connecting arrangement arranged in the connector housing, which arrangement comprises a first contact region for connection to the electrical conductor and a second contact region, connected to the first contact region, for connection to the connecting system of the solar module. Furthermore, a first row of contacts arranged in a first contact region is provided, at least one of the contacts in the first row being provided for connection to the electrical conductor, and the first row of contacts being produced from a first metal component. A second row of contacts arranged in a second contact region is also provided, at least one of the contacts in the second row being provided for connection to the connecting system of the solar module, and the second row of contacts being produced from a second metal component. The first and second rows of contacts are provided in a common electrically
non-conductive housing which surrounds the first and second rows, at least in part, and is mounted in the connector housing.

The connecting device according to the invention thus offers the advantage that it is relatively simple and inexpensive to produce. This is achieved in that the intermediate connecting arrangement arranged in the connector housing may be produced purely by machine as a functional unit and therefore only one component in the form of a functional unit of this type must still be fitted in a housing lower part of the connector housing. The contacts in the first row and the contacts in the second row may also be produced by machine from the first and second metal components. In particular, the first and second metal components are metal components which are different and separate from one another and are provided together in a common housing in the connector housing so as to form the intermediate connecting arrangement. The first metal component and/or the second metal component is/are formed, for example, by a respective punched grid which can be produced by machine.

In one embodiment of the invention, the first and second rows of contacts are provided with a common housing which comprises a first branch, which surrounds at least part of the first row of contacts, and a second branch, which surrounds at least part of the second row of contacts, the first and second branches being connected to one another by at least one connection element. The common housing is connected to, in particular locked with, the connector housing at the connection element between the first and second branches for example.

The common housing may, for example, be configured as a plastics material housing. The first and second rows of contacts are moulded from a common plastics material housing or cast in a common plastics material housing for example.

Furthermore, the common housing may have an opening, at which part of a connection of the metal components between two contacts is distanced in the region of the opening. In particular, the first and/or second rows of contacts are formed by a punched grid, at least part of a connection of the punched grid between two of the contacts being distanced at the opening in the common housing. It is thus possible for the first and second rows of contacts to be moulded with a common plastics material housing or cast in a common plastics material housing, and only then to punch out in the region of the housing opening corresponding connections between the contacts which are to be removed.

In a further embodiment of the invention, the first and/or second row of contacts comprises at least a contact portion, formed separately from the contacts, which is provided for connecting a diode component. The intermediate connecting arrangement or functional unit thus formed may therefore also be provided with corresponding bypass diodes.

In this regard, one embodiment of the invention provides for the contact portion to be configured for electrically contacting and mechanically fixing the diode component, in
particular for crimping the diode component to the contact portion. The contact portion is, for example, in such a form that a diode connecting wire which is contacted with the contact portion leads substantially straight out of the diode component, and is connected to the contact portion in such a way that the corresponding diode connecting wire, which is contacted with the contact portion, no longer has to be angled for assembly. In fact, the diode connecting wires may be connected to the corresponding contact portions in the supply state, in which the diode connecting wires extend straight out of the diode component. This considerably reduces the danger of mechanical damage to the diodes in the assembly process.

According to one embodiment of the invention, a diode component with diode connecting wires extending in a basically straight line and/or a short circuit connection is arranged between the first and second branches of the common housing outside said housing. In addition, the first and second rows of contacts each comprise, in particular, at least one contact portion, which portions are provided for connecting the diode component or short circuit connection, in particular a wire, between the first row and the second row of contacts.

In a further embodiment of the invention, a connection-contact element is provided for connecting the contact of the first row, which is connected to the electrical conductor, for example of a connecting cable, for connection to the electrical conductor. The connection-contact element is configured at a first end for releasable connection to the contact of the first row, and at the other end for connection to the electrical conductor, for example of the connecting cable. The releasable connection may, for example, be in the form of what is known as a Faston terminal, which is slid onto a corresponding contact blade of the contact of the first row. A tension spring for example may be provided at the other end of the connection-contact element for connecting the electrical conductor of the connecting cable.

A connection device according to the invention may be produced in a relatively simple and cost-effective manner, in particular in accordance with the following production method. A production method of this type comprises, in particular, the following steps:

A first metal component with a first row of contacts is produced, the contacts of the first metal component, for example in the form of a punched grid, being connected via respective connections of the first metal component. At least one of the contacts of the first row is provided for connection to the external electrical conductor, for example of a connecting cable. Furthermore, a second metal component with a second row of contacts is provided, the contacts of the second metal component, for example in the form of a punched grid, being connected via respective connections of the second metal component. At least one of the contacts of the second row is in this case provided for connection to the connecting system of the solar module. In a further step, at least part of the first row of contacts and at least part of the second row of contacts are provided in a common
housing. Parts of the first row and parts of the second row of contacts are, for example, moulded from a common plasties material housing. In a further step, at least some of the connections of the first and second metal components are removed from a number of contacts within the first row and second row of contacts, for example punched out through corresponding housing openings. Furthermore, at least one electrical connecting component, for example in the form of a diode component or a short circuit connection, is arranged between the first row and second row of contacts. In a further step, the common housing which surrounds the first row and second row of contacts is mounted in a connector housing, which is to be arranged on the solar module.

Further embodiments and developments of the invention are given in the sub-claims.

The invention is explained in more detail below with reference to the figures shown in the drawings, which figures illustrate embodiments in relation to the present invention and in which:

Fig. 1 is a schematic cross-section of a photovoltaic solar module, which is connected to an electrical connecting device in the form of a junction box,

Fig. 2 is a perspective view of an embodiment of a connecting device according to the invention,

Fig. 3 shows an embodiment of a metal component in the form of a punched grid, which is used according to an embodiment for producing a connecting device according to the invention,

Fig. 4 shows an embodiment of a plastics material housing, in which a plurality of contacts (not shown) of an intermediate connecting arrangement according to the invention are provided,

Fig. 5 shows various views of different stages of production when producing an intermediate connecting arrangement according to an embodiment of the invention,

Fig. 6 shows an embodiment of a connection-contact element for connecting one of the corresponding contacts of the intermediate connecting arrangement to an electrical conductor of a connecting cable according to an embodiment of the invention.

Fig. 1 is a schematic cross-section of a photovoltaic solar module, which is provided with a connecting device in the form of a junction box or connection box. The solar module 100 comprises a layer arrangement with a planar, radiation-side first layer 101, which may be in the form of a glass plate or a foil-type layer. The solar module 100 also comprises a planar second layer 103 which is remote from the radiation side and may also be in the form of a glass plate or a foil-type layer. In this embodiment, the layers 101 and 103 are respective glass plates. Between the two layers 101 and 103, there is at least one solar cell 102 or an arrangement of a plurality of solar cells 102, which supply electrical energy when they are irradiated with light, owing to a photovoltaic effect. The solar cell(s) 102 is/are connected to an electrical connecting system 104. This is only
indicated schematically in Fig. 1 and its purpose is, in particular, to interconnect the solar cell(s) and to connect them to the outside world electrically. The electrical connecting system 104 comprises, for example, a copper foil, which on one side is contacted electrically with the back of the solar cell(s) 102, and on the other side merges into an electrical conductor 3 of the solar module or is connected to an electrical conductor 3 of the solar module, said electrical conductor being, for example, in the form of a connecting foil or connecting ribbon. Via the electrical conductor 3, the electrical connecting system 104 of the solar module 100 can be connected to an external connecting line 2, for example in the form of a solar connecting cable.

As also shown in Fig. 1, on the back of the layer 103, which forms an outer face of the solar module, a connecting device 1 is fixed, for example by being stuck with adhesive 107. The layer 103 also has a through-opening 105, through which the electrical conductor 3 can be guided to the connecting device 1.

Fig. 2 is a schematic view of an embodiment of a connecting device 1, which can be attached to the back of the layer 103 of the solar module 100 according to Fig. 1. The connecting device 1 in the embodiment according to Fig. 2 comprises a connector housing 10, of which only the lower part is shown in Fig. 2. On the underside of the housing base 15 of the connector housing 10, the connecting device 1 may be attached to an outer face of the solar module, in particular to one of the main faces of the first or second layers 101, 103 of the solar module 100, as described above. The upper face of connector housing 10 is, in the end state, closed by a suitable cover, not shown in Fig. 2, so as to protect the inner components of the connector housing 10 against outside influences.

An intermediate connecting arrangement 4, also referred to as a functional unit hereinafter, is arranged in the connector housing 10 so as to connect the connection line 2 (Fig. 1) or at least one electrical conductor of the connection line 2 to the electrical connecting system 104, that is to say to the electrical conductor 3 (for example in the form of a film conductor) of the connecting system. For this purpose, the intermediate connecting arrangement 4 comprises a first contact region 5 in order to connect electrical conductors of the connecting cable 2 to the corresponding contacts of the intermediate connecting arrangement 4. The intermediate connecting arrangement 4 also comprises a second contact region 6 for connection to the connecting system of the solar module. In the connector housing 10, connecting ducts 11 are provided for inserting one or more electrical conductors of one or more connecting cables 2 inside the connector housing 10 for contact in the first contact region 5. Furthermore, a housing opening 12 is provided in the base 15 of the connector housing 10 for inserting the film conductor(s) 3 of the electrical connecting system 104 of the solar module inside the connector housing 10. The connector housing 10 also comprises an inner contour 13 which, for example, may take on the role of maintaining predefined insulator spacings between individual connecting components of the connecting device. However, it is also possible for the inner contour 13 of the housing to not be provided in another embodiment of the invention.
In the first contact region 5, the intermediate connecting arrangement or functional unit 4 comprises a first row 21 of contacts 20, in the present embodiment two of the contacts 20 being provided for connection to respective electrical conductors of the connecting cable(s) 2. In the second contact region 6, the intermediate connecting arrangement or functional unit 4 comprises a second row 31 of contacts 30, in the present embodiment four of the contacts 30 being provided for connection to respective film conductors 3 of the solar module. The first row 21 of contacts 20 and the second row 31 of contacts 30 are moulded from a common plastics material housing 80, which surrounds the first and second rows, at least in part, and is attached in the connector housing 10 to fixing means 14, as is explained in greater detail below. In the present embodiment connecting components in the form of diode components 71 and short circuit connections 72 are arranged between the first row 21 of contacts 20 and the second row 31 of contacts 30, as described in greater detail below. Foil springs, in particular in the form of what are known as D-springs 62, are provided on the contacts 30 to be connected to the connecting system of the solar module in order to connect respective film conductors 3 to the relevant contact 30. In the present embodiment, metal clamps in the forms of tension springs 63 are in turn arranged in the contact region 5 on the outer two contacts 20 so as to contact the corresponding electrical conductor of a connecting cable 2 with the respective contact 20.

Fig. 3 shows an embodiment of a metal component in the form of a punched grid which can be used to produce a connecting device according to the invention, as shown in Fig. 2. A punched grid, as shown in Fig. 3A, can be used to produce both the first row 21 of contacts 20 and the second row 31 of contacts 30. Two metal components 40 and 50, distanced from one another, are correspondingly used for the first row 21 and the second row 31, as shown in Fig. 3A. A first metal component 40 in the form of a punched grid correspondingly forms the first row 21 of contacts 20 and a separate second metal component 50 in the form of a second punched grid correspondingly forms the second row 31 of contacts 30.

The metal components 40 and 50 in the form of punched grids (what are known as lead frames) are initially produced, connected, from a common metal component, the common metal component being produced continuously, irrespective of the number of poles using a punch-bending tool. Corresponding contact regions form the subsequent contacts 20 and 30. The contacts 20 of the punched grid 40 are interconnected via respective connections 41 of the punched grid 40. The punched grid 50 for forming the contacts 30 is configured similarly to the punched grid 40, the contacts 30 being connected via respective connections 51 of the punched grid 50. As shown in Fig. 3A, the connections 41 and 51 form a respective connecting web, to one side of which the contacts 20 and 30 are fixed and on a side opposing the contacts 20 and 30 separate contact portions 61 are formed, which connect a respective diode connecting wire or a short circuit wire connection, as will be explained in greater detail below.
The punched grids 40, 50 may be produced from a metal component which is connectedly and continuously wound and temporarily stored on a spool. A metal component of this type may by used universally, irrespective of length. The punched grids 40 and 50 are produced by correspondingly trimming the metal component in such a way that two different and separate metal components in the form of the punched grids 40 and 50 are obtained, the first punched grid 40 producing the first row 21 of contacts 20 and the second punched grid 50 producing the second row 31 of contacts 30.

As shown in Fig. 3B, the contacts 20 and 30 are pre-bent in an earlier production step about the continuous metal component (two separate punched grids 40 and 50 not yet having been cut therefrom) or in a subsequent production step, in particular offset at the connecting web. In addition, the contact portions 61 are pre-bent to form a V-shape, as shown in Fig. 3B.

In accordance with this embodiment, the contacts 20 and 30 are configured so as to be identical in their original form, as can be seen in Figs 3A and 3B. During subsequent processing and in their end state they are rotated through 180° relative to one another in the horizontal plane in such a way that the contact portions 61 face one another, as shown in Fig. 5. The contacts 20 and 30 and rows 21 and 31 of contacts shown in Fig. 5 are thus, in this embodiment, identical metal parts which are processed differently in a subsequent production step, in particular bent and possibly trimmed, as explained in greater detail with reference to Fig. 5.

Fig. 4 shows an embodiment of a plastics material housing 80, in which the contacts 20 and 30 (not shown in Fig. 4) are arranged. The view according to Fig. 4 thus merely clarifies the construction of the plastics material housing, which does not exist as such in the form shown. In fact, the contacts 20 and 30 are also arranged in the plastics material housing 80, as explained in greater detail in Fig. 2 and in Fig. 5 below. The common plastics material housing 80 comprises a first branch 81, which surrounds the first row 21 of contacts 20, at least in part, and a second branch 82, which surrounds at least part of the second row 31 of contacts 30. The first branch 81 and the second branch 82 are connected to one another by at least one connection element 83, in the present case by a plurality of connection elements 83 in the form of connecting webs. It is possible to reduce the amount of material required to form the plastics material housing 80 by the configuration of said plastics material housing 80 as shown in Fig. 4. Openings 84 are provided in the branches 81 and 82 of the plastics material housing 80, through which openings at least some of the connections 41 and 51 of the punched grid can be removed, as shown in Fig. 3, for example by being stamped out through the openings 84.

The production of an embodiment of an intermediate connecting arrangement or functional unit 4 will be explained in greater detail below with reference to Fig. 5.

As shown in Fig. 5A, the punched grid 40 with the contacts 20 and the punched grid 50 with the contacts 30 are moulded from a common plastics material housing 80 or cast in a common plastics material housing 80. For this purpose, two punch-bending
parts, as shown in Fig. 3B are arranged opposite one another in such a way that the contact portions 61 face one another and the contacts 20 extend upwards, whilst the contacts 30 extend downwards. The punched grids 40 and 50 arranged opposite one another in this manner are then moulded or cast with plastics material in such a way that a plastics material housing 80 is produced, as explained with reference to Fig. 4. The contacts 20 of the punched grid 40, which form a first row 21 of contacts 20, and the contacts 30 of the second punched grid 50, which form a second row 31 of contacts 30, are thus arranged opposite one another in a common housing 80, the first branch 81 of the housing 80 being arranged along the first row 21 and the second branch 82 of the housing 80 being arranged along the second row 31, connected via the connecting webs 83 of the housing 80. The plastics material housing which surrounds, insulates and stabilises the punched grids and is produced, for example, by a moulding process, can be adjusted lengthwise by altering the moulding tool (conversion kits) depending on the client's preference/specification.

In a subsequent production step, as shown in Fig. 5B, the thus formed arrangement is contacted with diode components 71 and short circuit connections 72 in the form of jumpers. For this purpose, as can be seen in greater detail in Fig. 5D, a respective diode connecting wire 73 of the diode component 71 is arranged in a respective one of opposing contact portions 61 and crimped therewith, the V-shaped contact portions 61 being correspondingly crimped. Likewise, the short circuit connections 72 in the form of simple wire connections are arranged in opposing contact portions 61 of the first row 21 or second row 31, similarly to the diode components 71, and crimped with the contact portions. In order to better pre-position the diodes and jumpers, these are guided into their respective intended positions through slotted contours of the described plastics material housing, which surrounds the punched grids, before the crimping process. The diode components 71 and jumpers 72 may be arranged in place by machine and connected to the respective punched grid (lead frame) as described above. The metal connections or connection profiles 41 and 51, which are no longer needed owing to the universal configuration of the punched grids 40, 50, are removed by machine either before or after the crimping process. This is effected through the housing openings 84, as described above.

As shown in Fig. 5C, the contacts 30 for example are bent into their subsequent shape either before or after the crimping process, this being advantageous for the connections of the corresponding film conductors. Surplus metal connecting profiles may also be cut off or deformed by machine either before or after the crimping process. This is shown with reference to Fig. 5D, in which some of the contacts 20 or a respective part thereof have been separated in a finishing process, as is shown for example with reference to the two outer contacts 20. A further number of contacts 20 are bent in a finishing process, as shown with reference to the centre contact 20 according to Fig. 5D.

After the fitting process (providing the diode components 71 and jumpers 72) and the finishing process (stamping out, bending, separating), the thus formed functional unit
4 is electrically tested and released for assembly in the housing lower part of a junction box. The arrangement of the diode components 71 and the fixing of the punched grids 40 and 50 to opposing contact portions 61 offers the advantage that the diode connecting wires 73 (Fig. 5D) no longer have to be angled by 90 degrees before assembly, as is usually the case, but can be crimped in the condition at time of supply with basically straight diode connecting wires 73 with the contact portions 61. This considerably reduces the danger of damaging the diodes in the assembly process. The electrical and mechanical connection of the diodes to the respective punched grid may be carried out by way of an automated mechanical crimping process. In this regard however, it is also possible to produce the corresponding connection by way of a weld, adhesive or plug.

As shown in Fig. 2, a functional unit 4 thus produced may be locked to the connecting webs 83 via fixing means in the form of locking elements 14 of the connector housing 10, and thus be fixed in the connector housing 10. The film conductors 3 of the solar module (not shown in Fig. 2) are connected via the D-springs 62 to a number of contacts 30 of the first row 31. The two outer contacts 20 of the first row 21 of contacts are connected to the corresponding electrical conductor of a connecting cable 2 via respective connection-contact elements 90.

An embodiment of a connection-contact element 90 of this type is shown in greater detail in Fig. 6. The connection-contact element 90 forms a type of conductor rail having two terminals. At a first end 91, the connection-contact element 90 can be releasably connected to one of the contacts 20 of the first row 21 and at the opposite end 93 it can be connected to the electrical conductor(s) of a connecting cable 2. In order to form the releasable connection at the first end 91, a connection device 92 is provided which forms, for example, a socket-type connection, in particular what is known as a Faston terminal. A corresponding contact 20 is inserted into said Faston terminal, which contact is configured in this terminal region as a contact blade and is inserted into the opening in the Faston terminal so as to connect the contact 20 to the connection-contact element 90. A tension spring 63, for example, is arranged at the opposite end 93, into which spring the conductor of the connecting cable can be inserted when the tension spring is loaded, for example by pressing on the tension spring.

The connection-contact elements 90 may be automatically produced and fitted and have two main purposes. On the one hand, they contact the connecting cable(s) with the functional unit 4 and, on the other hand, they make it possible to electrically and mechanically release the functional unit 4 from the connector housing 10 by way of the releasable plug connections (for example via the connection means 92). It is thus possible, for example during repairs, to replace the functional unit 4 in a cost-effective manner with another functional unit 4 in a single step. It is also possible to release the functional unit 4 from the connector housing 10 in order to replace defective components, for example defective diodes 71, with functional components and to insert the repaired functional unit 4 into the connector housing 10 once more. If diodes should fail during operation, it is thus possible to locate the defective diodes concerned in situ, separate them and replace
them using a repair set (diode and two tension springs). As an alternative to exchanging individual defective diodes, the entire functional unit 4 can be removed from the connector housing 10 and can be replaced with a complete new functional unit without the electrical conductors of the connecting cable(s) 2 having to be electrically or mechanically released from the connector housing 10. The defective functional units may be repaired in a workshop at any time and anywhere.

One advantage of the invention is thus that, in the present embodiment, only one other functional unit, which can be produced purely by machine and is in the form of the intermediate connecting arrangement 4, must be assembled in the connector housing 10 in addition to two connection-contact elements 90 (connection-conductor rails). The functional unit and the connection-conductor rails may be fitted or fixed in place by way of snap-in hooks which are a component of a pre-existing, unchanged connector housing. Consequently, a number of manual assembly procedures are no longer necessary, as described above. Considerable cost savings can be made when producing a connecting device of this type in conjunction with an accompanying reduction in number of components, simplified construction of plastics material and metal components, savings in material and assembly costs and use of a production process which can be automated.

The invention was described above in greater detail with reference to an embodiment. However, the person skilled in the art will know that a connecting device for connecting a photovoltaic solar module in accordance with the principles of the present invention may be obtained in numerous ways, without being limited to the specific embodiment shown in the figures. The connecting device according to the invention may be attached to a solar module for connection thereof at basically any suitable point, the invention not being limited to the connecting device being fixed on the back of the solar module to one of its main faces, as shown in Fig. 1. The connection to the solar module may also be achieved via basically any type of electrical conductors, the aforementioned connection via film conductors only being one of many possible options.
CLAIMS

1. Connecting device (1) for connecting at least one external electrical conductor (2) to an electrical connecting system (3, 104) of a photovoltaic solar module (100), having:
   - a connector housing (10) for arranging on the solar module,
   - an intermediate connecting arrangement (4) arranged in the connector housing and having a first contact region (5) for connection to the electrical conductor (2) and having a second contact region (6) connected to the first contact region for connection to the connecting system (3) of the solar module (100),
   - a first row (21) of contacts (20) arranged in a first contact region (5), at least one of the contacts in the first row being provided for connection to the electrical conductor (2) and the first row of contacts being produced from a first metal component (40),
   - a second row of (31) of contacts (30) arranged in the second contact region (6), at least one of the contacts in the second row being provided for connection to the connecting system (3) of the solar module (100) and the second row of contacts being produced from a second metal component (50),
   - wherein the first and second rows (21, 31) of contacts (20, 30) are provided in a common housing (80) which surrounds the first and second rows of contacts, at least in part, and is mounted in the connector housing (10).

2. Connecting device according to claim 1, wherein at least one of the first metal components (40) and at least one of the second metal components (50) is formed by a punched grid.

3. Connecting device according to either claim 1 or claim 2, wherein the first and second rows (21, 31) of contacts are provided in a common housing (80) which comprises a first branch (81), which surrounds at least part of the first row (21) of contacts, and a second branch (82), which surrounds at least part of the second row (31) of contacts, the first and second branches being connected to one another by at least one connection element (83).

4. Connecting device according to claim 3, wherein the housing (80) is connected to, in particular locked with, the connector housing (10) at the connection element (83).

5. Connecting device according to any one of claims 1 to 4, wherein the first and second rows (21, 31) of contacts are moulded from a common plastics material housing (80) or cast in a common plastics material housing (80).
6. Connecting device according to any one of claims 1 to 5, wherein at least one of the first and second rows (21, 31) of contacts is formed by a punched grid (40, 50), at least part of a connection (41, 51) of the punched grid between two of the contacts (20, 30) being removed in the region of an opening (84) in the common housing (80).

7. Connecting device according to any one of claims 1 to 6, wherein at least one of the first and second rows (21, 31) of contacts comprises at least a contact portion (61), formed separately from the contacts (20, 30), which contact portion is provided for connecting a diode component (71).

8. Connecting device according to claim 7, wherein the contact portion (61) is configured for electrically contacting and mechanically fixing the diode component (71), in particular for crimping the diode component to the contact portion.

9. Connecting device according to either claim 7 or claim 8, wherein the contact portion (61) is in such a form that a diode connecting wire (73) which is contacted with the contact portion leads in a substantially straight line out of the diode component (71) and is connected to the contact portion (61).

10. Connecting device according to any one of claims 1 to 9, wherein the first and second rows (21, 31) of contacts each comprise at least one contact portion (61), which portions are provided for connecting a diode component (71) or a short circuit connection (72), in particular a wire, between the first row (21) and the second row (31) of contacts.

11. Connecting device according to any one of claims 1 to 10, wherein the first and second rows (21, 31) of contacts are provided in a common housing (80) which comprises a first branch (81), which surrounds at least part of the first row (21) of contacts, and a second branch (82), which surrounds at least part of the second row (31) of contacts, and a diode component (71) is arranged with diode connecting wires (73) which extend in a basically straight line and/or a short circuit connection (72) between the first and second branches (81, 82) outside the housing.

12. Connecting device according to any one of claims 1 to 11, wherein to connect the at least one contact (20) of the first row (21) to the electrical conductor (2), a connection-contact element (90) is provided, which is configured at a first end (91) for releasable connection to the at least one contact (20) of the first row (21) and at another end (93) for connection to the electrical conductor (2).
13. Solar module (100), comprising:
   - a layer arrangement with planar first and second layers (101, 103), which are arranged at a distance from each other, and at least one solar cell (102), which is arranged between the layers,
   - a connecting device (1) according to any one of the preceding claims, which is attached to the layer arrangement and connected to the connecting system (3, 104) of the solar module.

14. Method for producing a connecting device (1) for connecting at least one external electrical conductor (2) to an electrical connecting system (3, 104) of a photovoltaic solar module (100), with the following steps:
   - providing a first metal component (40) having a first row (21) of contacts (20), the contacts of the first metal component being connected via respective connections (41) of the first metal component, and at least one of the contacts (20) of the first row being provided for connection to the electrical conductor (2),
   - providing a second metal component (50) having a second row (31) of contacts (30), the contacts of the second metal component being connected via respective connections (51) of the second metal component, and at least one of the contacts (30) of the second row being provided for connection to the connecting system (3) of the solar module (100),
   - providing at least part of the first row (21) and second row (31) of contacts in a common housing (80),
   - removing at least some of the connections (41, 51) of the first and second metal components (40, 50) between a number of contacts (20, 30) within the first row and second row (21, 31),
   - arranging at least one electrical connecting component (71, 72) between the first row and second row (21, 31) of contacts,
   - mounting the common housing (80) in a connector housing (10) which is configured for arrangement on the solar module.