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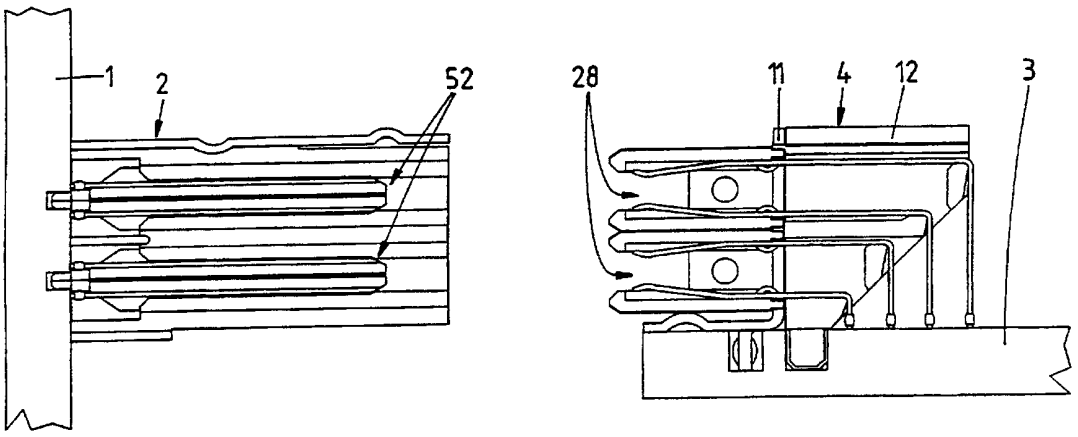
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(54) Title: CONNECTOR, METHOD FOR MANUFACTURING SUCH A CONNECTOR AND CONTACT ELEMENT FOR A CONNECTOR



(57) Abstract: A connector is described, comprising a housing and a plurality of contact elements mounted in the housing. The housing comprises at least two interconnected housing parts having an elongated mainly rectangular flat shape. Each housing part has a series of open grooves in one of the main surfaces. The grooves extend transverse to the longitudinal direction of the housing part along the full transverse dimension of the main surface. The contact elements are made as single beam contact elements mounted in these grooves. These contact elements include a contacting portion received with play in the corresponding groove and a mounting portion fixed in the groove.

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Connector, method for manufacturing such a connector and contact element for a connector

The invention relates to a connector, comprising a housing and a plurality of contact elements mounted in the housing, said housing having surfaces with grooves, wherein each contact element has a contacting portion received with play in a corresponding groove and a mounting portion fixed in the housing, to a method for manufacturing such a connector, and to a contact element for a connector.

Connectors of this type are known in various embodiments. In view of component cost and utilization of cabinet space in combination with a growing requirement for a high-density, high-speed connector, there is a growing need to miniaturize the connector. A constraint in miniaturizing a connector is the requirement for improved signal integrity in combination with increased signal clock speed. US-A-4 734 060 discloses a connector and method of the above-mentioned type, wherein the contact elements are partially accommodated in cavities of the housing aligned with the grooves and partially in the grooves, wherein the retention of the contact elements occurs in the passages, where the contact elements are fully surrounded by plastic material. The mounting of the contact elements requires an axial insertion of the contact elements, wherein a significant axial length of the contact element has to pass through the cavity. Further, for flexibility purposes the contact elements in both the male and female connectors have a longitudinal tapering in cross-section with a thickened contacting dome at their free end. This shape of the contact elements entails drawbacks in terms of manufacturing and results moreover in internal stress. During the mating cycle sufficient space must be available within the connectors for the contact elements to deflect along a distance corresponding

to twice the dimension of the thickened part. The design of this connector imposes limitations regarding miniaturizing and manufacturing the connector.

The invention aims to provide an improved connector and improved method of manufacturing the same.

To this end the connector of the invention is characterized in that the housing comprises at least two interconnected housing parts having an elongated mainly rectangular flat shape, each housing part having a series of open grooves in one of the main surfaces, said grooves extending transverse to the longitudinal direction of the housing part along the full transverse dimension of the main surface, wherein the contact elements are made as single beam contact elements, each contact element having a contacting portion received with play in the groove and a mounting portion fixed in the groove.

In this manner a new connector design is obtained in which the single beam contact elements are partly extending in air and even at the mounting section are only partly enclosed by insulating material. The use of single beam contact elements provides the possibility to reduce the pitch between successive rows of contacts and moreover reduces the effective radiating contact surface, thereby minimizing interaction between contacts. The use of single beam flat contact elements results in advantages in the production of the contact elements. The contact dimple on the spring sections in the female connector ensures a good connection between corresponding contact elements of mated male and female connectors.

Moreover, the use of housing parts with a grooved main surface results in a simplified manufacturing of the connector. Therefore, the invention also provides an improved method for manufacturing the connector, wherein a housing part is provided, said housing part having an elongated mainly rectangular flat shape and a series of open grooves in one of the main surfaces, said grooves extending transverse to the longitudinal direction of the housing part

along the full transverse dimension of the main surface, wherein the contact elements are made as single beam contacts and are inserted into said grooves in a direction perpendicular to the main surface of the housing part. In this manner manufacturing requires insertion along a very short distance only, wherein mutual contact between the housing and plated areas of the contact elements is fully avoided.

Preferably, a plurality of interconnected contact elements is provided, wherein the interconnected contact elements are inserted into the grooves of a housing part in one step.

In this manner a connector is obtained wherein the number of contact elements in column direction can be easily adapted by adding further modules to the connector. Thereby, the connector design of the invention allows to provide any number of rows without tooling-up a new housing mould, resulting in a flexible and low cost manufacturing.

In order to stack two or more connectors in row direction to increase the number of contact elements in row direction, it is preferred that in row direction each module is provided with flat end surfaces, wherein the distance between the first and last contact elements of a row of contact elements and the end surfaces is such that with two modules stacked in row direction the pitch of adjacent contact elements of stacked modules equals an integer times the pitch between successive contact elements in row direction. In this manner any size of connector length can be used, wherein a constant pitch between all contact elements is maintained.

Preferably, the transverse dimension of one module equals twice the pitch between successive contact elements in row direction. Thereby, the number of contact elements per unit of length is the same in row and column direction.

The connector comprises a number of assembled components, wherein the mounting frame provides a mutual positioning and interconnection of the components. Right-angled and straight embodiments can be manufactured using the same

front housing sections and mounting frame.

It is advantageous if the metal mounting frame is provided with location projections for mounting the connector on a printed circuit board. Thereby the metal mounting frame is adapted to provide at least a strong mechanical connection to the printed circuit board so that the contact elements can be provided with terminals optimized for a surface mount connection.

According to the invention it is advantageous if the location projections of the mounting frame are made as contact sections for connecting the mounting frame to a ground of a printed circuit board. The mounting frame provides for a connection of the ground of the connector to the ground of the printed circuit board.

In the connector design of the invention, the housing is an assembly modules with two identical joined housing parts, so that any waviness or curvature of the housing parts will be mutually compensated resulting in a flat module with accurate shape and dimensions.

In the connectors of the male and female type, the spring portions of the female contact elements are accurately centred on the true position of the male contact elements, so that a correct connection between the male and female contact elements is guaranteed.

The invention will be further explained by reference to the drawings in which some embodiments of the connector of the invention are shown.

Fig. 1 shows a male and a female embodiment of the connector of the invention, the male and female connectors providing a backpanel connector assembly.

Fig. 2 shows some female contact elements used in the female connector of fig. 1; fig. 2A showing a top view of a plurality of interconnected contact elements and fig. 2B showing a side view of one contact element.

Fig. 3 shows some male contact elements of the male connector of fig. 1; fig. 3A showing a top view of a plurality of interconnected contact elements and fig. 3B showing a

side view of one contact element.

Fig. 4 shows an exploded view of one housing part of the female connector of fig. 1 and a plurality of interconnected female contact elements to be inserted into the housing part.

Fig. 5 shows an exploded view of two housing parts of fig. 4 with the contact elements inserted.

Fig. 6 shows the two housing parts of fig. 5 as assembled.

Figs. 7-9 show an alternative embodiment of a part of a female connector in a manner corresponding to figs. 4-6.

Fig. 10 shows two female contact elements used in the female connector of figs. 7-9.

Fig. 11 is a perspective view of a part of an embodiment of a female connector of the invention.

Fig. 12 is a schematically shown cross section of the female connector of fig. 11.

Fig. 13 is an exploded view of the female connector of fig. 1.

Fig. 14 is a perspective view of the female connector of fig. 13 as assembled.

Fig. 15 is a front view of the female connector of fig. 14.

Fig. 16 is a rear view of the female connector of fig. 14 without tail unit and with straight female contact elements.

Fig. 17 schematically shows a cross section of the female connector of fig. 14.

Fig. 18 shows an exploded view of one housing part of the male connector of fig. 1 with a plurality of interconnected male contact elements to be inserted into the housing part.

Fig. 19 shows an exploded view of two of the housing parts of fig. 18 with the contact elements inserted.

Fig. 20 shows the two housing parts of fig. 19 as assembled.

Fig. 21 is a schematical cross section of the two assembled housing parts of fig. 20.

Fig. 22 is an exploded view of the male connector of fig. 1 including four housing parts of fig. 18.

Fig. 23 is a perspective view of the male connector of fig. 22.

Fig. 24 is a lateral cross section of the male connector of fig. 23.

Fig. 25 is a cross section view of the male connector of fig. 23.

Fig. 26 schematically shows a front view of two male housing parts before assembly with separately shown male contact elements.

Fig. 27 shows a detail of the two housing parts of fig. 26.

Fig. 28 shows a perspective view of a further embodiment of the male connector of the invention.

Fig. 29 shows a further embodiment of the female connector of the invention made as a cable connector.

Fig. 30A-30C show front views of three different sizes of male connectors of the invention.

Fig. 31 shows a perspective view of three male connectors of the invention stacked end-to-end.

Fig. 32A-32D schematically show the guiding and centring of the female contacts during mating of the male and female connectors of the invention.

Fig. 33 shows in a larger scale a cross section of the mated male and female connectors of fig. 1 to illustrate the centring of the female contact elements on the male contact elements.

Fig. 34A and 34B schematically show the male and female modules of a connector of the invention unmated and mated, respectively.

Fig. 35A and 35B schematically show the male and female connectors of fig. 1 unmated and mated, respectively.

Fig. 36A and 36B show a further embodiment of male and female connectors of the invention in the same manner as

fig. 35A and B.

Fig. 37 shows by way of illustration a backpanel with two daughter boards, wherein the mother board at the left side is connected to the back panel by means of a prior art connector assembly and wherein the daughter board at the right side is connected to the back panel using a connector assembly of the invention.

Fig. 38 shows a perspective view of the female connector of fig. 1 with straight contact elements illustrating the manner of providing a solder reservoir on the tail ends of the contact elements and the hold downs of the connector, respectively.

Fig. 39 schematically shows three steps in a side and top view, respectively of the manner of providing a solder reservoir on the tail ends of the contact elements in fig. 38.

Fig. 40 further illustrates the manner of providing a solder reservoir on the tail ends of the contact elements of fig. 38.

Figs. 41A-41C show the use of the solder reservoir in the female connector of fig. 38.

Referring to fig. 1 there is shown a backpanel 1 with a male connector 2 and a daughter board 3 with a female connector 4. In this case the male connector 2 is made as a straight connector, while the female connector 4 is made as a right-angled connector. The male connector 2 comprises a metal outer shielding 5 enclosing four housing parts 6. Each housing part 6 has an elongated mainly rectangular flat shape, wherein a series of open grooves 7 is provided in one of the main surfaces of a housing part 6. The grooves 7 extend lateral to the longitudinal direction of the housing part 6. Male contact elements 8 are made as single beam contact elements and are mounted in the grooves 7 as will be described later.

The female connector 4 comprises also four housing parts 9, each housing part having an elongated mainly rectangular flat shape. In one of the main surfaces of a hous-

ing part 9 a series of open grooves 10 is provided. The female connector 4 further comprises a metal frame 11 and a tail unit 12. The metal frame 11 integrates the housing parts 9 and the tail unit 12 into the complete female connector 4.

Each housing part 9 of the female connector 4 is provided with a plurality of female contact elements 13, wherein these contact elements 13 are made as single beam contact elements and are mounted in the grooves 10.

The male and female contacts 8,13 are shown in detail in fig. 2 and 3, each showing a part of a strip of female contact elements 13 and male contact elements 8, respectively. As both the male and female contact elements 8,13 are made as single beam contact elements, the production steps of both types of contact elements are mainly the same. The female contact elements 13 comprise a neck or mounting section 14 with two small protrusions 15 for retaining the contact element in the groove 10 of the housing part 9. The contact element 13 further comprises a tail section 16 and a spring section 17. The spring section 17 carries a first contact dimple 18, whereas in the preferred embodiment shown the mounting section 14 carries a second contact dimple 19. The co-operation of the contact dimples 18, 19 with the male contact elements 8 will be described later. It is noted however that in an alternative embodiment the female contact elements can be manufactured with the first contact dimple 18 only.

At the end of the tail section 16, a recess 20 is provided for receiving a solder reservoir. Further the end of the tail section 16 is provided with a chamfer 21 to improve the surface mount connection with a printed circuit board. The female contact elements 13 are interconnected by carriers 22 with an intermediate pilot hole 23 and the carriers 22 are connected to a strip 24 with corresponding pilot holes 25.

As shown in fig. 3, the male contact elements 8 are interconnected in the same manner by carriers 22 and a strip

24. Each male contact element 13 is provided with an intermediate mounting section having two small protrusions 15 for retaining the contact element in a groove 7 of the housing part 6. The distance between the two protrusions 15 can be smaller than distance shown in fig. 3. The front section of the contact element 8 between the tip and the first protrusion 15 functions as a contact spring section 61 as will be described later. The tail end of the male contact elements 8 is also provided with a chamfer 21 and further a recess 20 is provided for a solder reservoir.

During manufacturing of the connectors 2,4, the mounting section of the contact elements 8,13 is pressed into the groove 7 or 10, respectively, onto the bottom thereof, wherein the contact elements are retained in the grooves at their mounting sections, while the spring sections 17,61 extends unsupported and can deflect during mating of the connectors 2,4.

The thin flat contact element design allows manufacturing of both types of contact elements from thin mill-rolled stock material, wherein the contact elements 8,13 have a constant thickness in cross-section. During manufacturing substantially stress free contact elements are obtained having a contact surface texture devoid of any roughness irregularities. The thin flat contact element design further lends itself for selective metal plating, wherein the co-operating parts of the male and female contact elements 8,13 can be provided with a precious metal plating, whereas the tail end with recess 20 and chamfer 21 can be provided with a tin-lead plating. If necessary a nickel plating can be provided between the precious metal plating and the tin-lead plating as a separation. The precious metal plating is only necessary on one side of the contact elements 8,13 as the other side faces the housing part 6,9.

Figs. 4-6 show three steps of manufacturing the female connector 4 of fig. 1. Fig. 4 shows one female housing part 9 which in the embodiment shown is provided with twenty-four grooves 10 for receiving female contact elements

13. Twenty-four female contact elements 13 are provided as part of a strip of female contact elements still interconnected by the carrier 22 and strip 24. It will be clear that any other number of grooves and contact elements can be used as desired.

The pilot holes 23,25 provide for an easy handling of the strip of female contact elements 13 which are mass inserted in one step into the grooves 10 of the female housing part 9. During the insertion step of the contact elements 13, the contact elements 13 are separated from the carriers 22. In this manner a female housing part 9 with inserted female contact elements 13 is obtained as shown in fig. 5. During the insertion step the neck or mounting section 14 with the protrusions 15 is forced into a mounting part 26 of the corresponding groove 10 to retain the contact element 13 in the groove. The contacting spring section 17 is received with play in the corresponding groove 10 so that the spring action of the contact element can provide a contacting force through deflection during a mating cycle, when the contact dimple 18 is in contact with an opposing contact element 8.

As stated above, during the manufacturing process, the array of substantially flat thin contact elements 13 connected to the carrier 22 and lying in one plane can be severed en masse from this carrier by a suitable punch tool. This tool moves further perpendicularly with respect to the plane of the contact elements 13 towards the grooves 10 of the female housing part 9 located below the contact elements. In this manner the punch tool mass-inserts the contact elements 13 in one step into the housing part 9. The protrusions 15 of each contact element 13 are forced into the material of the walls of the corresponding grooves 10. The forces caused in successive grooves 10 are in opposite directions and are staggered with respect to each other. The material of the housing part 9 between the staggered protrusions provides a spring function to retain the contact elements in the grooves. Moreover the plated contacting sur-

faces of the contact elements can not be scratched during insertion.

Two identical female housing parts 9 together with metal end plates 27 provide one female connector module 28 shown in fig. 6. In the embodiment of figs. 4-6, the recesses 20 are provided with a solder lump or dot 29. However, such a solder dot 29 can also be provided in the recesses 20 in a later manufacturing step. The end plates 27 provide for a mutual positioning of the female housing parts 9.

The female housing parts 9 shown in figs. 4-6 are selectively metallized at their outer surface 30 and edges 30' providing a shielding of the connector module 28. In an alternative embodiment shown in figs. 7-10, a shielding of the contact elements 13 is provided by using female housing parts 9 made as metal die cast components. In this embodiment the end plates 27 can be made as an integral part of the housing part 9. The female contact elements 13 are provided with an insulating mounting element 31 at the neck section 14 (see figs. 7 and 10). This mounting element 31 is received in a mounting part 32 of the grooves 10. Just as in the embodiment of figs. 4-6, a strip of female contact elements 13 including twenty-four contact elements is provided for mass insertion of the contact elements 13 into the grooves 10 of a housing part 9. Two housing parts 9 with inserted contact elements 13 are assembled to provide one female connector module 28 shown in fig. 9.

Although in the embodiment shown in figs. 4-6 the end plates 27 are shown as separate elements, the end plates 27 generally are provided as an integral part of the metal frame 11. In the embodiment of figs. 11 and 12 a metal frame 11 is shown by way of example for a female connector of the invention including eight female connector modules 28 so that the female connector comprises sixteen rows of contact elements 13, each row including twenty-four contact elements in the embodiment shown.

Fig. 13 shows an exploded view of the female con-

nector 4 of fig. 1, the female connector 4 being shown at a larger scale in fig. 14. In this case, the female connector comprises two female connector modules 28 so that the connector comprises four rows of contact elements 13, each row including twenty-four contact elements in the embodiment shown. As the female connector is an assembly of one or more female connector modules 28, wherein each connector module is an assembly of two identical housing parts 9, it will be understood that the design of the female connector provides for a high flexibility in manufacturing a connector with any desired number of rows of connector elements. In the connector design described the number of rows of contact elements can be incremented in steps of two rows by simply adding a connector module of two housing parts. All housing parts are held together as an integral housing. Expensive tooling to manufacture a new housing is not necessary.

As mentioned above, the number of contact elements in one row can be chosen as desired. The number of twenty-four contact elements 13 in one row is only given by way of example. In the embodiments described, the lateral or transverse dimension of the connector module 28 is 2,0 mm whereas the length of the module is 25 mm. The pitch of the contact elements 13 in longitudinal direction is 1,0 mm. At both longitudinal ends the distance of a contact element from the end is such that, when more contact elements 13 in a longitudinal array are required, two or more modules 28 can be stacked end-to-end, wherein a pitch between adjacent contact elements 13 of adjacent modules is obtained which is an integer times the pitch of the elements 13 within a module.

In the embodiment shown in figs. 11,12, the female connector is made as a straight connector, wherein all contact elements 13 have the same length. In the embodiment of figs. 1 and 13, the female connector 4 is a right-angled female connector, wherein the female contact elements 13 in successive rows have a different length.

To receive the two female connector modules 28, the metal frame 11 is provided with three flat ribs 33, wherein

the upper and lower ribs 33 are provided with circular openings 34 for receiving mounting pegs 35 of the tail unit 12 and the housing parts 9. In the embodiment shown in the drawings, the pegs 35 are integral plastic parts of the housing part 9 and tail unit 12, respectively. However the pegs 35 can also be provided as metal parts which are insert-moulded with the housing parts 9 and/or tail unit 12. Further it will be clear that instead of round openings 34 and pegs 35 different shapes may be used. The central rib 33 is provided with elongated openings 36 to receive the pegs 35 of two female housing parts 9. All ribs 33 are provided with a rectangular saw form providing recesses 37 receiving the tail sections 16 of the female contact elements 13 as shown in detail in fig. 16. The upper and lower ribs 33 are further provided with rectangular recesses 38 for receiving rectangular pegs 39 of the tail unit 12 to provide a further mutual fixation of the tail unit 12 and metal frame 11. Further the upper rib 33 is provided with larger recesses 40 aligned with slots 41 provided in the upper surface of the tail unit 12. The location and size of the recesses 40 and slots 41 can be varied to provide a polarisation and coding area.

The tail unit 12 is also selectively metallized at its outer surface to provide a shielding of the contact elements 13. Further the front face, including the pegs 35 and 39 is metallized, so that the metal frame 11 is connected with the metallization of the tail unit 12. In the same manner, the edge of the housing parts 9 and the pegs 35 are metallized to interconnect the metallization of the housing parts 9 with the metal frame 11. In this manner an integral shielding of the female connector 4 is obtained.

The metal frame 11 is bent perpendicularly to form a surface mount hold-down ledge 42 along the length of the connector 4. This ledge 42 is provided with a plurality of contact dimples 43 supporting the lower female housing part 9 and contacting the metallization of this housing part as can be seen in fig. 17.

The metal frame 11 also comprises three contact terminals 44 with a semi-circular end and a solder reservoir recess 45, which contact terminals 44 can be used to position and fix the connector 4 on a printed circuit board. In the embodiment described the contact terminals 44 provide a hold-down function to mount the connector on the printed circuit board. Further, the terminals 44 can be connected to a common ground of the printed circuit board to connect the shielding of the connector to ground. Recess areas 46,47 of the metal frame 11 have the function to properly position and accept corresponding protrusions of the outer shielding 5 of the male connector 2. This outer shielding 5 further contacts the end plates 27 which are provided with contact dimples 48 for this purpose.

When the female connector parts are assembled, the elongated openings between the ribs 33 are aligned with channels 49 in the tail unit 12, which channels 49 are separated by an intermediate wall 50 of insulating material. This intermediate wall 50 is provided with elongated pegs 35 engaging the elongated openings 36 of the central rib 33. At the end of each channel 49 an end wall 51 is provided as shown in fig. 17. During assembly of the female connector, the female contact elements 13 are straight and can pass through the channels 49 and the spacing between the end walls 51 and the intermediate and upper walls of the tail unit 12. When the housing parts 9, the metal frame 11 and the tail unit 12 are assembled, the tail sections 16 of the female contact elements 13 are bent 90° to provide the right-angled female connector. As can be seen in fig. 17, the rear side of the end walls 51, intermediate wall 50 and lower wall 52 are inclined to the front end, so that the tail sections 16 of the contact elements 13 can be sufficiently bent to obtain a right-angled rest position.

Figs. 18-20 show in a manner similar to figs. 4-6 successive manufacturing steps in manufacturing the male connector 2 of fig. 1. Fig. 18 shows a male housing part 6 made of insulating material having twenty-four grooves 7 for

receiving the male contact elements 8 and extending lateral to the longitudinal direction of the housing part 6. A strip of twenty-four male contact elements 8 interconnected by the carriers 22 and strip 24 is shown in fig. 18 and these contact elements 8 are mass inserted into the grooves 7, wherein the pilot holes 23,25 provide for an easy handling of the strip of contact elements during insertion. During the insertion step the male contact elements 8 are separated from the carriers 22. The assembly step of contact elements and housing part is the same as described with respect to the female housing part.

As described by reference to fig. 3, the male contact elements 8 are provided with retention protrusions 15 for retaining the male contact elements 8 in the grooves 7. Retention of the contact elements 8 in the housing part 6 occurs in the same way as described above. Two identical housing parts 6 with male contact elements 8 are assembled to obtain one male connector module 52 shown in fig. 20. Such a male connector module 52 can be mated with a female connector module 28 by inserting the module into the receiving space of the female connector module 28 as will be described later.

The housing parts 6 are selectively metallized at least at the surface opposite of the grooved surface with male contact elements 8. The metallized surface 53 is provided with protrusions 54 which are also metallized. These protrusions are fittingly received in openings 55. The surfaces 53 with protrusions 54 and openings 55 provide coupling surfaces for joining the housing part 6, the protrusions 54 and openings 55 being examples of coupling members. As the assembled housing parts 6 are identical, any waviness or curvature due to moulding of thin parts, is identical and opposite so that the mutual retention of the two housing parts by the protrusions 54 and openings 55 ensure a flat male connector module 52. The metallized protrusions 54 provide for a partial shielding between adjacent contact elements 8.

As can be seen in figs. 18-20, two of the contact elements 8 have a greater length providing for a first make, last break operation when mating and unmating the male and female connectors. The metallization of the protrusions 54 is indicated by a shading in a section of the male connector 2 shown in fig. 25. Fig. 26 shows an exploded view of one male connector module 52 with corresponding male contact elements 8 and fig. 27 shows a detail of the male connector module at a larger scale. The metallization 53 of the male housing part 6 is schematically indicated by a dashed line. This metallization 53 provides for the shielding between the two rows of male contact elements 8 of one connector module 52.

At both longitudinal ends the housing part 6 is provided with a coupling section 56 for connecting the male connector module 52 to the outer shielding 5. These coupling sections 56 are also metallized to connect the metallization 53 to the outer shielding 5. The coupling sections 56 are partially separated from the housing part 6 by a slot 57. Between the coupling sections 56 and the housing part 6 a raised edge 58 is provided as a stacking element. Two male connector modules 52 can be positioned with these raised edges 58 upon each other with the centre planes of the two connector modules 52 located at a distance of 2 mm from each other in the embodiment shown.

At the rear end of the housing part 6 protrusions 59 with sloping ends are provided, which protrusions less high than the raised edges 58. These sloping protrusions 59 allow for a free passage of thermal energy through the male connector 2.

Fig. 21 schematically shows a cross section of a male connector module 52 showing that the front end 60 of the housing parts 6 of the connector module 52 slightly tapers such that the front ends of the contact elements 8 are supported in air and can operate as a contact spring section 61. The location of the retaining protrusions 15 is such that the spring section 61 of the contact element 8 is in-

deed flexible.

Fig. 22 shows an exploded view of the male connector 2 of fig. 1 showing the outer shielding 5 as two shielding halves 62,63 and an inner shielding strip or plate 64 located between the two male connector modules 52. If such an inner shielding strip 64 is used the ends of this strip are received between the stacking elements 58 as shown in fig. 24. The distance of 2 mm between the centre planes of successive modules is in this case determined by the raised edges 58 and the thickness of the strip 64. The generally U-shaped shielding halves 62,63 can be interconnected by interconnection members 62' and 63' at the ends of their legs. In the interconnected position the shielding halves 62,63 provide an elongated receiving space for the two connector modules 52. The shielding halves 62,63 each have two slots 65 which during assembling the connector are slit into the slots 57 between the coupling sections 56 and the housing parts 6 and in the assembled situation shown in fig. 23 receive the body of these housing parts 6. As shown in fig. 23 the shielding provides the outer wall of the connector 2, which outer wall directly faces the contact elements 8.

The metallization of the coupling sections 56 provide for an interconnection of the metallization with the outer shielding 5. Between the slots 65 an opening 66 can be seen in fig. 22 for receiving an extension 64' of the inner shielding strip 64.

Fig. 24 schematically shows a cross section of the male connector 2 showing the location of the inner shielding strip 64.

The outer shielding 5 is provided with polarization and coding fingers 67 which during mating are received in the polarization and coding slots 41 of the tail unit 12 of the female connector 4. These polarization fingers 67 are provided with contact dimples 68 for contacting an optional metal cap (see fig. 35B) of the female connector 4 not shown in fig. 1. In fig. 23 the outer shielding 5 is further provided with optional hold down press-fit terminals 69 to con-

nect the outer shielding to a printed circuit board. At the rear end of the outer shielding 5, ridges 70 are provided for connection to the printed circuit board. At the backside of the male connector 2 plastic pegs 71 provide for a proper alignment of the male connector with respect to the printed circuit board or backpanel 1 where they are received in corresponding holes. The circuit strips 72a for the ridges 70 and holes 72b, 72c for the terminals 69 and the pegs 71, respectively, for mounting the connector on the printed circuit board and for accurately orientation and positioning of the modules are shown in fig. 1 and 31. The tail ends of the male contact elements 8 are surface mounted to contact pads 72d of the back panel also shown fig. 1 and 31.

Fig. 28 shows an alternative embodiment of the male connector of the invention which is made as a right-angled male connector 73. In this case a tail unit 74 is combined with the straight male connector 2, the tail unit 74 corresponding to the tail unit 12 of the female connector 4. Further, instead of male connector elements 8 with equal length, the length of the contact elements of successive rows will be different in this case. Although not shown in fig. 28, a metal mounting frame 11 can be used to interconnect the front housing and tail unit and to provide a hold-down and electrical connection to the printed circuit board as described with respect to the female connector.

As a further alternative embodiment, fig. 29 shows a female cable connector 75, wherein instead of the tail unit 12 a straight tail unit 76 is used to introduce the cable 77 into the connector 75.

Figs. 30A-30C show front views of three different embodiments of male connectors having four, six or eight rows of male contact elements 8, respectively. Accordingly, the male connector is provided with two, three, or four male connector modules 52.

Fig. 31 shows by way of example three male connectors 2 stacked end-to-end and mounted on a back panel 1.

The co-operation of the male and female contact

elements 8,13 during mating of the male and female connectors 2,4 and the mating operation will be explained by reference to figs. 32-36.

Fig. 32A schematically shows a part of a male housing part 6 with three grooves 7 wherein for the sake of simplicity a male contact element 8 is shown in the central groove 7 only. As can be seen in the drawings the spring portion 61 of the contact element 8 lies at a distance from the front end of the groove 7, so that the female contact element 13 will be guided and centred before contacting the contact element 8. Further only one female contact element 13 is shown wherein the female housing part 9 is only schematically indicated. The width of the grooves 7 is smaller than the width of the spring portion 17 of the female contact element 13 to facilitate the receipt of the spring portion by the groove. Fig. 32B shows section A-A of fig. 32A indicating the manner in which the contact dimple 18 is guided and centred by oblique sides 78 of the groove 7 in the male housing part 6. In this manner a centring of the female contact element 13 with respect to the groove 7 and thereby with respect to the male contact element 8 is obtained. Therefore, if due to manufacturing tolerances the longitudinal axis of the female contact elements 13 is slightly skew with respect to the longitudinal axis of the grooves and the male contact elements 8, the female contact element will be oriented by the male groove 7, wherein the mounting section 14 acts as a pivot, so that the tail section 16 is also centred.

When the male connector is further mated with the female connector 4, the full engagement position of figs. 32C and 32D is obtained, wherein the contact dimple 18 has wiped along the contact section 61 of the male contact element 8 and wherein the contact dimple 19 contacts the spring section 61. As shown in section B-B in fig. 32D, the spring section 17 of the female contact element 13 is slightly pressed upwardly into the groove 10 of the female housing part 9.

Fig. 33 partially shows a cross section of the fully mated connectors 2,4. The schematically indicated metallization 30,53 of the male and female housing parts 6,9 provides for a shielding surrounding each row of mated contact elements 8 and 13.

Figs. 34A and 34B show by way of example one female connector module 28 and one male connector module 52 unmated (fig. 34A) and mated (fig. 34B). In the mated position of fig. 34B the contact dimples 18,19 are contacting the male contact element 8, wherein the spring section 17 of the female contact element 13 provides for the required flexibility and contact force for contact dimple 18, whereas the free support of the spring section 61 of the male contact element 8 provided by the tapering front end 60 of the male connector module 52, provides for the flexibility and contacting force for the contact dimple 19. As noted above, in an alternative female contact elements 13 can be used having one contact dimple 18 at the front end only. However, to increase safety margins the use of two contact dimples 18,19 is generally desired in telecommunication applications for example. The provision of both contact dimples 18,19 on the female contact elements 13 only shows the advantage, that it is not necessary for two contact dimples to pass each other as would be the case if both male and female contact elements were provided with one contact dimple.

Fig. 34B further shows that the opening between the ribs 33 of the metal frame 11 provides a passage for the male connector module 52 in the fully mated position.

Figs. 35A and 35B show schematically cross sections of the male and female connectors 2 and 4 of fig. 1 in the unmated and mated positions, respectively. In fig. 35B the female connector 4 is provided with a metal cap 79. The contact dimples 68 of the outer shielding 5 contact the inner side of this metal cap 79.

Figs. 36A and 36B show as an alternative a right-angled male connector 80 and a straight female connector 81 in the unmated and mated positions, respectively.

Figs. 35 and 36 clearly show that the main elements of the male and female connectors 2,80 and 4,81 are the same in the straight and right-angled embodiments. Further, each connector is a modular construction of one or more male or female connector modules 52,28 and especially in case of a right-angled embodiment, each connector further comprising a metal frame 11 a tail unit 12. The connector design described thereby shows the advantage that a connector with a desired number of rows of contact elements can be provided using the same production tooling equipment. It is not necessary to design special customised moulds for customised housings. The mass insertion of the male and female contact elements 8,13 into the respective grooves 7,10 of the housing parts 6,9 provides for an efficient manufacturing. The contact element design as single beam contact elements allows the use of the mill-rolled surface of the starting strip material as contact surface, resulting automatically in a contact surface with low roughness without the necessity of additional manufacturing steps to reduce contact surface roughness. Moreover, the use of single beam contacts provides the possibility to increase the density of the contact elements by reducing the pitch between adjacent rows of contacts. Moreover the use of single beam contacts reduces the effective contact radiating surface, thereby minimizing intercontact interaction, i.e. reducing cross talk.

By way of example fig. 37 shows a backpanel 82 with at the left side a daughter board 83 and at the right side a daughter board 84. The daughter board 83 is connected to the backpanel by male and female connectors 85,86 of the prior art having four rows of male and female contacts. The daughter board 84 is connected to the backpanel by male and female connectors 2,4 of the present invention also having four rows of male and female contact elements 8,13. A comparison of the prior art male and female connectors 85,86 and the male and female connectors 2,4 of the present invention shows a significant reduction of the space occupied by the connectors and a significant increase in contact den-

sity.

A further advantage of the connectors of the invention described is the surface mount connection to the printed circuit boards. As also indicated in fig. 37, the surface mount connection of the contact elements 8,13 to the printed circuit boards 82,84 allows for a smaller pitch of the contact pads on the printed circuit boards. In view of the use of chamfered ends 21 of the contact elements 8,13 and the presence of the solder reservoir at the tail ends of the contact elements a reliable surface mount connection can be obtained despite tolerances in coplanarity of the tail ends of the connector elements and bow of the printed circuit board.

Figs. 38-40 shows by way of example a manner of providing solder balls in the recesses 20 of the female contact elements 13. To this end a string 91 of solder balls 92 interconnected by thin strips of solder material is taken from a supply reel 93, wherein twenty-four solder balls 92 are aligned with the tail ends 16 of the female contact elements 13. The solder balls 92 are arranged at substantially the same pitch as the contact elements. By means of a tool 94 the solder balls 92 each having a slot 95 are slid on the tail sections 16 as indicated by an arrow in fig. 38. The tool 94 has an array of positioning openings 97 for receiving the solder balls and channels 98 joining these openings for receiving the tail ends of the contact elements during pushing the solder balls on these tail ends. The first step of providing the solder balls 92 on the tail sections 16 is shown in step 1 of fig. 39. When the solder balls 92 are aligned with the recesses 20 as shown in step 2 of fig. 39, two compression tools 96 are moved towards each other as indicated by arrows in fig. 38 and fig. 39, step 3. The compression tools 96 flatten the solder balls 92 on the tail sections 16 and press the solder material into the recess 20. Fig. 40A schematically shows the way in which a solder ball is provided in a side view. When the solder balls 92 are mounted on the tail sections 16, the tail sections 16 of

the contact elements 13 can be bent along 90° as shown in fig. 40B.

Fig. 38 also shows a manner to provide the recesses 45 of the contact terminals 44 with a solder reservoir.

It is noted that although in the embodiment of figs. 38-40 solder balls are used, it is also possible to use solder material in other shapes. The use of the solder balls or other type of solder lumps results in the advantage that an accurately predetermined amount of solder material can be provided as a solder reservoir. Thereby there is no chance to cause short circuiting by an excess amount of solder material. The solder material used is preferably a preflux solder material. The interconnection strips break during soldering and the material flows to the tail ends and is sub-divided to the two adjacent tail ends.

Fig. 41A-41C show the way in which the solder reservoirs provided on the tail sections 16 of the contact elements 13 and the contact terminals 44 are used in practice. In the detail shown in fig. 41B it is indicated how the solder dot in the recess 20 reflows during soldering to provide the desired surface mount connection. The contact sections 44 are received in holes 97 of the printed circuit board where reflow of the solder towards the interface between the surface of the printed circuit board and the lower face of the ledge 42 of metal frame 11 occurs.

The invention is not restricted to the above described embodiments which can be varied in a number of ways within the scope of the attached claims.

CLAIMS

1. Connector, comprising a housing and a plurality of contact elements mounted in the housing, said housing having surfaces with grooves, wherein each contact element has a contacting portion received with play in a corresponding groove and a mounting portion fixed in the housing, characterized in that the housing comprises at least two interconnected housing parts having an elongated mainly rectangular flat shape, each housing part having a series of open grooves in one of the main surfaces, said grooves extending transverse to the longitudinal direction of the housing part along the full transverse dimension of the main surface, wherein the contact elements are made as single beam contact elements, each contact element having a contacting portion received with play in the groove and a mounting portion fixed in the groove.

2. Connector according to claim 1, wherein the housing parts are identical.

3. Connector according to claim 1 or 2, wherein the housing parts are made of plastic material and are selectively metallized, in particular at the surface opposite of the grooved surface.

4. Connector according to claim 1, wherein the housing parts are die-cast metal parts, wherein the contact elements are fixed in the grooves by insulating elements.

5. Connector according to any one of the preceding claims, wherein two housing parts are positioned with their grooved surface with contact elements directed towards each other and at a distance from each other to provide a female connector module enclosing a receiving space for a male connector module.

6. Connector according to any one of claims 1-4, wherein two housing parts having a flat main surface opposite of the grooved surface are positioned with their flat surfaces against each other to provide a male connector module having opposite grooved surfaces with contact elements

and adapted to be inserted into the receiving space of a female connector module.

7. Connector according to any one of the preceding claims, wherein the contact elements have a constant thickness.

8. Method for manufacturing a connector according to any one of the preceding claims, wherein a housing part is provided, said housing part having an elongated mainly rectangular flat shape and a series of open grooves in one of the main surfaces, said grooves extending transverse to the longitudinal direction of the housing part along the full transverse dimension of the main surface, wherein the contact elements are made as single beam contacts and are inserted into said grooves in a direction perpendicular to the main surface of the housing part.

9. Method according to claim 8, wherein a plurality of interconnected contact elements is provided, wherein the interconnected contact elements are inserted into the grooves of a housing part in one step.

10. Method according to claim 9, wherein the contact elements are separated from each other before insertion into the grooves.

11. Method according to claim 8, 9 or 10, wherein the contact elements each are provided with an insulating support element, wherein the supporting element is inserted into a groove and clampingly received in the groove.

12. Method according to claim 8, 9 or 10, wherein each contact element is provided with two retention protrusion, one at each longitudinal side, wherein during insertion the retention protrusions are forced into the material of the housing part.

13. Connector, comprising a housing and a plurality of contact elements mounted in the housing, said housing having surfaces with grooves, wherein each contact element has a spring portion received with play in a corresponding groove and a mounting portion fixed in the housing, wherein the spring portion is provided with a contact dimple pro-

jecting out of the groove, characterized in that the housing comprises at least one module of two interconnected housing parts having an elongated mainly rectangular flat shape and determining an intermediate receiving space, each housing part having a series of open grooves in a main surface adjacent the receiving space, said grooves extending transverse to the longitudinal direction of the housing part along the full transverse dimension of the main surface, wherein the contact elements are made as single beam flat contact elements, wherein the mounting portion of each contact element is fixed in a groove, wherein the mounting portion of the contact element is also provided with a contact dimple projecting towards the receiving space.

14. Connector adapted to be mated with a connector according to claim 13, comprising a housing and a plurality of contact elements mounted in the housing, said housing having surfaces with grooves, wherein each contact element has a spring portion received with play in a corresponding groove and a mounting portion fixed in the housing, characterized in that the housing comprises at least one module of two interconnected housing parts having an elongated mainly rectangular flat shape, each housing part having a series of open grooves in a main surface, said grooves extending transverse to the longitudinal direction of the housing part along the full transverse dimension of the main surface, wherein the housing parts of a module are joined at their main surfaces opposite of the grooved surfaces, wherein the contact elements are made as single beam flat contact elements mounted in said grooves, each contact element having a spring portion received with play in the corresponding groove and a mounting portion fixed in the groove.

15. Connector according to claim 13 or 14, wherein the housing parts of one module are identical.

16. Connector according to any one of claims 13-15, wherein the housing parts are made of plastic material and are selectively metalized, in particular at the surface opposite of the grooved surface.

17. Connector according to any one of claims 13-15, wherein the housing parts are die-cast metal parts, wherein the contact elements are fixed in the grooves by insulating mounting elements.

18. Contact element for a connector according to any one of the preceding claims, wherein the contact element is made as a single beam flat contact element comprising a tail section, a mounting section and a spring section.

19. Contact element according to claim 18, wherein the spring section is provided with a contact dimple and extends obliquely upwardly with respect to the mounting and tail sections.

20. Contact element according to claim 19, wherein the mounting section is provided with a contact dimple.

21. Contact element according any one of claims 18-20, wherein the mounting section is provided with two retention protrusions, one at each side of the flat contact element.

22. Contact element according to any one of claims 18-20, wherein the mounting section is provided with an insulating mounting element.

23. Contact element according to any one of claims 18-22, wherein the outer end of the tail section is chamfered.

24. Contact element according to any one of claims 18-23, wherein the tail section is provided with a solder reservoir.

25. Connector, comprising a housing and a plurality of contact elements mounted in the housing, said contact elements being arranged in rows and columns, characterized in that the housing comprises at least two modules, each module having two interconnected housing parts with an elongated mainly rectangular flat shape, wherein each housing part is provided with one row of contact elements, said modules being stacked in column direction.

26. Connector according to claim 25, wherein in row direction each module is provided with flat end surfaces,

wherein the distance between the first and last contact elements of a row of contact elements and the end surfaces is such that with two modules stacked in row direction the pitch of adjacent contact elements of stacked modules equals an integer times the pitch between successive contact elements in row direction.

27. Connector according to claim 25 or 26, wherein the transverse dimension of a module equals twice the pitch between successive contact elements in row direction.

28. Connector according to claim 25, 26 or 27, wherein each housing part is provided with a plurality of projecting pegs at a longitudinal edge for positioning the housing parts on a printed circuit board.

29. Connector according to any one of claims 25-28, wherein each housing part has one row of open grooves in a main surface, said grooves extending transverse to the longitudinal direction of the housing part along the full transverse dimension of the main surface, wherein the contact elements are made as single beam contact elements mounted in said grooves, each contact element having a contacting portion received with play in the corresponding groove and a mounting portion fixed in the groove.

30. Connector according to any one of claims 25-29, wherein all housing parts are identical.

31. Connector according to any one of claims 25-30, wherein the housing parts are made of plastic material and are selectively metallized, in particular at the surface opposite of the grooved surface.

32. Connector according to any one of claims 25-30, wherein the housing parts are die-cast metal parts, wherein the contact elements are fixed in the grooves by insulating elements.

33. Connector of the female type according to any one of claims 25-32, wherein two housing parts of one module determine an intermediate receiving space for a module of a connector of the male type, wherein the grooved surfaces with contact elements are directed towards the receiving

space.

34. Connector according to claim 33, comprising at least two stacked modules, wherein the outer surfaces of the adjacent housing parts of two successive modules are contacting each other.

35. Connector of the male type according to any one of claims 25-32, adapted to be mated with a female connector according to claim 33 or 34, wherein two housing parts of one module are joined at their main surfaces opposite of the grooved surface, their grooved surfaces with contact elements being directed away from each other.

36. Connector according to claim 35, comprising at least two stacked modules, wherein each housing part is provided with stacking element at each longitudinal end, the stacking elements of a module being aligned and determining said transverse dimension of one module.

37. Connector, comprising a housing and a plurality of contact elements mounted in the housing, said contact elements being arranged in rows and columns, characterized in that the housing comprises front and tail housing sections and an intermediate metal mounting frame mutually positioning and interconnecting the front and tail housing sections.

38. Connector according to claim 37, wherein the metal mounting frame is provided with location projections for mounting the connector on a printed circuit board.

39. Connector according to claim 37 or 38, wherein the front housing section comprises at least one module of two interconnected housing parts, each housing part having an elongated mainly rectangular flat shape and accommodating one row of contact elements, wherein the mounting frame and each housing part are provided with co-operating mounting members for positioning the housing parts with respect to the mounting frame and with respect to each other.

40. Connector according to claim 37, 38 or 39, wherein in row direction the dimension of the connector and the distance between the first and last contact elements of

a row of contact elements and the end of the connector is such that with two connectors stacked in row direction the pitch of adjacent contact elements of stacked connectors equals an integer times the pitch between successive contact elements in row direction.

41. Connector according to claim 39 or 40, wherein the tail housing section and the mounting frame are provided with co-operating mounting members for positioning the tail housing section with respect to the mounting frame.

42. Connector according to claim 39, 40 or 41, wherein the mounting members of the housing sections comprise protrusions and the mounting members of the mounting frame comprise holes for receiving the protrusions.

43. Connector according to claim 42, wherein the front housing section comprises at least two modules, wherein the adjacent housing parts of the modules are provided with protrusions engaging common holes of the mounting frame.

44. Connector according to claim 42 or 43, wherein the protrusions of the housing sections have a friction fit in the holes of the mounting frame.

45. Connector according to any one of claims 38-44, wherein the mounting frame is provided with an elongated slot and an elongated mounting bar at both sides of the slot for each module, wherein the mounting bar between successive slots is a common mounting bar for adjacent housing parts of successive modules.

46. Connector according to claim 45, wherein the edge(s) of each mounting bar adjacent a slot are provided with recesses, each recess providing a passage for a contact element.

47. Connector according to any one of claims 37-46, wherein the housing sections are selectively metallized, the metallizations of the front and tail housing sections being interconnected through the mounting frame.

48. Connector according to any one of claims 37-46, wherein the housing sections are made as metal parts, the

housing sections being interconnected through the mounting frame.

49. Connector according to claim 47 or 48, wherein the location projections of the mounting frame are made as contact sections for connecting the mounting frame to a ground of a printed circuit board.

50. Connector according to claim 47, 48 or 49, wherein the mounting frame is provided with a contact ledge with contact dimples contacting the outer side of the front housing section.

51. Connector according to any one of claims 38-50, wherein the mounting frame is provided with end plates for mutually positioning the housing part of a module.

52. Connector according to any one of claims 37-51, wherein the tail housing section is provided with wall parts for supporting tail sections of the contact elements, said wall parts being adapted to act as bending support for the tail sections of the contact elements.

53. Connector, comprising a housing and a plurality of contact elements mounted in the housing, said contact elements being arranged in rows and columns, said housing including at least two parallel surfaces with a row of elongated grooves, each groove accommodating a contact element, characterized in that the housing comprises at least one module of two interconnected identical housing parts having an elongated mainly rectangular flat shape, each housing part having a coupling surface with complementary coupling members opposite of a surface with said grooves, wherein the housing parts of a module are joined at their coupling surfaces by said complementary coupling members.

54. Connector according to claim 53, wherein the coupling members are made as projections and openings, wherein the projections of one housing part of a module are received with a friction fit in the openings of the other housing part of the same module.

55. Connector according to claim 54, wherein the projections and openings are elongated, the projections and

openings being arranged in aligned pairs of one projection and one opening, wherein the longitudinal axis of each pair extends parallel to the longitudinal axis of the grooves.

56. Connector according to claim 55, wherein each pair of one projection and one opening is located in between two grooves at the opposite surface of a housing part.

57. Connector according to any one of claims 53-56, wherein the housing comprises at least two stacked modules, wherein each housing part at the surface with the grooves is provided with a stacking element at each longitudinal end, the stacking elements of a module being aligned and determining a transverse dimension of one module which equals twice the pitch of the contact elements in row direction.

58. Connector according to any one of claims 53-57, wherein each longitudinal end of a housing part is provided with a coupling section for coupling the housing with a metal shielding.

59. Connector according to claim 58, wherein an inner shielding plate is provided between two stacked modules, wherein the ends of the inner shielding plate are received between the stacking elements of the stacked modules, the stacking elements together with the thickness of the inner shielding plate determining said transverse dimension.

60. Connector according to any one of claims 53-59, wherein the contact elements are made as single beam flat contact elements mounted in the grooves, each contact element having a constant thickness along its length and including a spring portion received with play in the corresponding groove and a mounting portion fixed in the groove.

61. Connector according to claim 60, wherein the housing part at the side of the spring sections of the contact elements is tapered to provide a gap between the housing material and the spring sections.

62. Connector according to any one of claims 53-61, wherein the housing parts are made of plastic material and are selectively metallized at least at the surface with coupling members.

63. Connector according to claim 54 and 62, wherein the projections are metallized.

64. Connector according to any one of claims 53-62, wherein the housing parts are metal parts, wherein the contact elements are fixed in the grooves by insulating mounting elements.

65. Connectors of the female and male type, each connector comprising a housing and a plurality of contact elements mounted in the housing, said housing having surfaces with grooves, wherein each contact element has a spring portion received with play in a corresponding groove and a mounting portion fixed in the housing, wherein in the female connector the spring portion is provided with a contact dimple projecting out of the groove, characterized in that in the male connector, the male contact elements are flat at least along their spring portion, the spring portion of the male contact elements lying at a distance from the front end of the grooves, wherein the grooves of the male housing have a width smaller than the width of the spring portion of the female contact elements, wherein during mating of the male and female connectors the grooves of the male housing each are adapted to receive the spring portions of the female contact elements and to guide and centre the same before contacting a male contact element.

66. Connectors according to claim 65, wherein the grooves of the male housing are provided with oblique sides for receiving and centring the contact dimple on the spring portions of the female contact elements.

67. Connectors according to claim 65 or 66, wherein the spring portion of the female contact elements extends obliquely outwardly out of the corresponding groove, wherein during mating of the male and female connectors the spring portions of the female contact elements after being centred by a groove of the male housing, each are adapted to be forced towards the groove of the female housing by the male contact element.

68. Connectors according to any one of claims 65-

67, wherein the mounting portions of the female contact elements each are provided with a contact dimple, wherein the flat spring portions of the male contact elements are adapted to contact the contact dimples of these mounting portions.

69. Connector of the female type, comprising a housing and a plurality of contact elements mounted in the housing, said housing having surfaces with grooves, wherein each contact element has a spring portion received with play in a corresponding groove and a mounting portion fixed in the housing, wherein the spring portion is provided with a contact dimple projecting out of the groove, characterized in that the spring portion of the contact elements extends obliquely outwardly out of the corresponding groove.

70. Connector of the male type, comprising a housing and a plurality of contact elements mounted in the housing, said housing having surfaces with grooves, wherein each contact element has a spring portion received with play in a corresponding groove and a mounting portion fixed in the housing, characterized in that the contact elements are flat at least along their spring portion, the spring portion of the male contact elements lying at a distance from the front end of the grooves, wherein the grooves of the housing each are adapted to receive the spring portions of female contact elements and to guide and centre the same before contacting a male contact element.

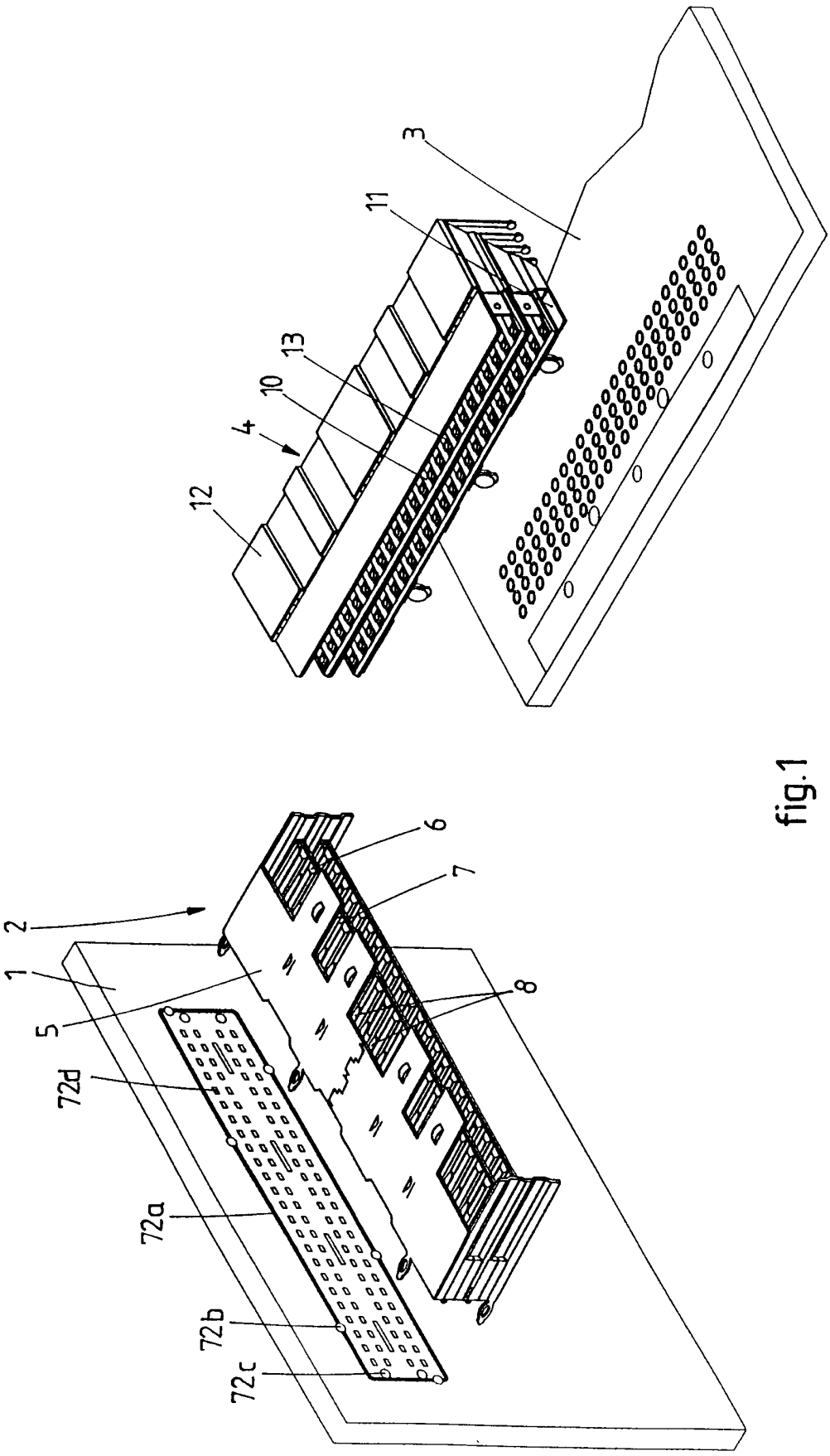


fig.1

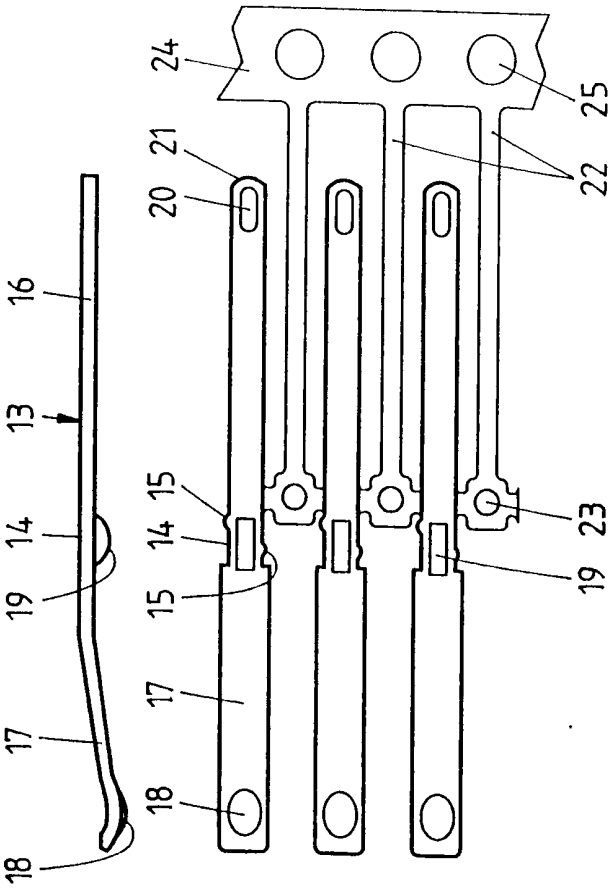


fig.2B

fig.2A

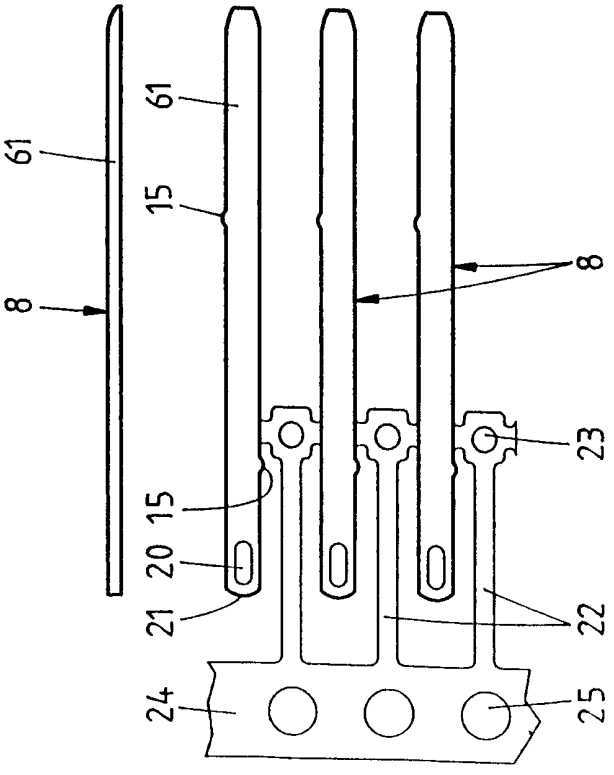


fig.3B

fig.3A

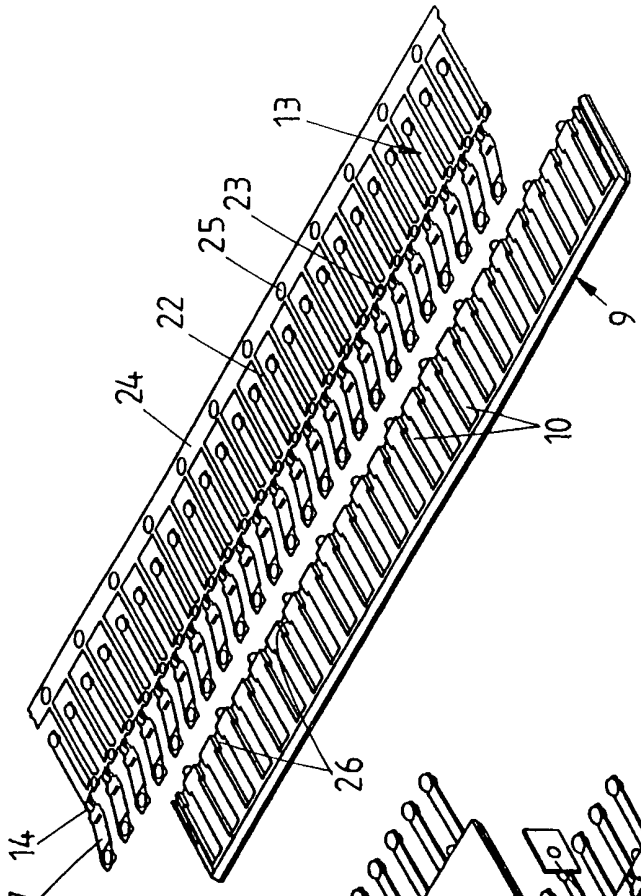


fig.4

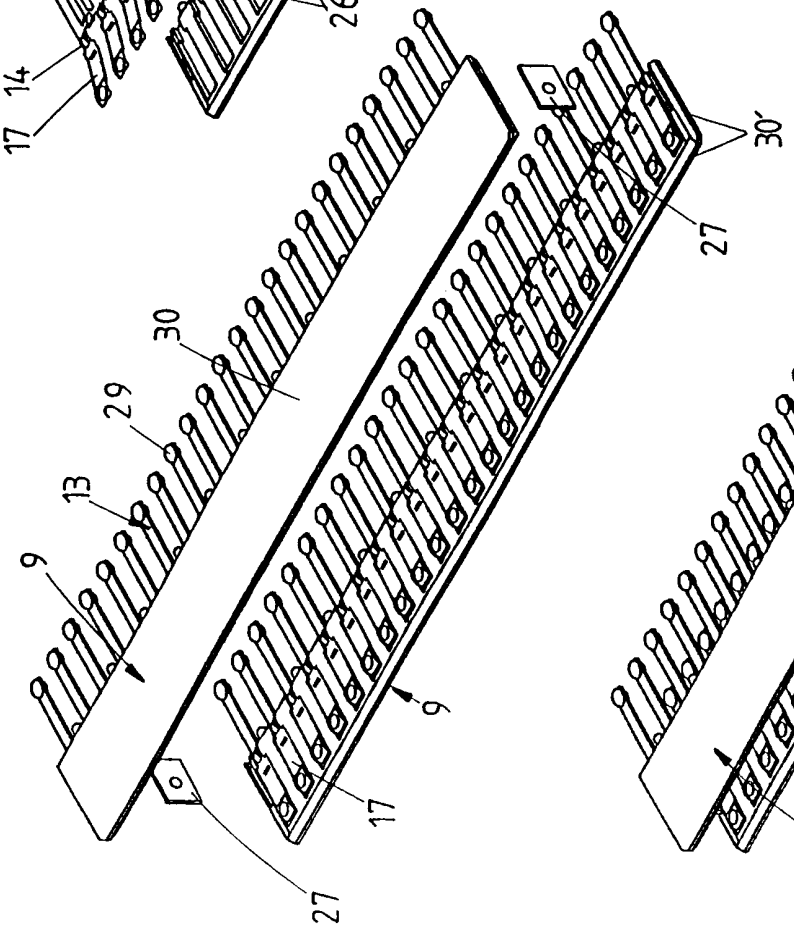


fig.5

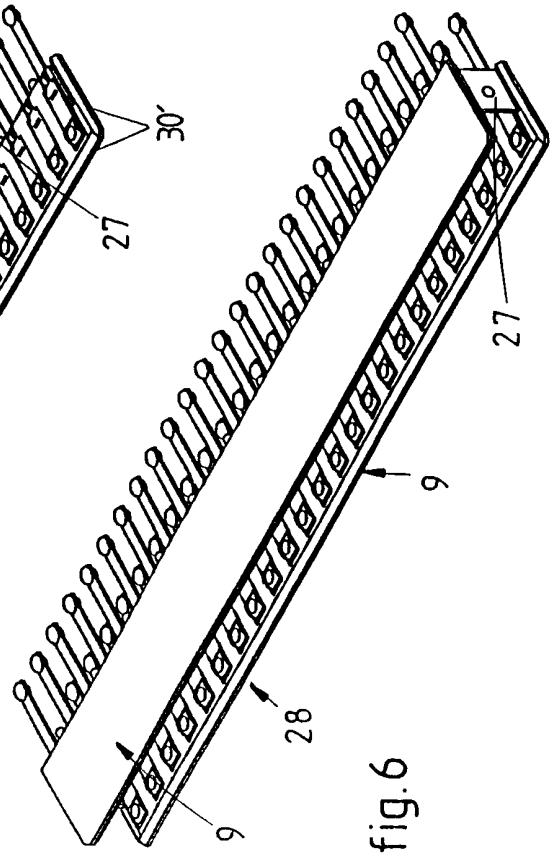


fig.6

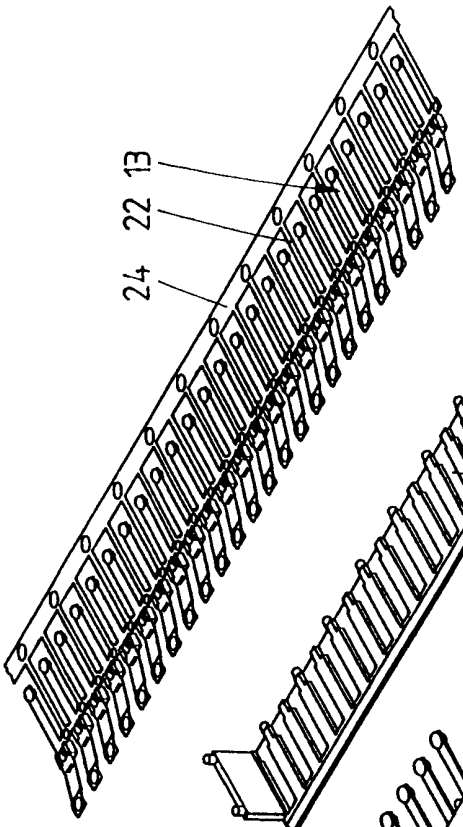


fig.7

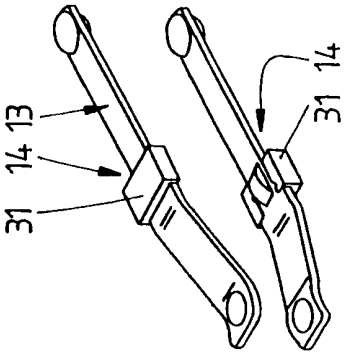


fig.10

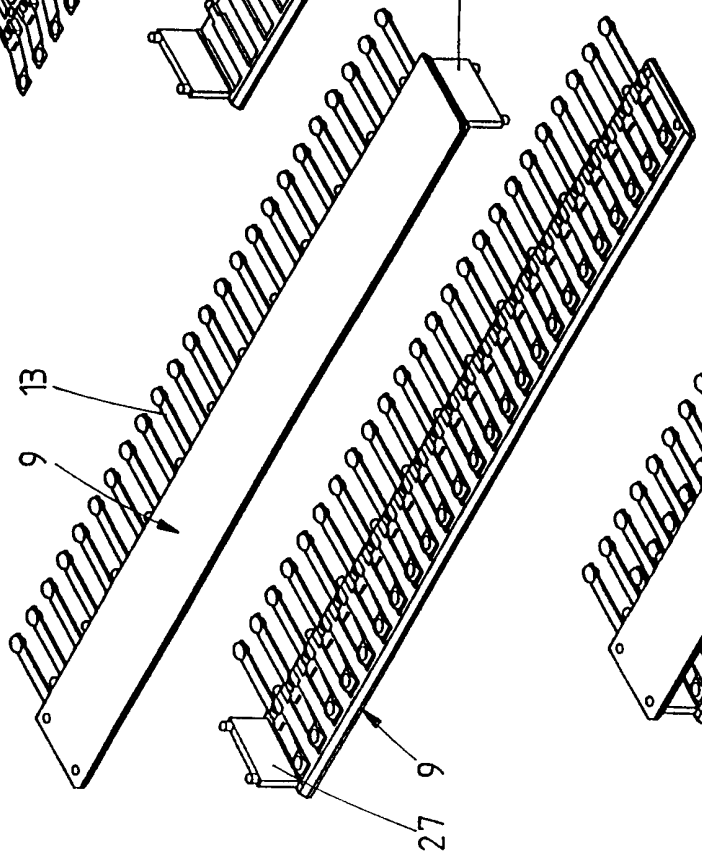


fig.8

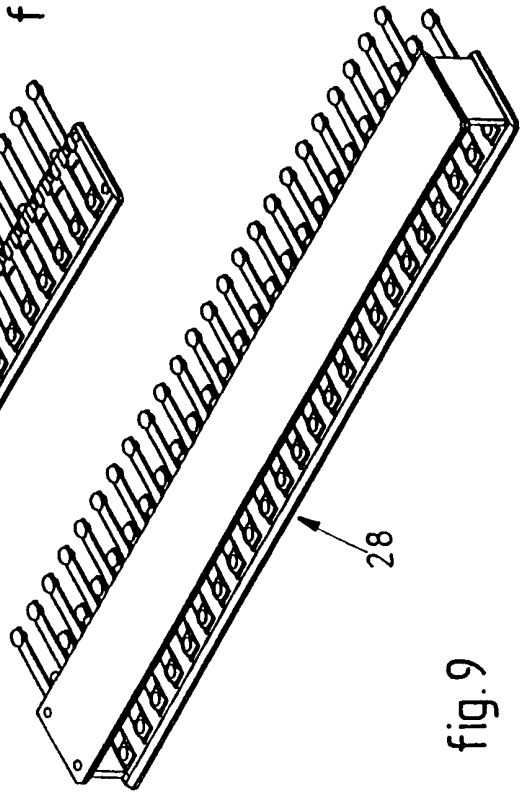


fig.9

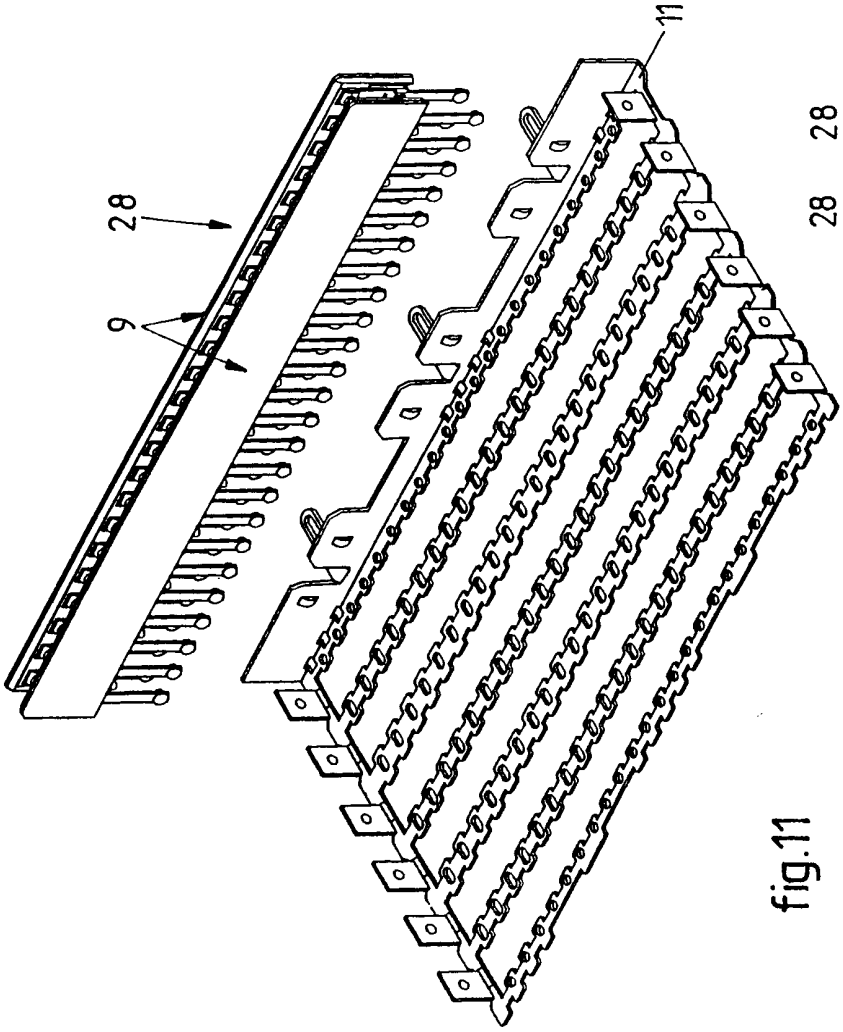


fig.11

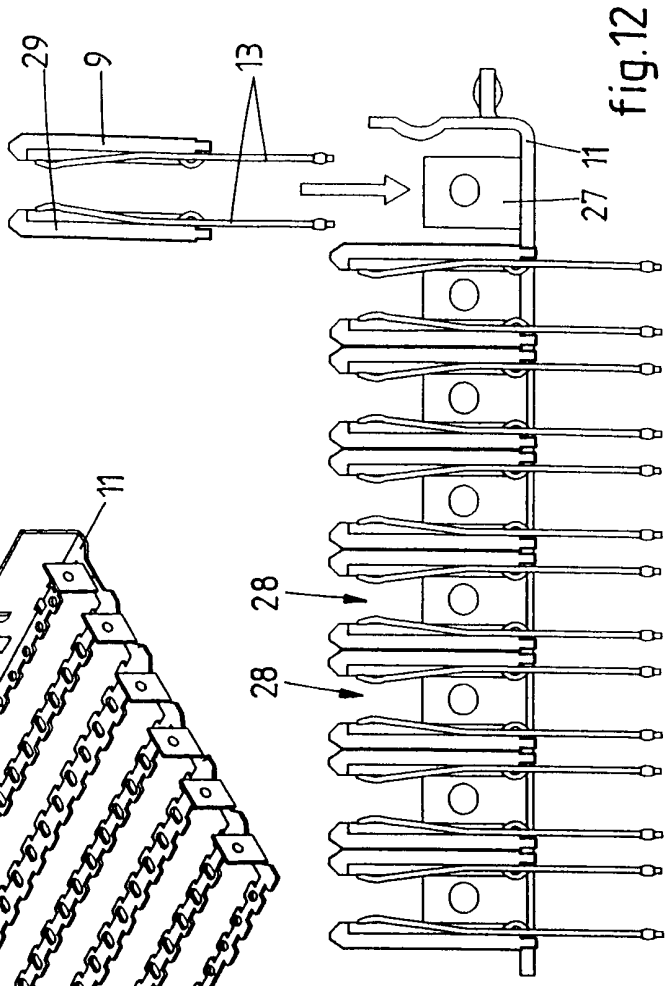


fig.12

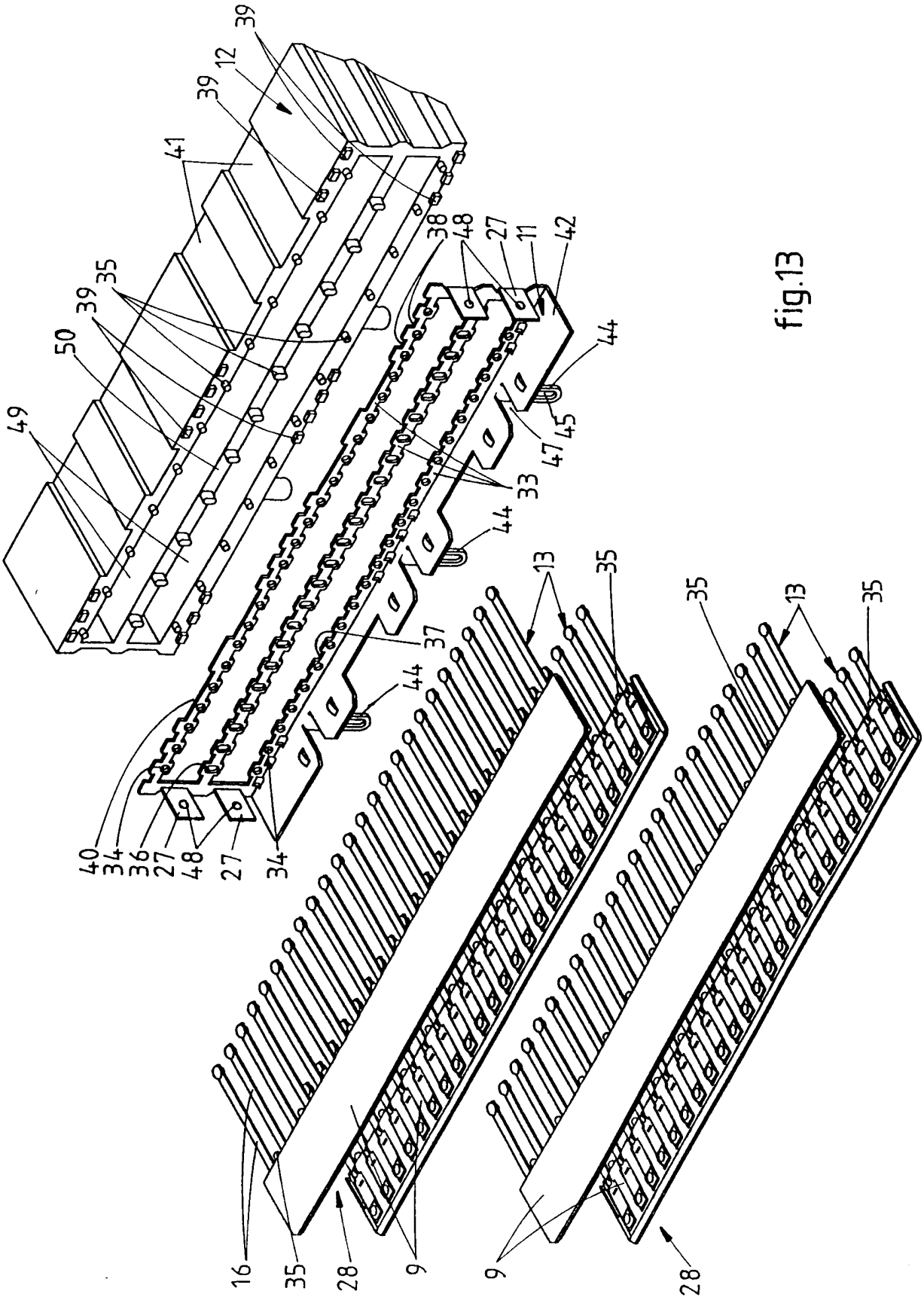

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fig.13

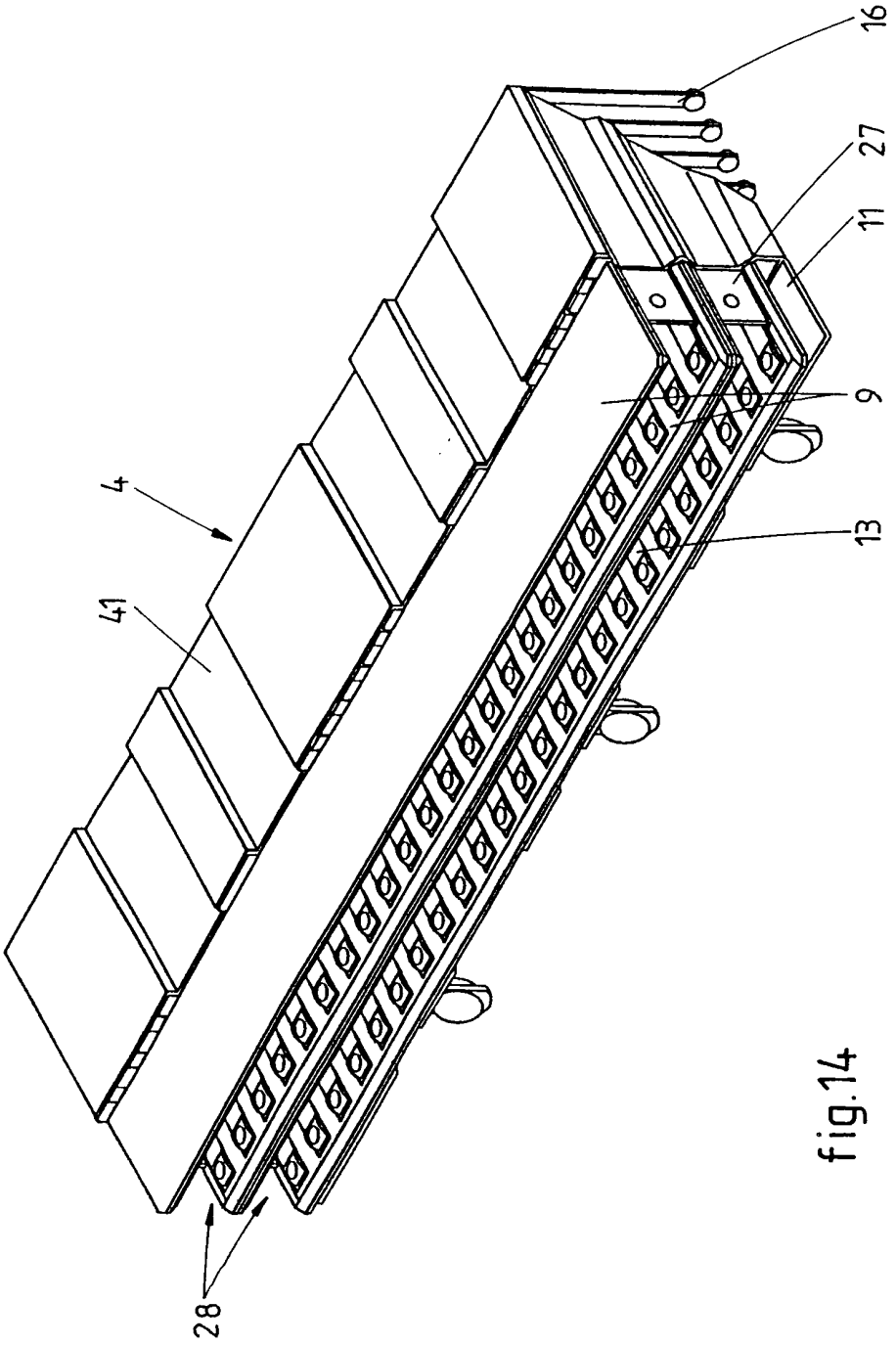


fig.14

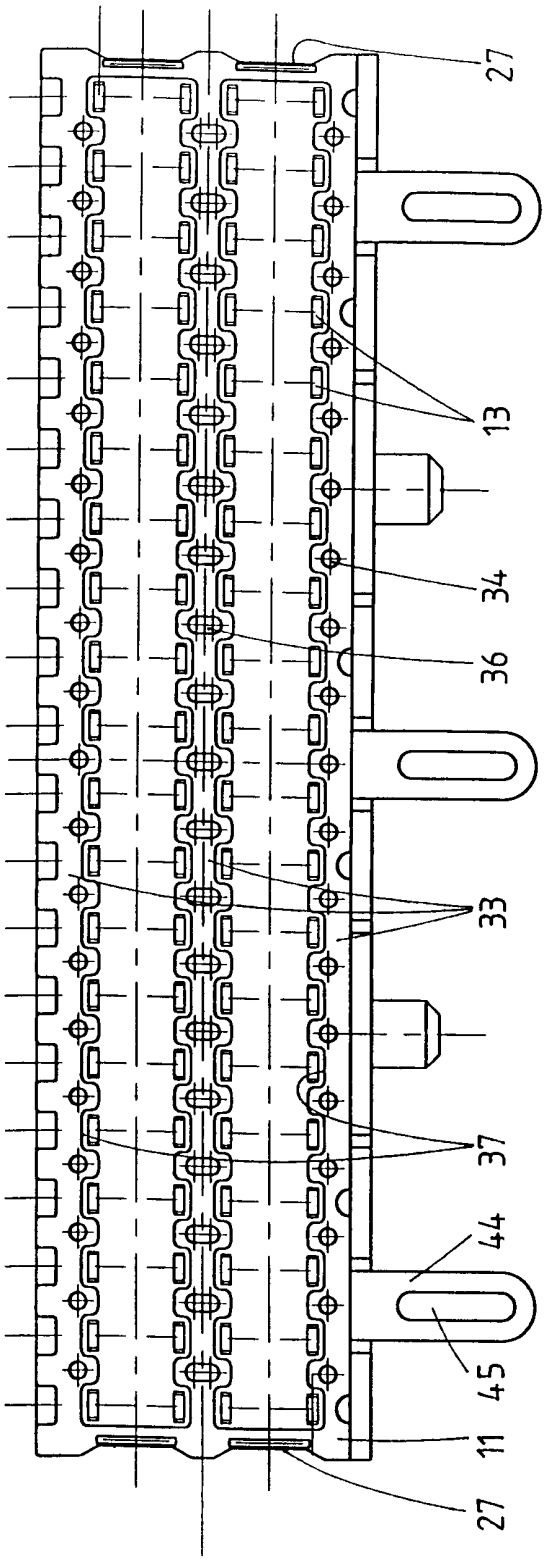


fig. 16

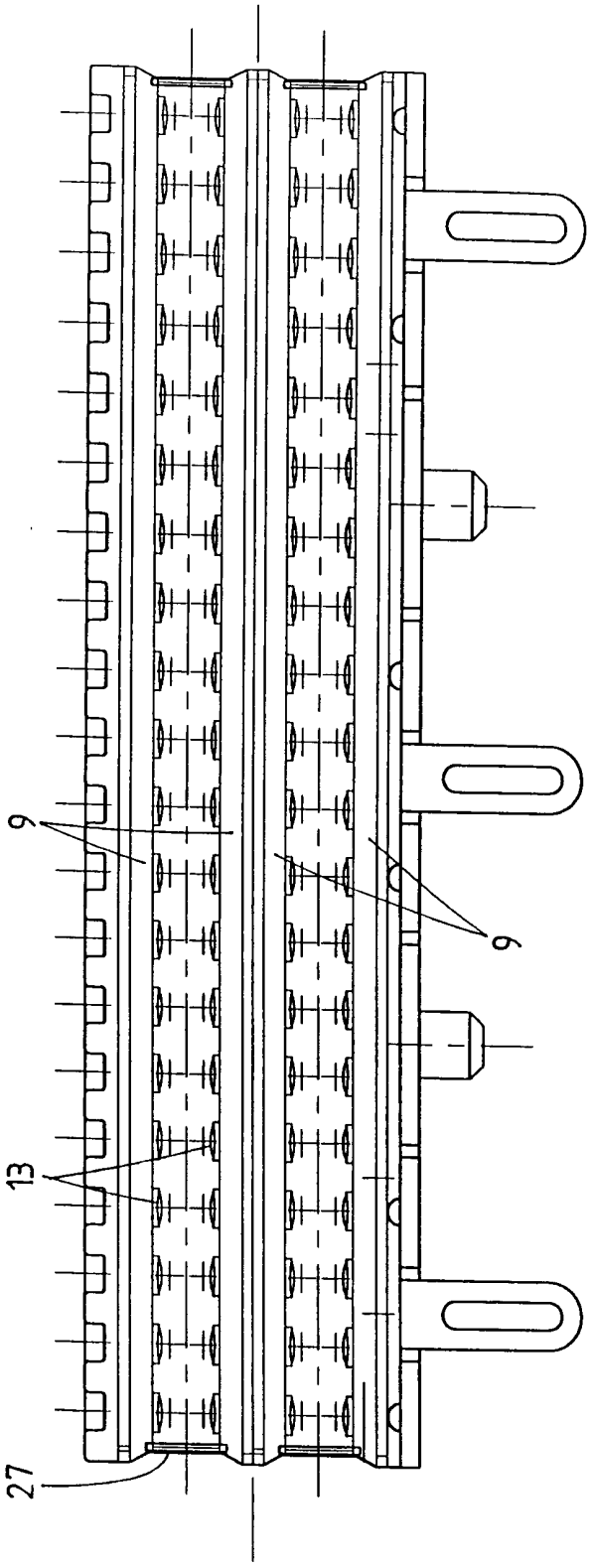


fig.15

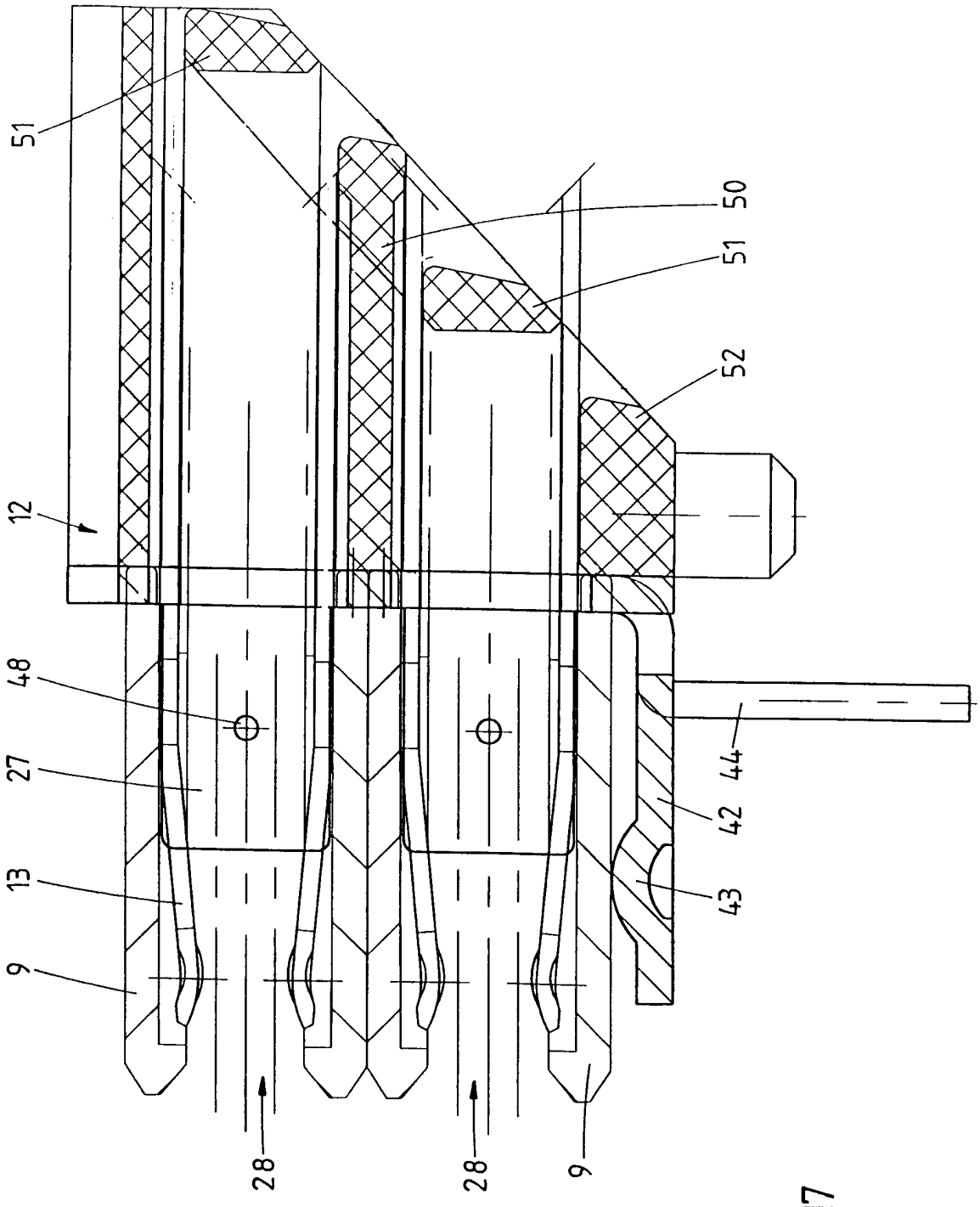


fig.17

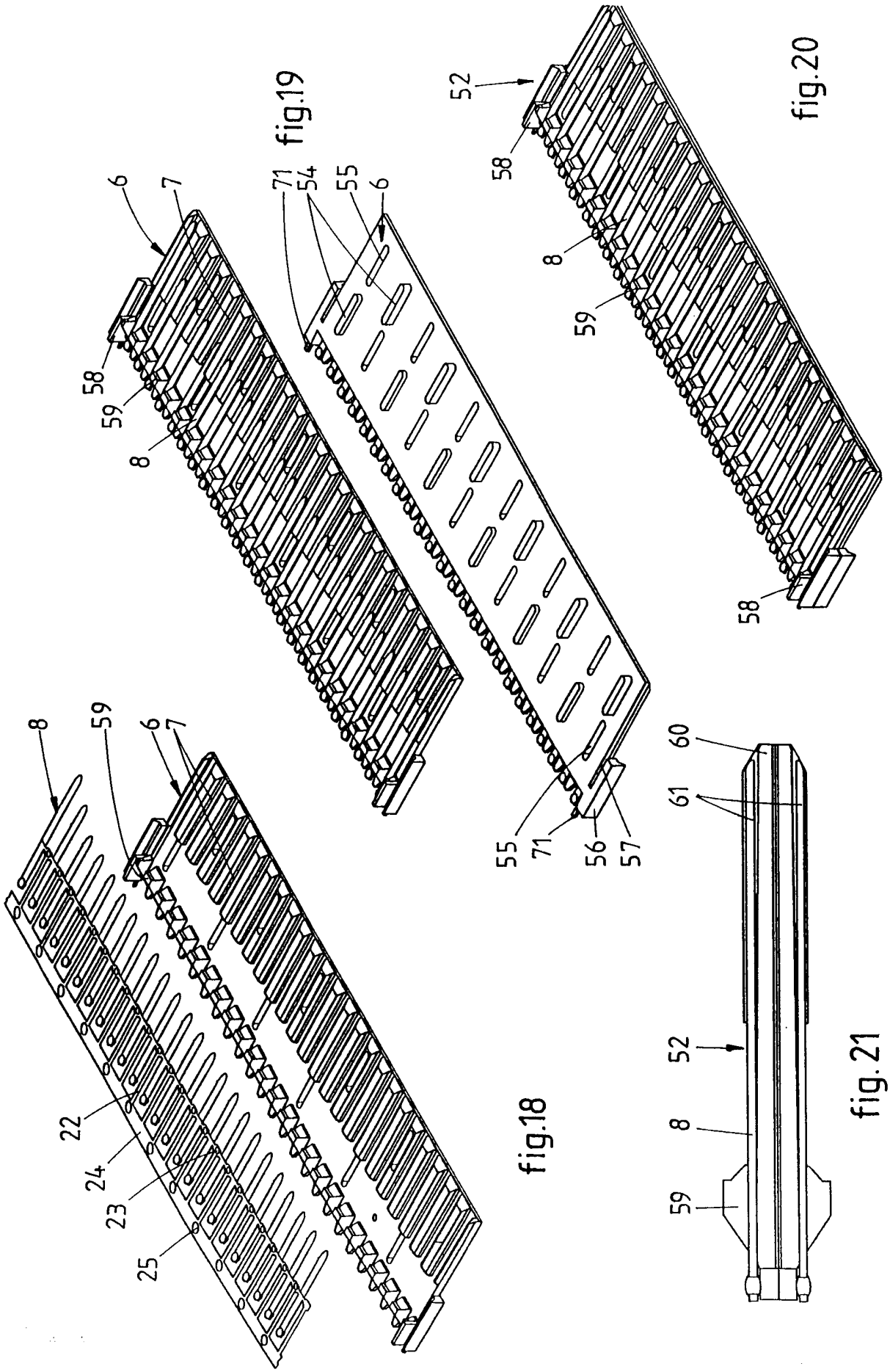


fig.18

fig.19

fig.20

fig.21

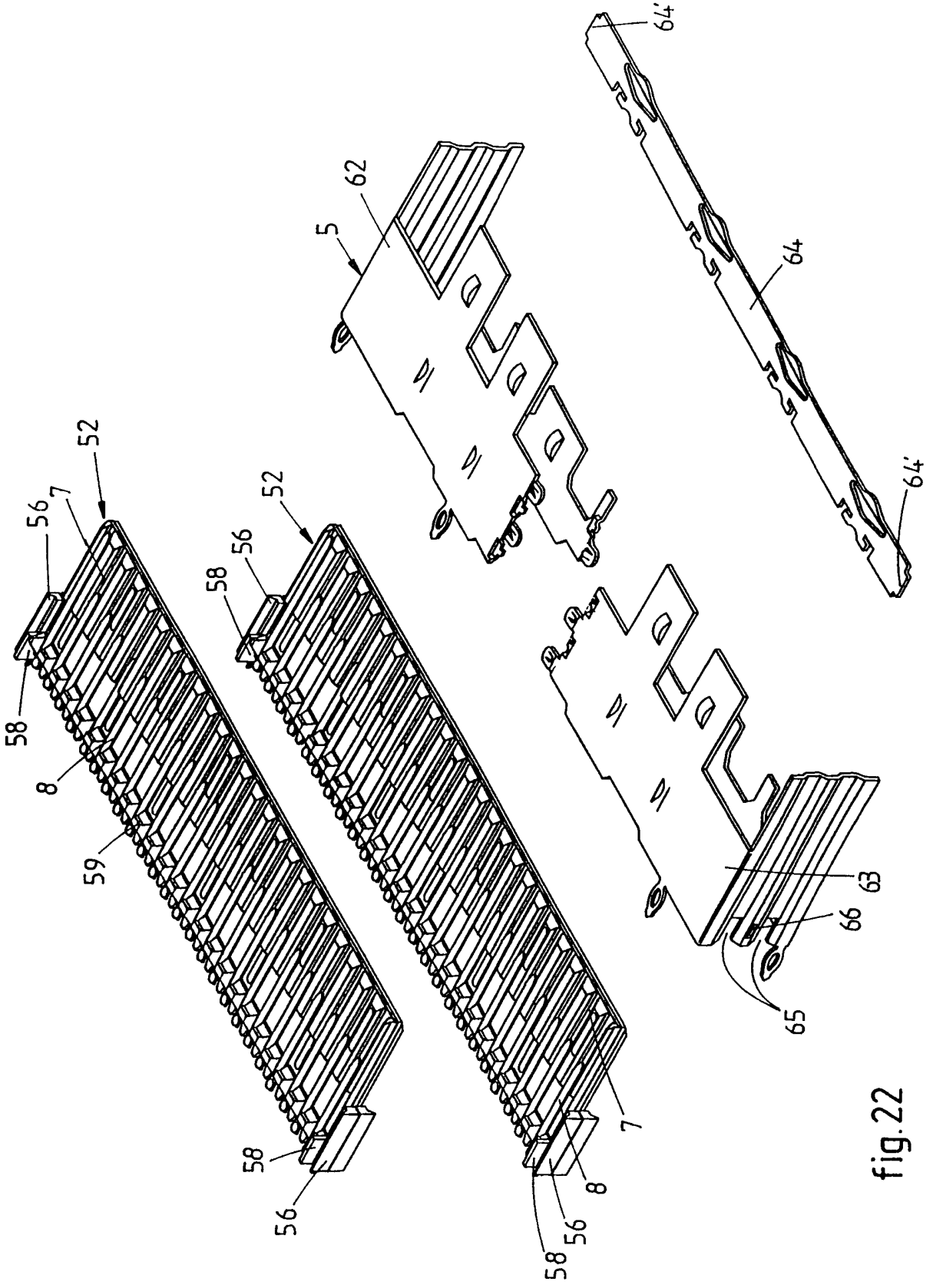


fig.22

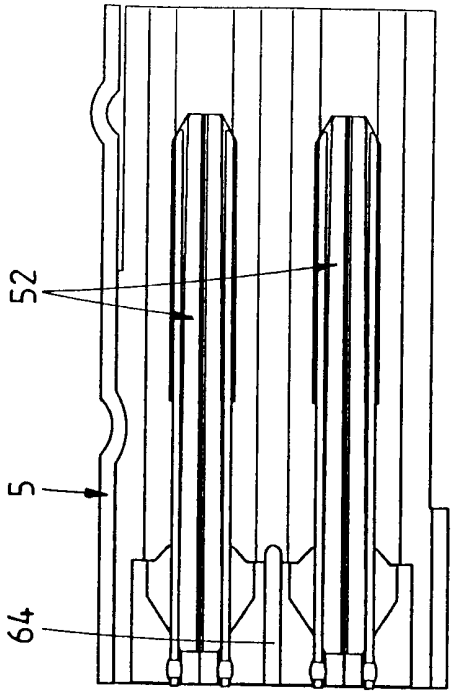


fig.24

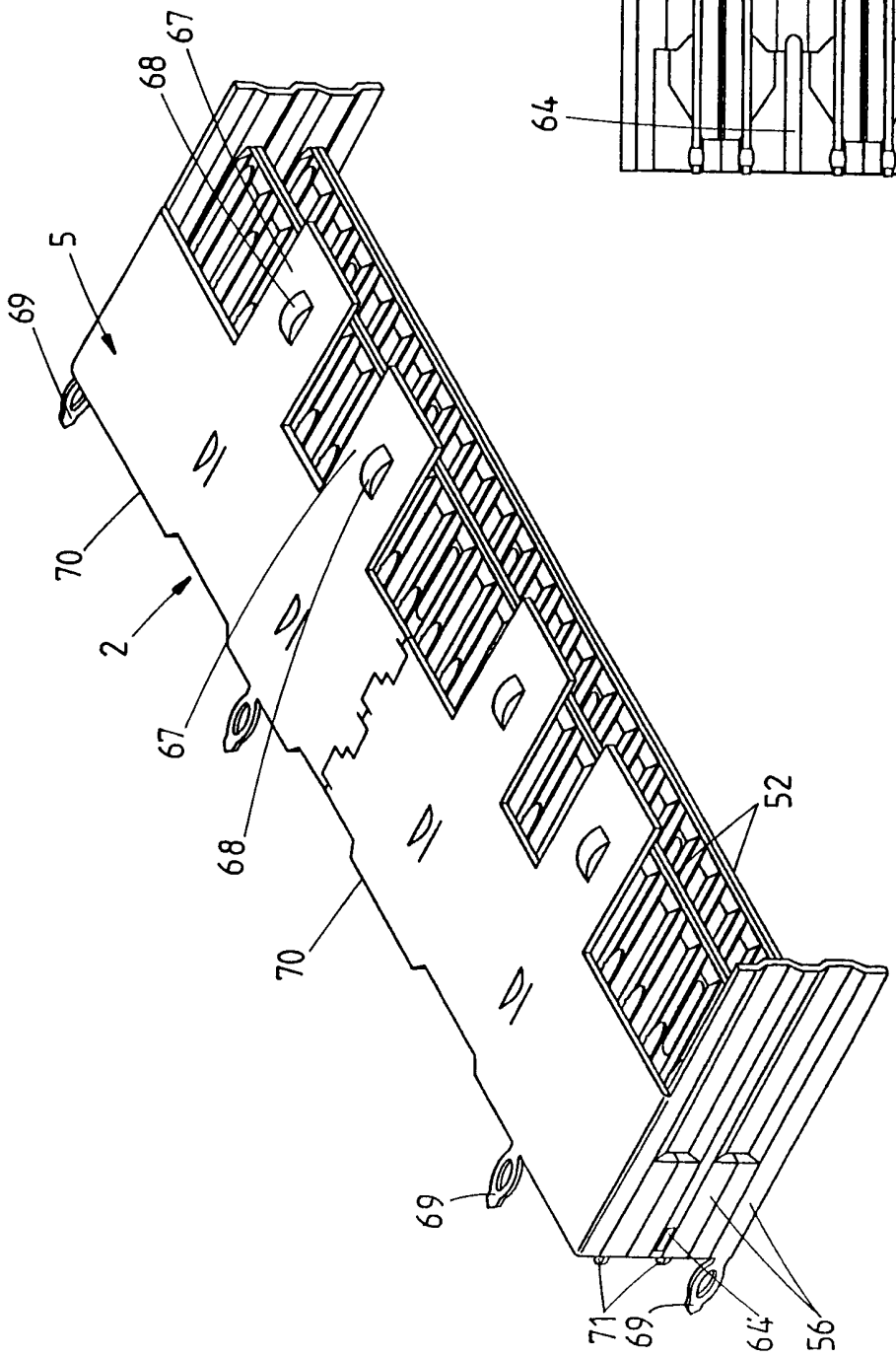


fig.23

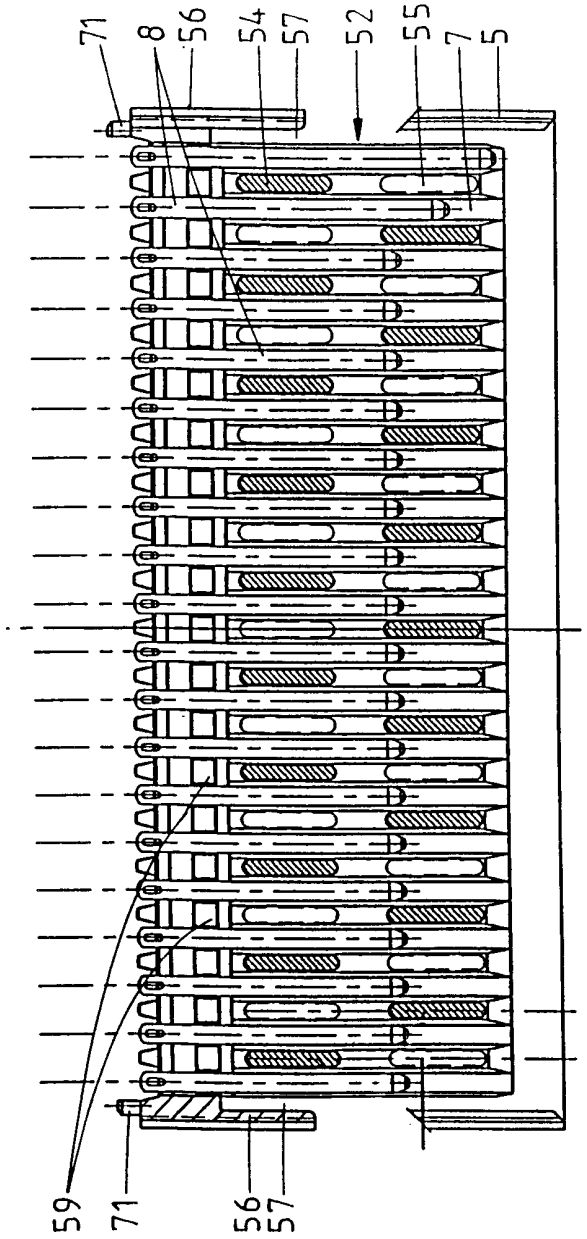


fig.25

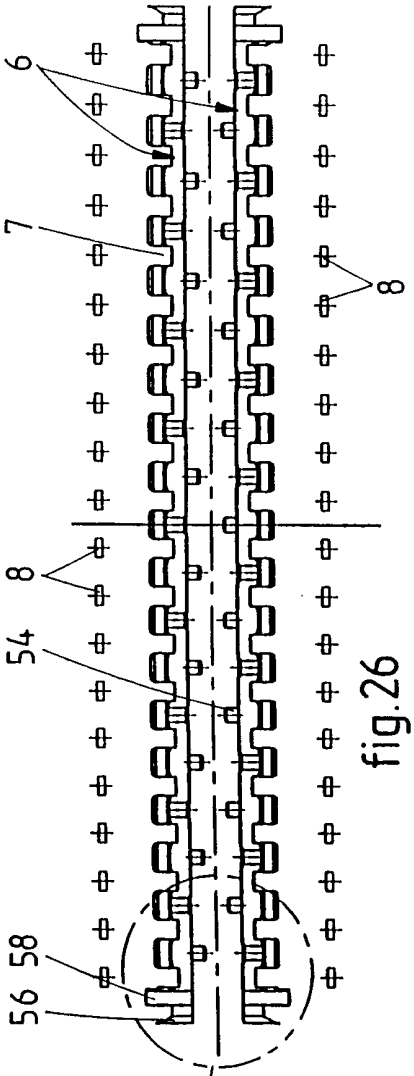


fig.26

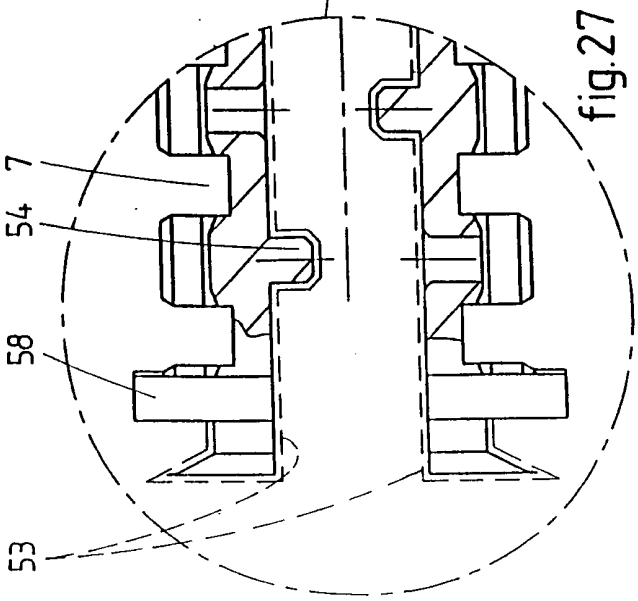


fig.27

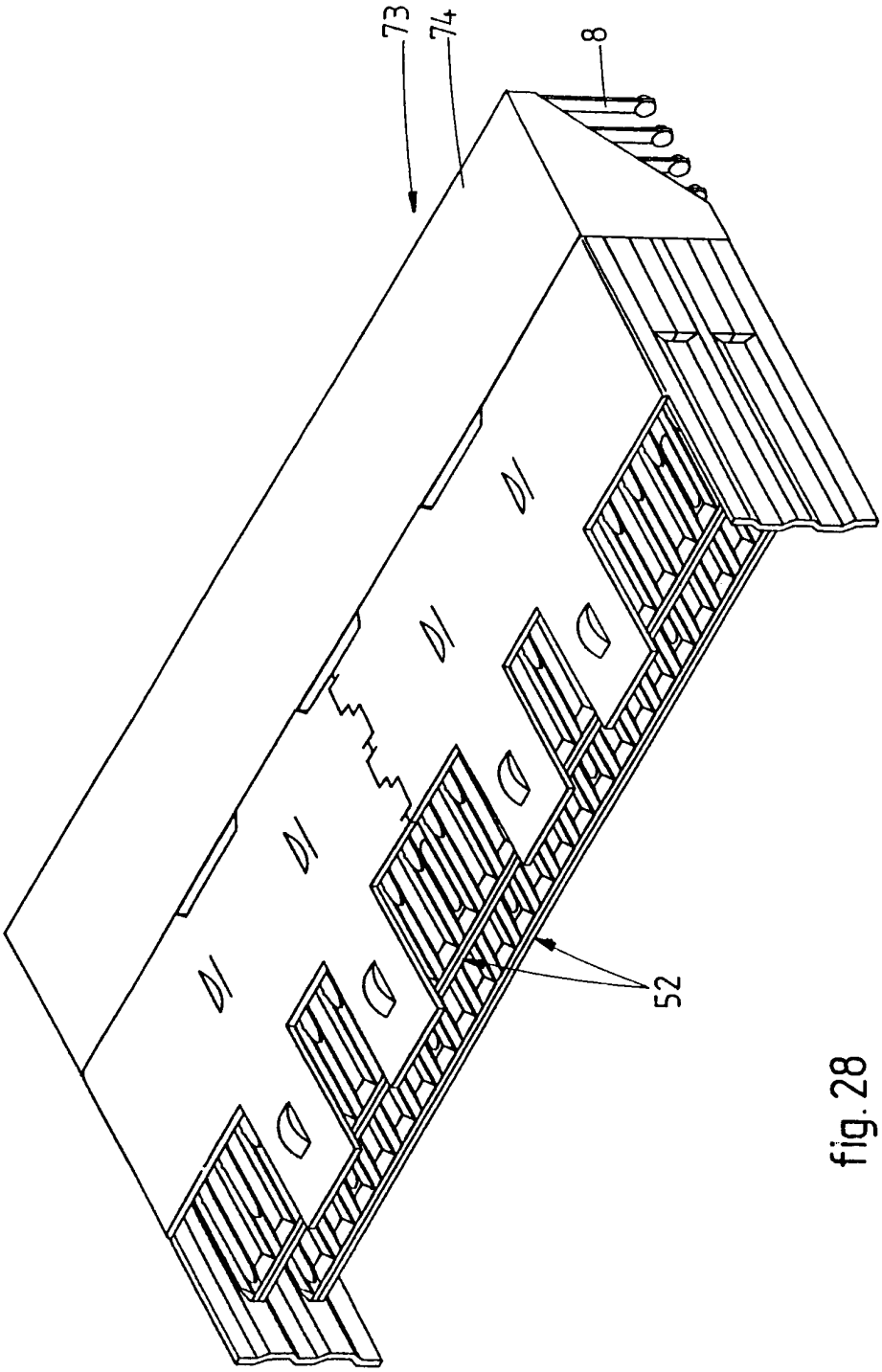


fig. 28

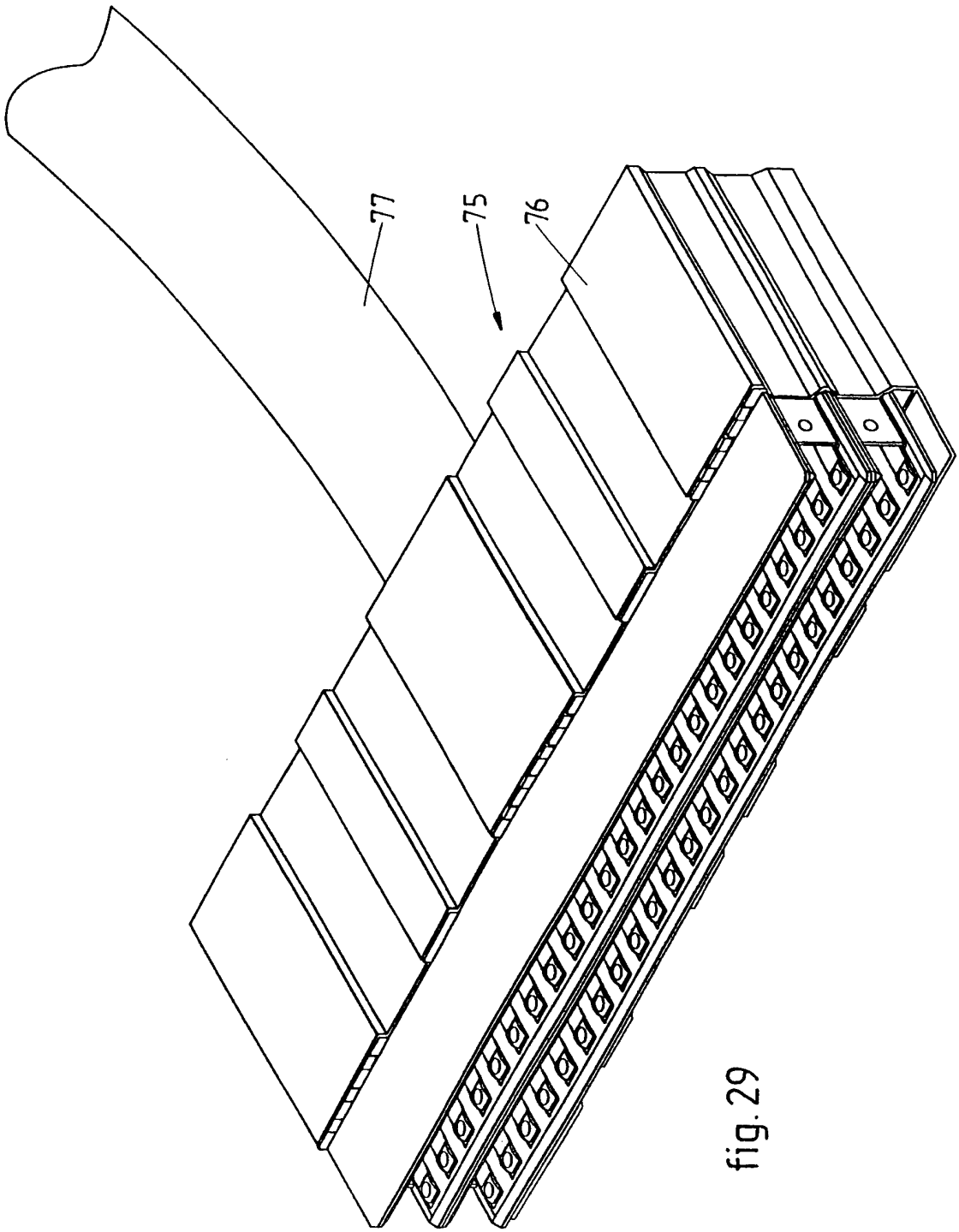


fig. 29

fig.30A

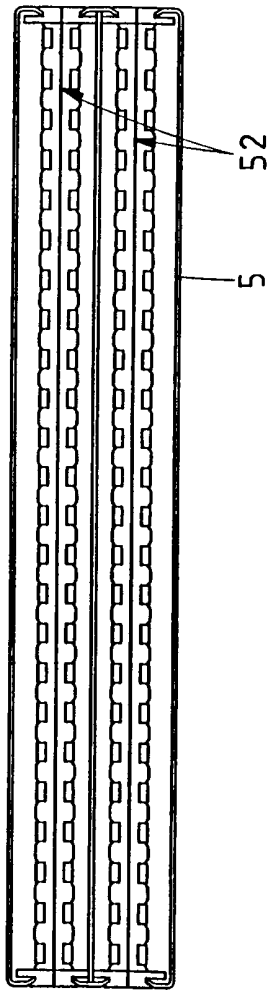


fig.30B

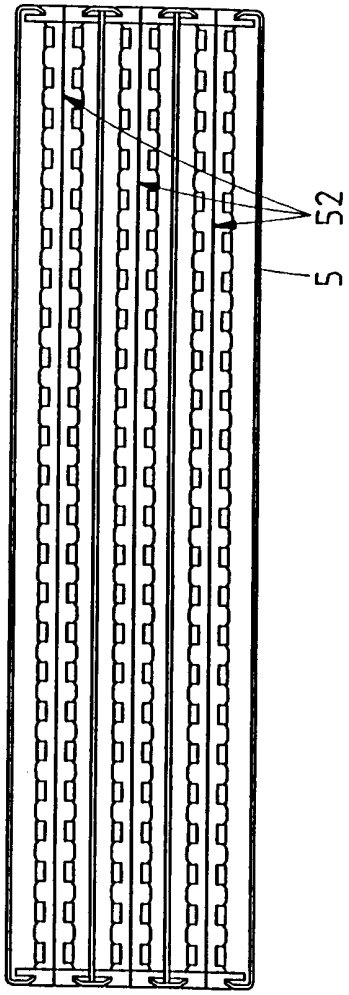
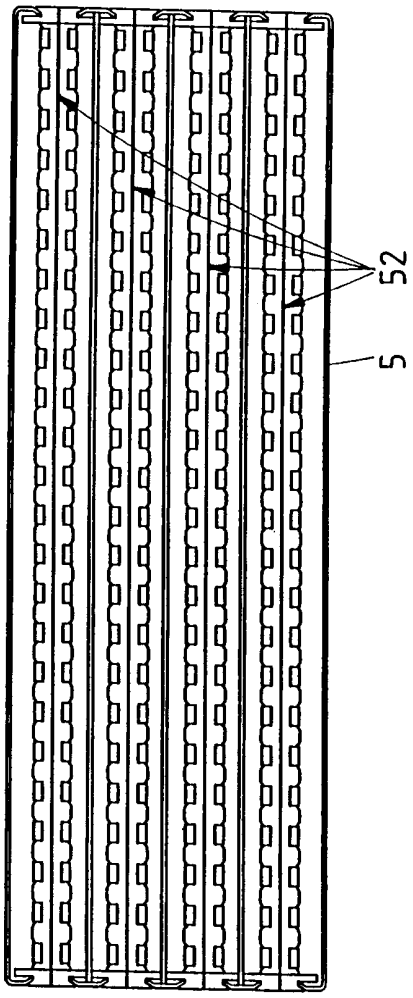


fig.30C



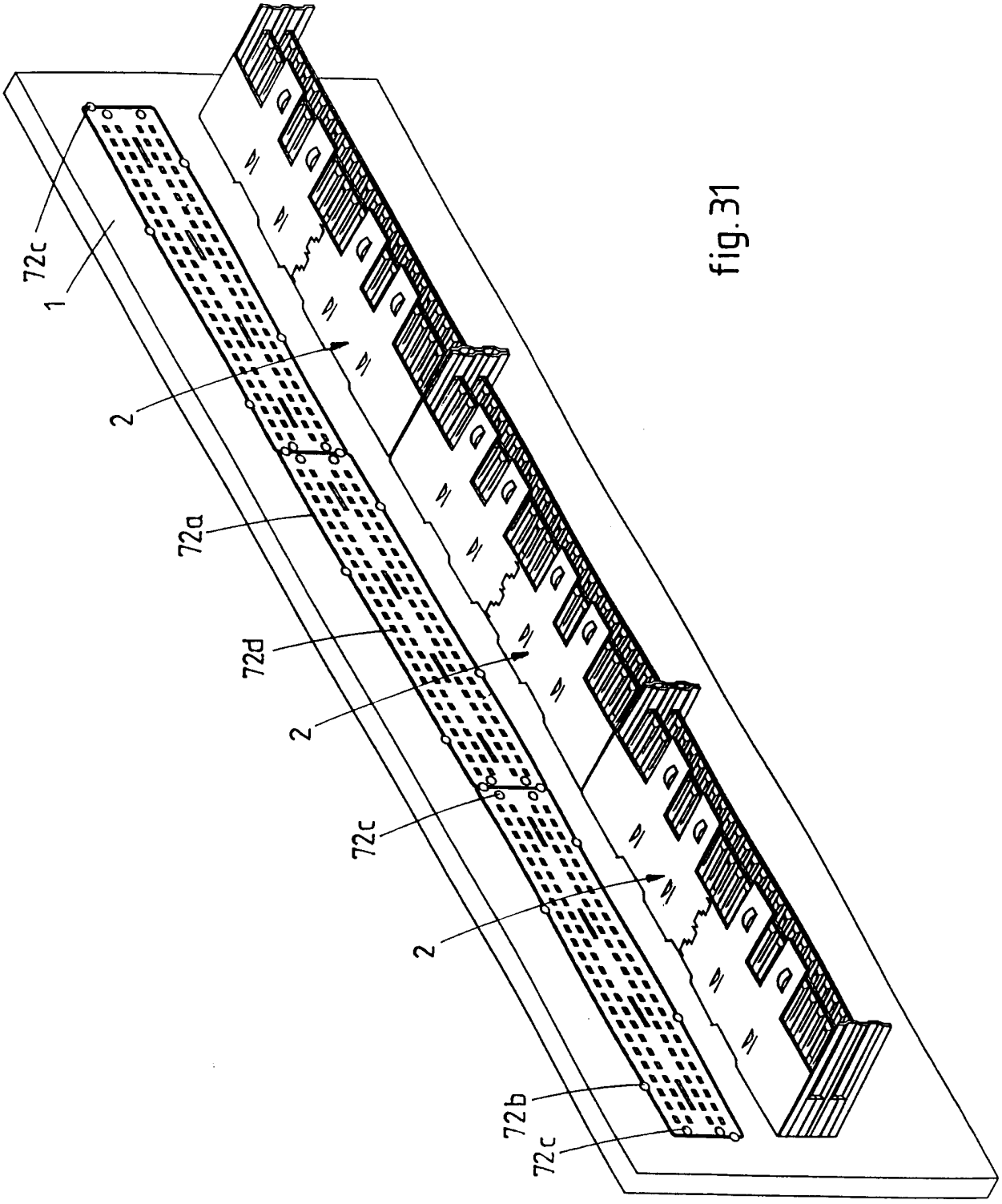


fig.31

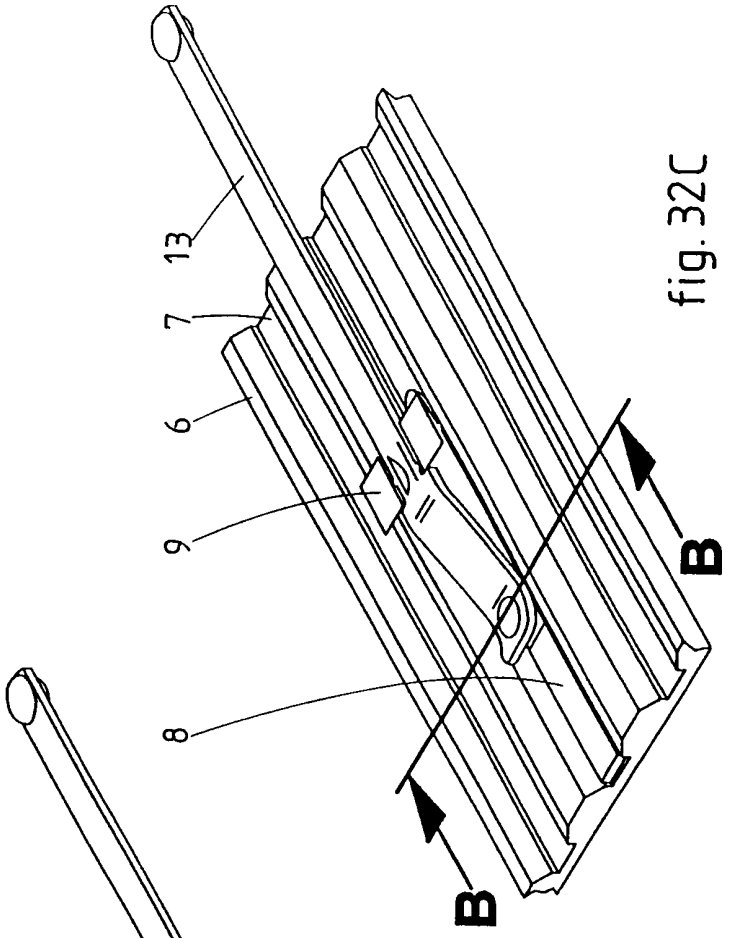


fig.32C

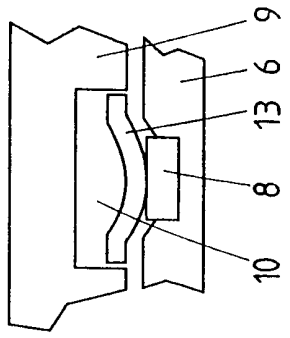


fig.32D

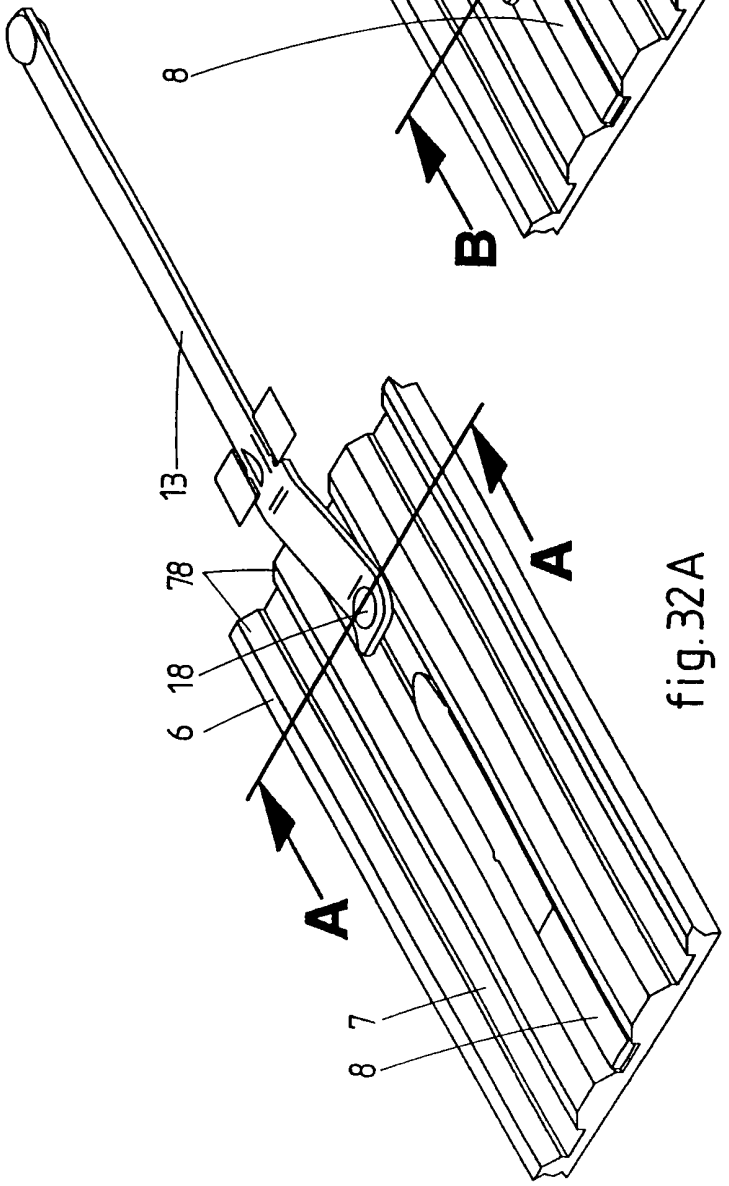


fig.32A

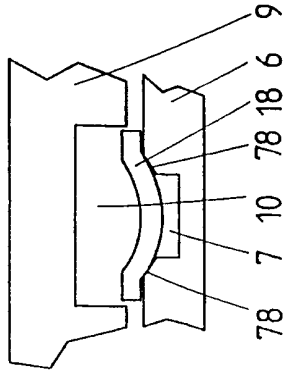


fig.32B

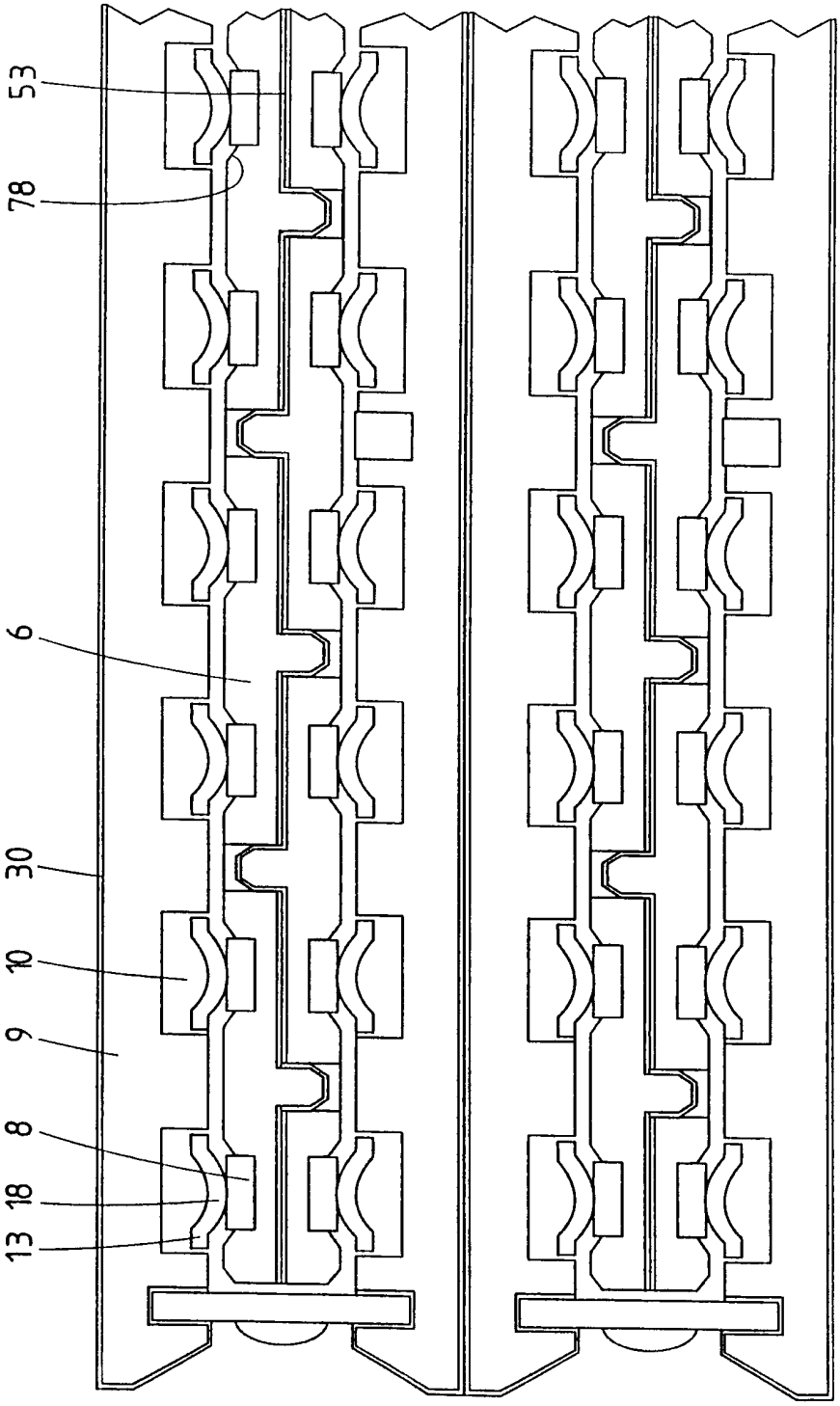


fig.33

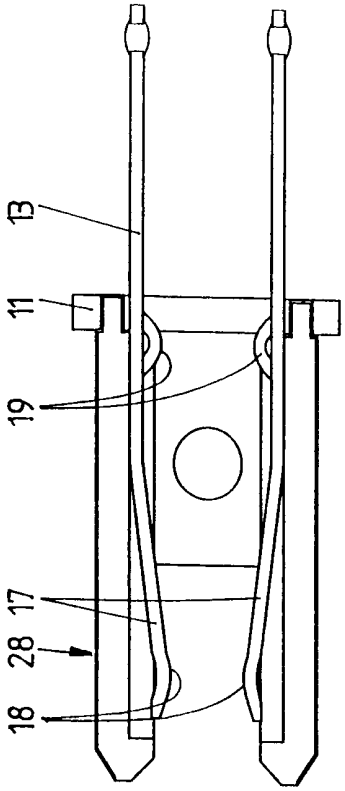


fig.34A

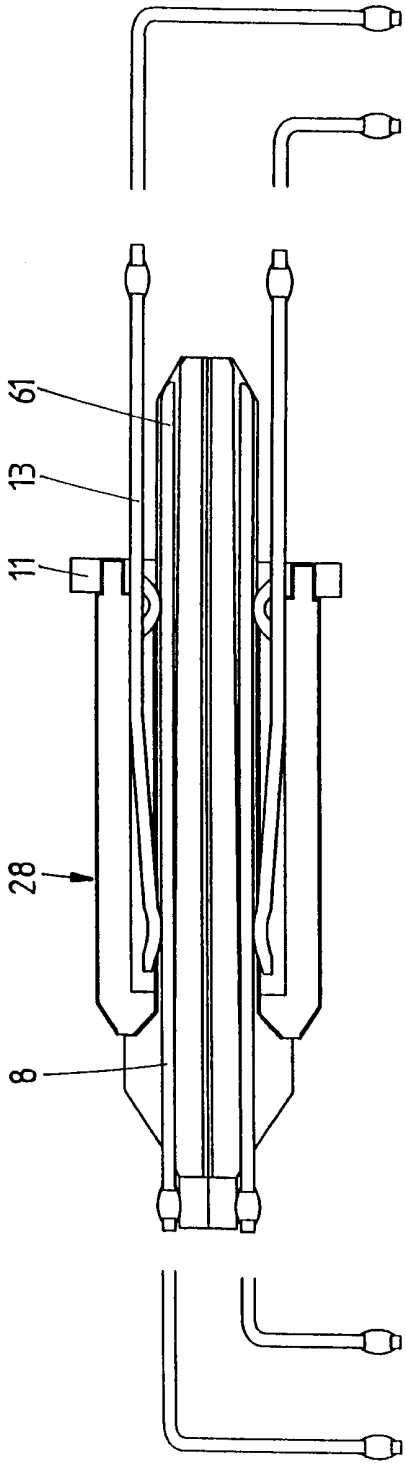
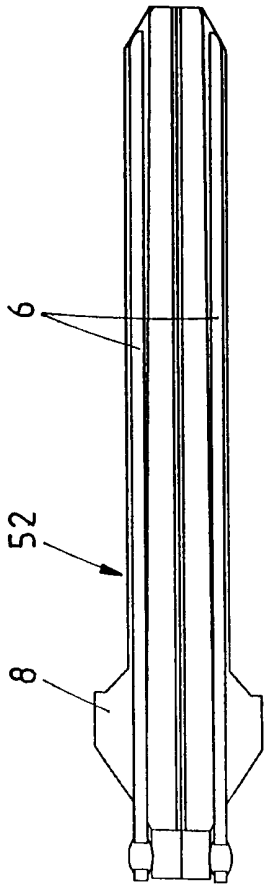


fig.34B



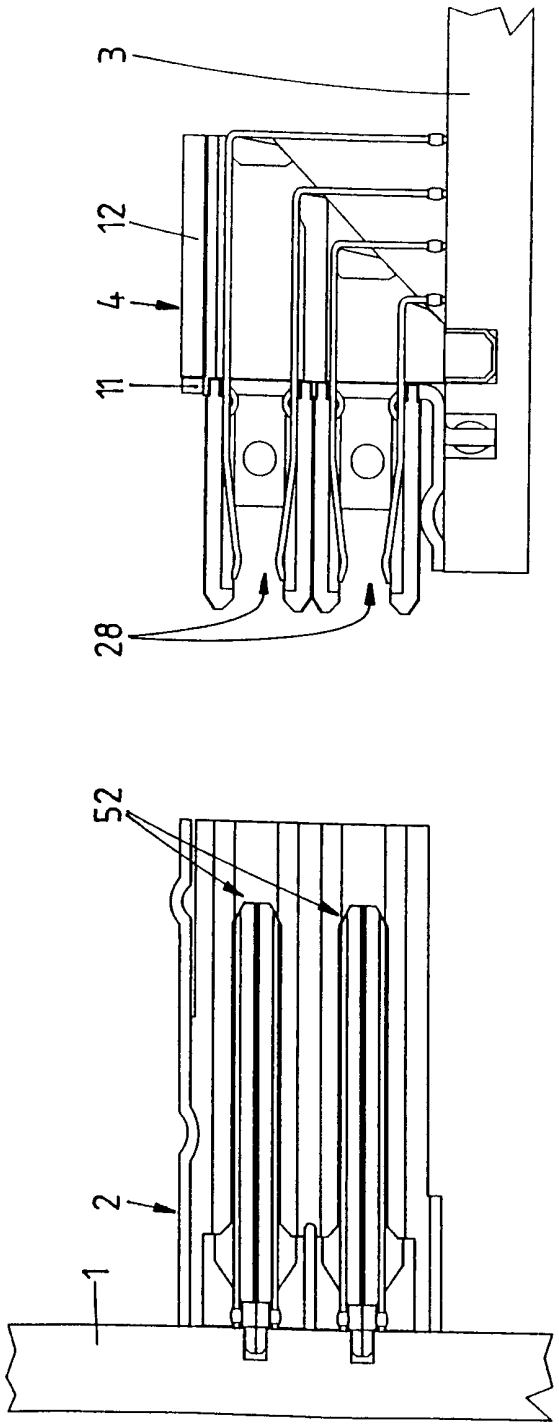


fig.35A

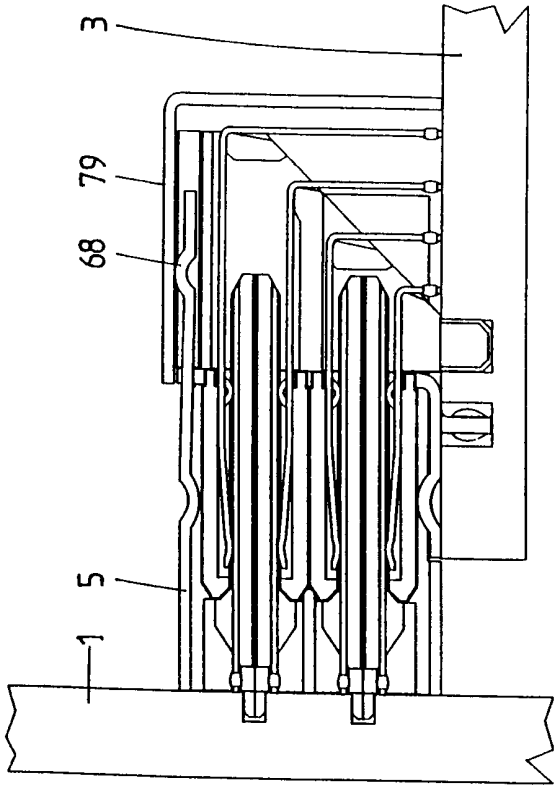


fig.35B

fig.36A

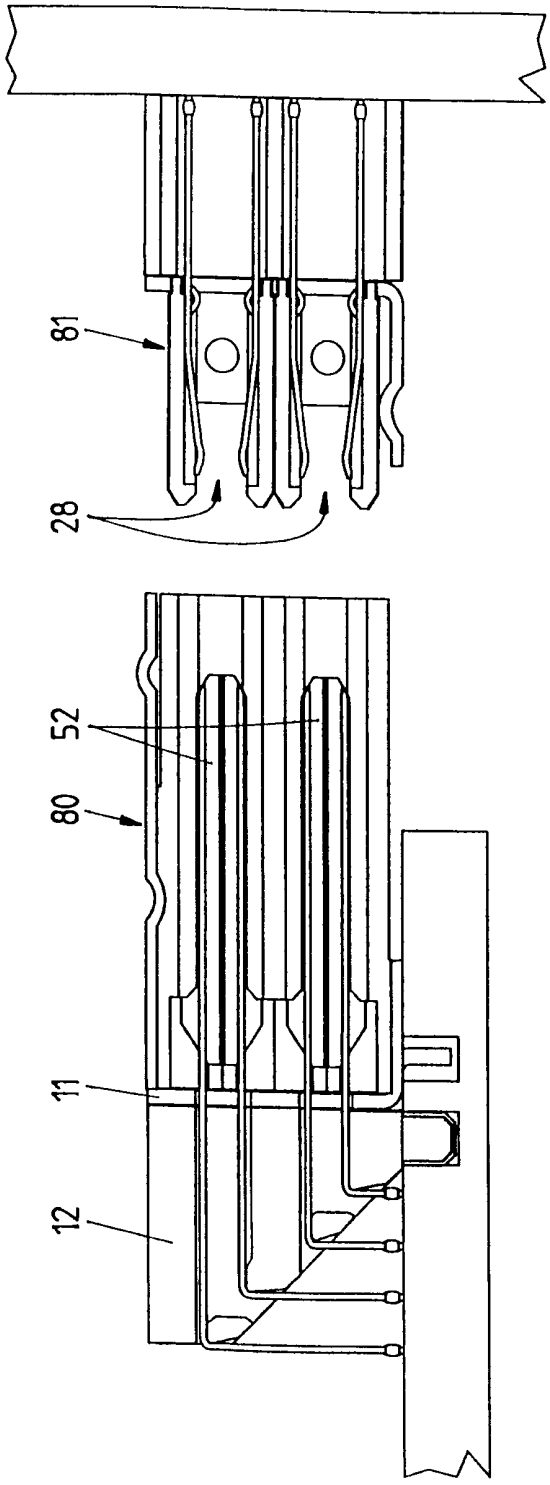
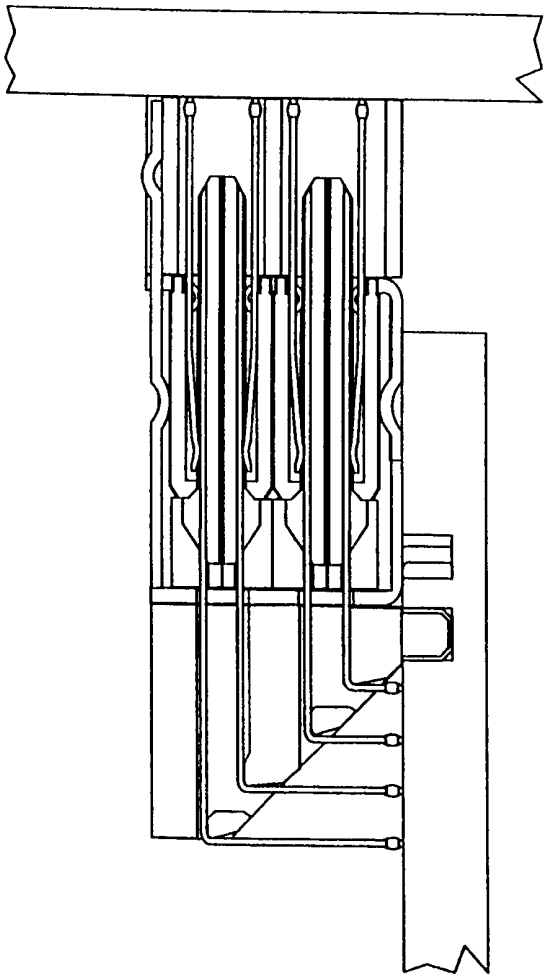


fig.36B



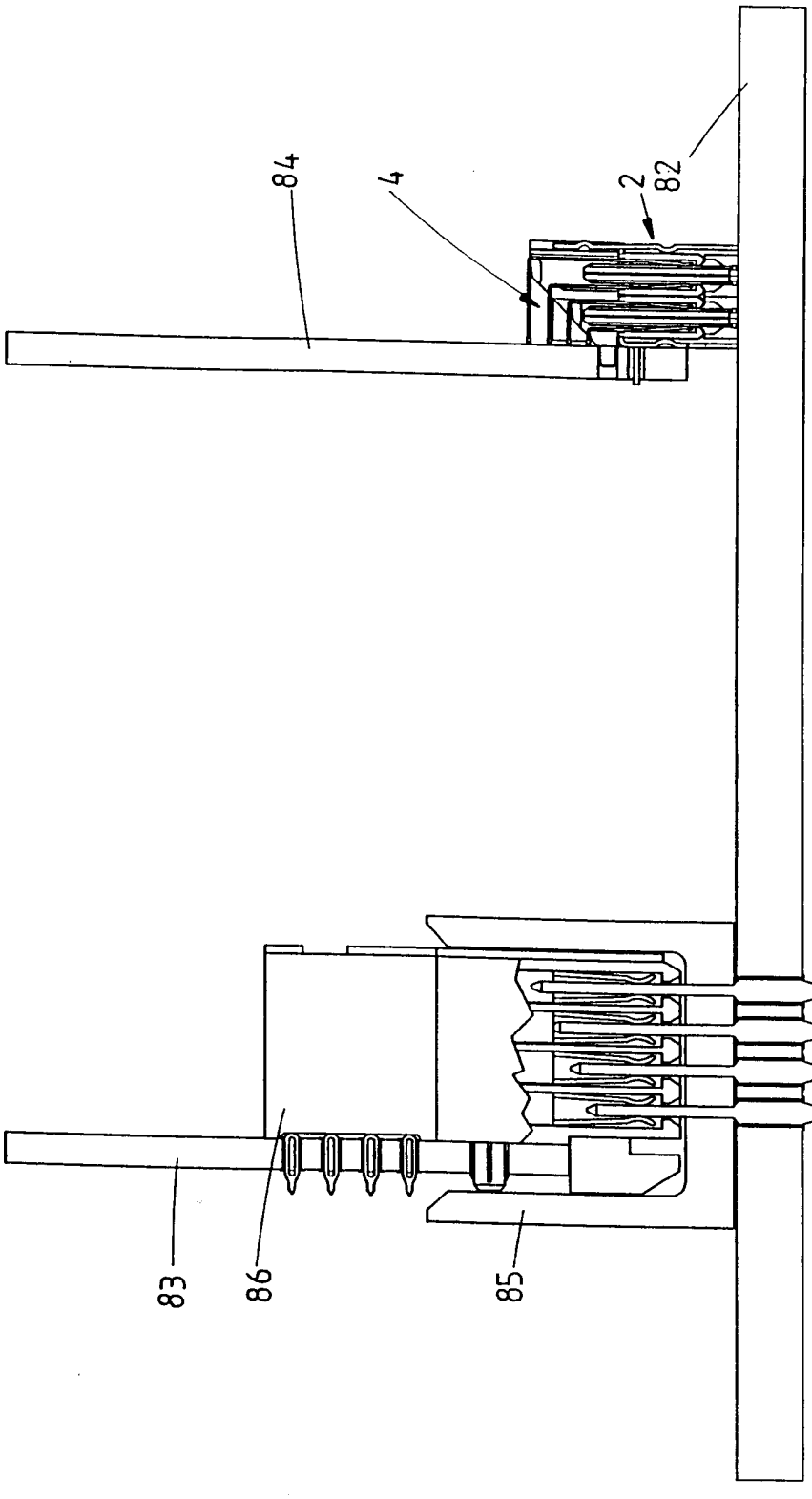


fig.37

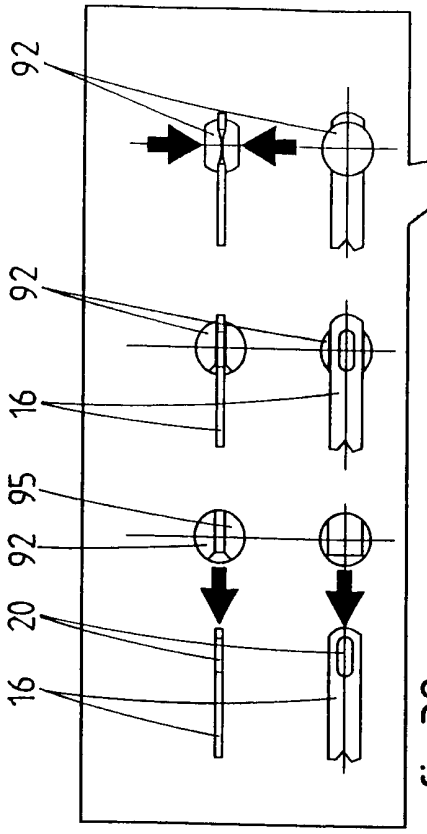


fig.39

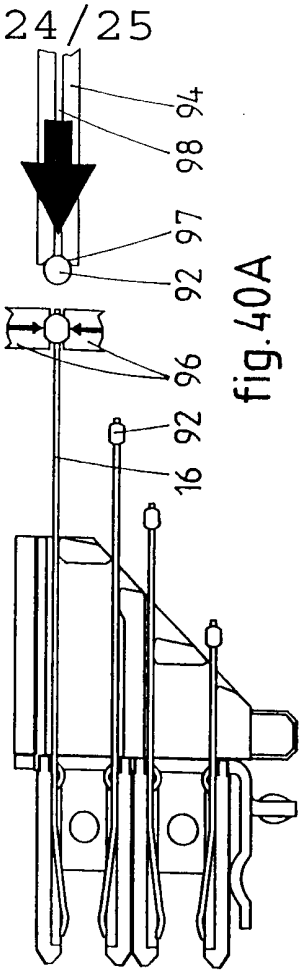


fig.40A

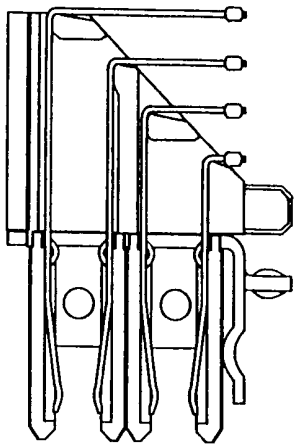


fig.40B

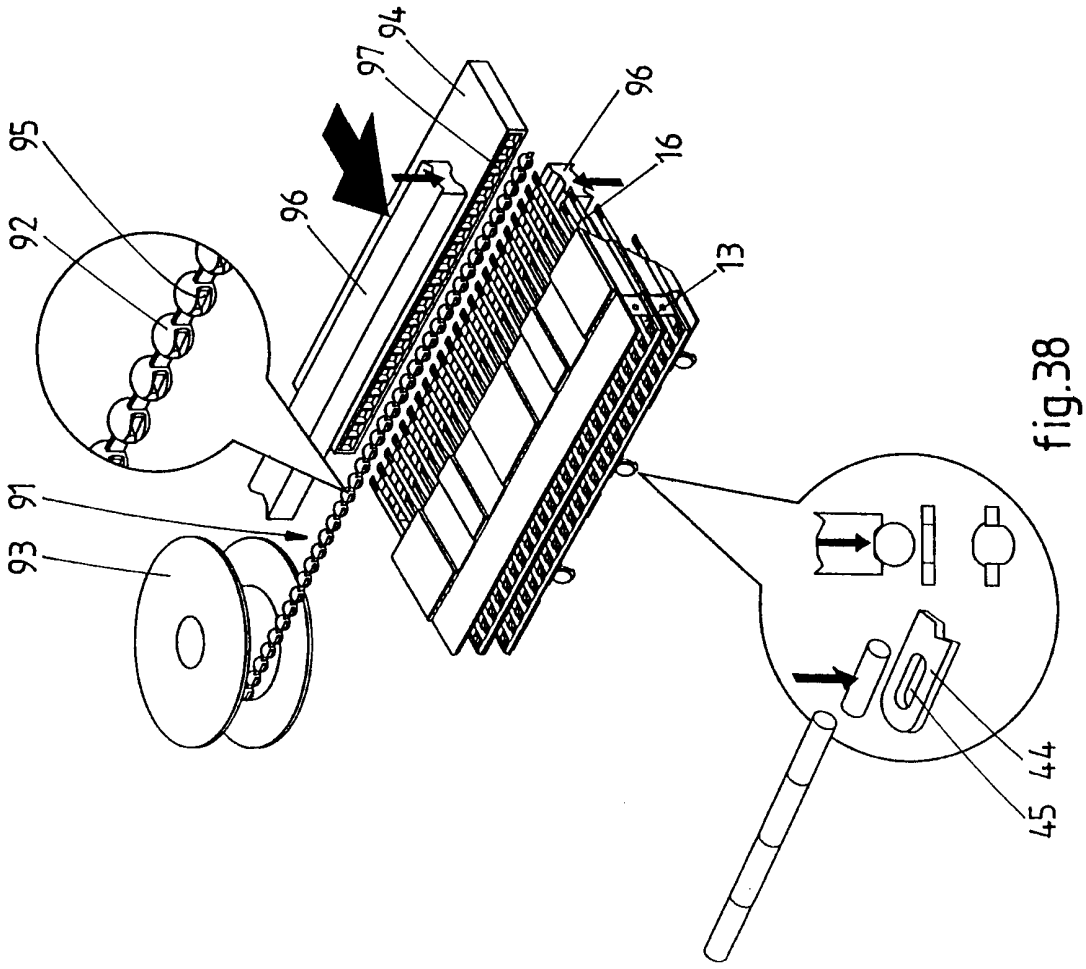


fig.38

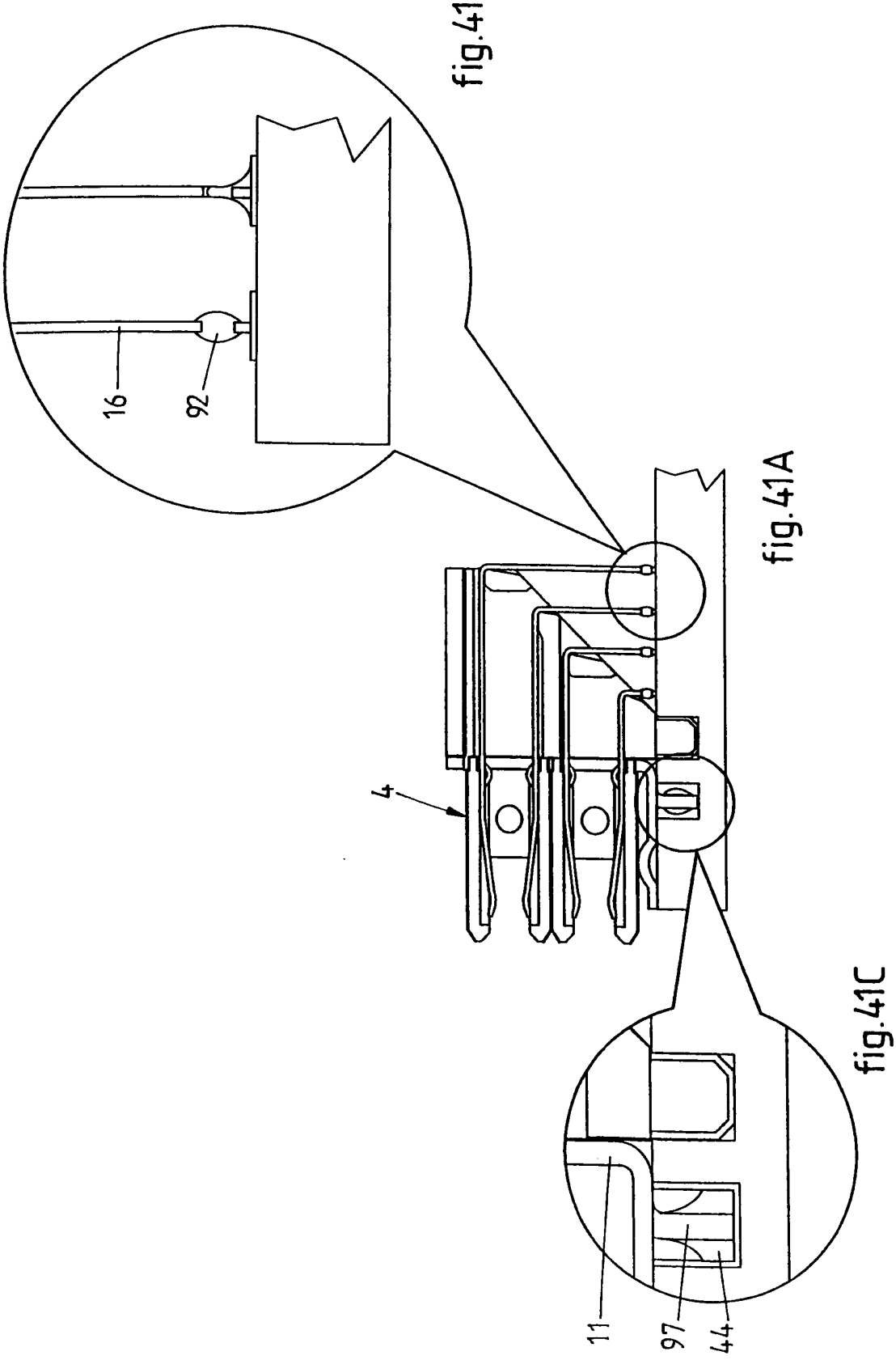


fig.41B

fig.41A

fig.41C

INTERNATIONAL SEARCH REPORT

Interi nal Application No
PCT/NL 00/00422

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01R12/16 H01R13/658 H01R13/514 H01R13/26

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01R

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

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

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 4 054 346 A (SCHULTZ RONALD L) 18 October 1977 (1977-10-18) column 3, line 13 -column 5, line 38; figures 1-3	69 65-67,70
Y	EP 0 028 436 A (DU PONT) 13 May 1981 (1981-05-13) page 3, line 11 -page 5, line 18; figures 1-4	65-67
Y	US 5 295 843 A (GRIESEMER DAVID A ET AL) 22 March 1994 (1994-03-22) column 2, line 19 -column 3, line 39; figures 1-12	70
A	WO 87 07441 A (AMP INC) 3 December 1987 (1987-12-03) page 2, line 4 - line 23; figures 1,2	1,4,8, 12,17,32

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
1 September 2000	08/09/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Criqui, J-J

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INTERNATIONAL SEARCH REPORT

Inter. nal Application No
PCT/NL 00/00422

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	WO 97 11509 A (SIEMENS AG ;ZELL KARL (DE); SEIBOLD JUERGEN (DE); SEIDEL PETER (DE) 27 March 1997 (1997-03-27) page 2, line 35 -page 3, line 1; figure 1	2,15,30
A	EP 0 852 414 A (BERG ELECTRONICS MFG) 8 July 1998 (1998-07-08) page 3, column 3, line 5 - line 12; figures 1A-1C	3,16,31, 62
A	FR 2 347 797 A (JOVY ROBERT) 4 November 1977 (1977-11-04) page 4, line 14 - line 26; figures 1,3A,4A	7-9,12
A	EP 0 268 441 A (DU PONT) 25 May 1988 (1988-05-25) page 3, column 4, line 1 - line 38 page 4, column 5, line 48 -column 6, line 18; figures 2,7	6,14,15, 25,26, 30,31, 34,35
A	EP 0 735 624 A (SIEMENS AG) 2 October 1996 (1996-10-02) page 4, column 6, line 46 -page 5, column 7, line 19; figure 1	4,11,17, 22
A	US 5 354 219 A (WANJURA GUENTER) 11 October 1994 (1994-10-11) page 4, line 16 - line 27; figures 3,4	13,15
A	US 5 169 325 A (YAEGASHI HIROKATSU ET AL) 8 December 1992 (1992-12-08) column 5, line 24 - line 46; figures 26-29	18-21
A	EP 0 843 383 A (BERG ELECTRONICS MFG) 20 May 1998 (1998-05-20) abstract; figure 6	23,24
A	WO 92 09119 A (DU PONT) 29 May 1992 (1992-05-29) page 23, line 25 -page 34, line 6; figures 11-13	25,26, 33-36
A	US 5 863 222 A (MYER JOHN MARK ET AL) 26 January 1999 (1999-01-26) column 2, line 65 -column 3, line 10; claim 1	37-52
A	WO 93 08621 A (BOSCH GMBH ROBERT) 29 April 1993 (1993-04-29) page 4, paragraph 4 -page 5, paragraph 1; claim 1	37-52

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INTERNATIONAL SEARCH REPORT

Interi nal Application No
PCT/NL 00/00422

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 561 497 A (WHITAKER CORP) 22 September 1993 (1993-09-22) column 3, line 53	37
A	EP 0 780 933 A (MOLEX INC) 25 June 1997 (1997-06-25) column 7, line 15 -column 8, line 2	37
X	US 3 854 790 A (PROVINSKY J) 17 December 1974 (1974-12-17) column 3, line 44 -column 4, line 29	53
X	US 5 320 555 A (OKABE TOSHIAKI) 14 June 1994 (1994-06-14) column 6, line 25 - line 26	53
A	US 5 827 091 A (BRISKI CURT M ET AL) 27 October 1998 (1998-10-27) abstract	53
A	US 4 067 637 A (NAROZNY RONALD S) 10 January 1978 (1978-01-10) column 3, line 4 -column 6, line 5	53
A	US 5 639 250 A (KESSLER THOMAS ET AL) 17 June 1997 (1997-06-17) column 2, line 36 -column 4, line 55	53
A	EP 0 693 795 A (CONNECTOR SYSTEMS TECH NV) 24 January 1996 (1996-01-24) column 4, line 1 -column 8, line 57	53

1

INTERNATIONAL SEARCH REPORT

information on patent family members

Inter nal Application No
PCT/NL 00/00422

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4054346 A	18-10-1977	NONE	
EP 0028436 A	13-05-1981	NL 7908112 A	01-06-1981
US 5295843 A	22-03-1994	CN 1094859 A	09-11-1994
		DE 69414428 D	17-12-1998
		DE 69414428 T	12-05-1999
		EP 0607920 A	27-07-1994
		JP 6231821 A	19-08-1994
		US 5785557 A	28-07-1998
WO 8707441 A	03-12-1987	JP 2004150 C	20-12-1995
		JP 7019632 B	06-03-1995
		JP 62281281 A	07-12-1987
WO 9711509 A	27-03-1997	AT 187281 T	15-12-1999
		DE 59603801 D	05-01-2000
		EP 0852078 A	08-07-1998
		ES 2140890 T	01-03-2000
		JP 11500265 T	06-01-1999
		PT 852078 T	31-05-2000
		US 5984733 A	16-11-1999
EP 0852414 A	08-07-1998	US 6083047 A	04-07-2000
		CA 2225151 A	07-07-1998
		CN 1190807 A	19-08-1998
		JP 10270133 A	09-10-1998
FR 2347797 A	04-11-1977	NONE	
EP 0268441 A	25-05-1988	AT 101757 T	15-03-1994
		CA 1289211 A	17-09-1991
		DE 3789089 D	24-03-1994
		DE 3789089 T	14-07-1994
		HK 1000397 A	13-03-1998
		JP 2737843 B	08-04-1998
		JP 63158766 A	01-07-1988
		KR 9102264 B	08-04-1991
		US RE35508 E	13-05-1997
		US 5169324 A	08-12-1992
		AU 607444 B	07-03-1991
		AU 8128187 A	19-05-1988
		US 4824383 A	25-04-1989
		US 5057028 A	15-10-1991
EP 0735624 A	02-10-1996	DE 19511507 A	02-10-1996
		JP 3025430 B	27-03-2000
		JP 8273763 A	18-10-1996
		US 6012927 A	11-01-2000
		US 5785534 A	28-07-1998
US 5354219 A	11-10-1994	SE 466126 B	16-12-1991
		AU 648858 B	05-05-1994
		AU 9109091 A	22-07-1992
		BR 9107247 A	05-04-1994
		CA 2098115 A,C	21-06-1992
		DE 69120688 D	08-08-1996
		DE 69120688 T	21-11-1996

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter nal Application No
PCT/NL 00/00422

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5354219 A		EP 0651919 A	10-05-1995
		ES 2092673 T	01-12-1996
		FI 932669 A	11-06-1993
		JP 6507267 T	11-08-1994
		RU 2089978 C	10-09-1997
		SE 9004125 A	16-12-1991
		WO 9211671 A	09-07-1992
US 5169325 A	08-12-1992	DE 4126172 A	11-02-1993
EP 0843383 A	20-05-1998	CN 1183656 A	03-06-1998
		JP 10284192 A	23-10-1998
		SG 67440 A	21-09-1999
WO 9209119 A	29-05-1992	US 5057028 A	15-10-1991
		DE 69132088 D	04-05-2000
		DE 69132142 D	31-05-2000
		EP 0556307 A	25-08-1993
		EP 0678940 A	25-10-1995
		JP 3058283 B	04-07-2000
		JP 6504874 T	02-06-1994
		US RE35508 E	13-05-1997
		US 5169324 A	08-12-1992
US 5863222 A	26-01-1999	NONE	
WO 9308621 A	29-04-1993	DE 9113111 U	18-02-1993
EP 0561497 A	22-09-1993	US 5167531 A	01-12-1992
		US 5161999 A	10-11-1992
		DE 69309761 D	22-05-1997
		DE 69309761 T	13-11-1997
		JP 2892903 B	17-05-1999
		JP 6029061 A	04-02-1994
		KR 183463 B	15-05-1999
EP 0780933 A	25-06-1997	US 5104326 A	14-04-1992
		DE 69129580 D	16-07-1998
		DE 69129580 T	04-02-1999
		EP 0496082 A	29-07-1992
		ES 2118072 T	16-09-1998
		JP 2029108 C	19-03-1996
		JP 4303578 A	27-10-1992
		JP 7048391 B	24-05-1995
		KR 9602140 B	10-02-1996
		SG 43102 A	17-10-1997
US 3854790 A	17-12-1974	NONE	
US 5320555 A	14-06-1994	NONE	
US 5827091 A	27-10-1998	US 5681185 A	28-10-1997
US 4067637 A	10-01-1978	CA 1079824 A	17-06-1980
		DE 2754656 A	15-06-1978
		DE 7737422 U	03-05-1978
		FR 2373898 A	07-07-1978
		GB 1541380 A	28-02-1979

INTERNATIONAL SEARCH REPORT

...ormation on patent family members

Intern ...al Application No
PCT/NL 00/00422

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4067637 A		IT 1090814 B	26-06-1985
		JP 53072191 A	27-06-1978
		JP 57016476 B	05-04-1982
		SE 7713834 A	10-06-1978
US 5639250 A	17-06-1997	DE 4427451 C	22-02-1996
		EP 0696091 A	07-02-1996
EP 0693795 A	24-01-1996	US 5743765 A	28-04-1998
		DE 69417224 D	22-04-1999
		DE 69417224 T	30-09-1999
		JP 8288019 A	01-11-1996