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(11) **EP 1 033 787 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
06.09.2000 Bulletin 2000/36

(51) Int. Cl.⁷: **H01R 13/193, H01R 13/08**

(21) Application number: **00104302.5**

(22) Date of filing: **02.03.2000**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **04.03.1999 US 262767**

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(54) **Electrical connector with terminal pins**

(57) An electrical connector system (10) includes a flat flexible circuit (56) having at least one pin-receiving hole (60) therein, and a printed circuit board (14) having at least one pin-receiving hole (46b) therein aligned with the hole in the flat flexible circuit. An electrical connector (16) includes a dielectric housing (50) and a dual-diameter terminal pin (68) having a distal end (68a) of a smaller diameter and a proximal end (68b) of a larger diameter. When the connector is mounted to the flat

flexible circuit (56) and the printed circuit board (14), the distal end (68a) of the pin (68) can be inserted successively through the hole (60) in the flat flexible circuit (56) with minimal insertion resistance and into the hole (46b) in the printed circuit board (14), while the proximal end (68b) of the pin can be inserted into the hole (60) in the flat flexible circuit (56) with higher insertion resistance.

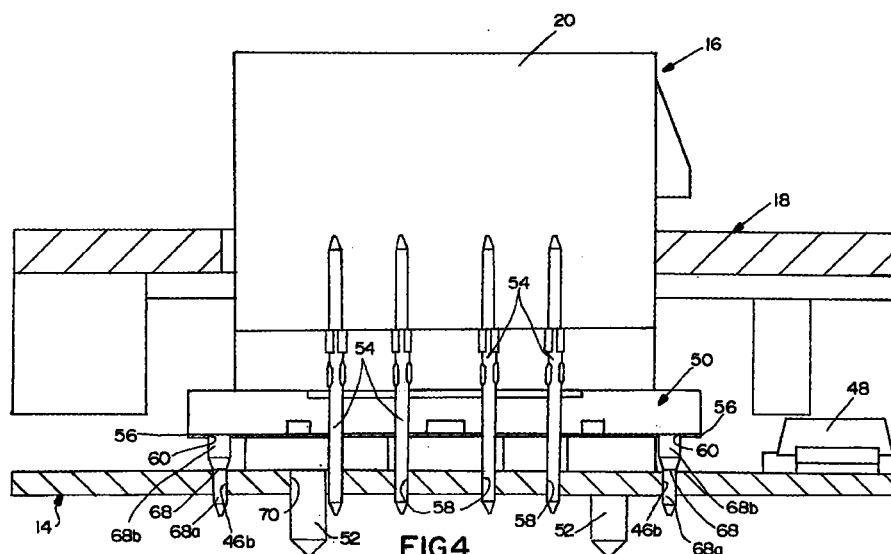


FIG.4

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Description

Field of the Invention

[0001] This invention generally relates to the art of electrical connectors and, particularly, to an electrical connector which includes one or more terminal pins. As disclosed herein, the connector includes a shield having at least one ground pin.

Background of the Invention

[0002] A wide variety of electrical connectors are known wherein one or more terminal pins are provided for making electrical connections to a complementary connecting device. For instance, the terminal pins may interconnect within terminal sockets of a complementary mating connector. In many applications, the terminal pins are inserted into holes in a printed circuit board, a flat flexible circuit or the like for making electrical connections to those substrate-like components. The printed circuit board typically has conductive circuit traces on the board and/or in the holes for connection, as by soldering, to the terminal pins. The flat flexible circuit typically has pin-receiving holes which are smaller in diameter than the pins, themselves, and the pins are engaged with conductive films on the flexible circuit. The terminal pins may be signal pins or ground pins, and the pins may be stand-alone components or integral components of a shield, for instance.

[0003] In addition, it often is desirable to plate terminal pins with a highly conductive plating material to enhance the electrical connections made by the pins. There have been electrical connector applications wherein terminal pins are required to be inserted sequentially through holes in a flat flexible circuit and then into holes in a printed circuit board or other electrical device. Problems are anticipated with pins which are plated before insertion, because the plating material could tend to scrape off of the pins as they are inserted through the flat flexible circuit and before inserting into the holes in the printed circuit board or other connecting device. For instance, if the pins are plated with conductive tin material, tin "slivers" could be created which are very undesirable in the connector interface. The present invention is directed to avoiding these problems by providing an electrical connector system which employs dual-diameter pins.

Summary of the Invention

[0004] An object, therefore, of the invention is to provide a new and improved electrical connector which uses terminal pins.

[0005] Another object of the invention is to provide a shielded electrical connector system wherein the pins are integral components of a shield of the connector.

[0006] In the exemplary embodiment of the inven-

tion, a shielded electrical connector system is shown to include a flat flexible circuit having at least one pin-receiving hole therein. A printed circuit board has at least one pin-receiving hole therein aligned with the hole in the flat flexible circuit. An electrical connector includes a dielectric housing having a conductive shield mounted about at least a portion thereof. The shield includes at least one dual-diameter ground pin having a distal end of a smaller diameter and a proximal end of a larger diameter. Therefore, when the connector is mounted to the flat flexible circuit and the printed circuit board, the distal end of the pin can be inserted successively through the hole in the flat flexible circuit with minimal resistance and then into the hole in the printed circuit board for connection to a ground trace on the board. The larger diameter proximal end of the pin can be inserted into the hole in the flat flexible circuit with higher resistance.

[0007] The invention is not limited to inserting the terminal pin through a flat flexible circuit and then into a hole in a printed circuit board. For instance, the pin could be inserted through the flat flexible circuit and then into a terminal socket of a different type of connecting device. In addition, the pin does not necessarily have to be an integral component of the shield.

[0008] As disclosed herein, each of the flat flexible circuit and the printed circuit board includes a plurality of respectively aligned pin-receiving holes. The shield includes a corresponding plurality of the dual-diameter ground pins. Specifically, the conductive shield substantially surrounds the dielectric housing, and the dual-diameter ground pins are spaced generally along the periphery of the housing.

[0009] It also is contemplated that the flat flexible circuit includes a flexible dielectric substrate less than 0.050 inch thick with a generally round pin-receiving hole of a given diameter and with a ductile conductive film on the substrate in an area at least about the hole. The diameter of the proximal end of the ground pin is greater than the hole, and the difference between the diameter of the proximal end of the ground pin and the diameter of the hole is on the order of 5% to 50% of the diameter of the hole.

[0010] Other objects, features and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawings.

Brief Description of the Drawings

[0011] The features of this invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with its objects and the advantages thereof, may be best understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements in the figures and in which:

FIGURE 1 is an exploded perspective view of an electrical connector system in which the invention is applicable;

FIGURE 2 is an exploded perspective view of the electrical connector assembly in the system of Figure 1 and which incorporates the terminal pins of the invention;

FIGURE 3 is a fragmented perspective viewing showing the terminal pins of the connector assembly inserted through the flat flexible circuits;

FIGURE 4 is a section through the connector assembly mounted in the system of Figure 1, with the die-cast housing not shown; and

FIGURE 5 is a section through one of the holes in one of the flat flexible circuits, with the proximal end of one of the dual-diameter pins inserted into the hole.

Detailed Description of the Preferred Embodiment

[0012] Referring to the drawings in greater detail, and first to Figure 1, the invention is embodied in an electrical connector system, generally designated 10, which includes a die-cast metal housing, generally designated 12, which receives a printed circuit board, generally designated 14, on which an electrical connector assembly, generally designated 16, is mounted. A metal cover, generally designated 18, substantially closes the assembly onto the housing, with receptacles 20 of the connector assembly projecting through openings or apertures 22 in the cover.

[0013] More particularly, housing 12 is recessed, as at 24, for receiving printed circuit board 14 to which connector assembly 16 has been mounted. The housing has four internally threaded corner bosses 26 for receiving appropriate fasteners (such as screws, not shown) inserted through four mounting holes 28 at the corners of cover 18. The housing has additionally internally threaded mounting bosses 30 for receiving appropriate fasteners extending through notches 32 in a pair of end wings 34 of connector assembly 16. The fasteners are inserted through holes 35 in cover 18. Additional fasteners are inserted through holes 35a in the cover and into the mounting bosses 30a on the housing. Printed circuit board 14 seats onto a plurality of edge platform bosses 36 within recess 24 of housing 12 and onto a plurality of central platform bosses 38 having projecting pin portions 38a for insertion into appropriate mounting holes 40 in the printed circuit board.

[0014] Printed circuit board 14 of connector system 10 has corner holes 40 and corner notches 42 aligned with corner bosses 26 of housing 12 for passing there-through of the appropriate fasteners. The printed circuit board also has side notches 44 aligned with mounting bosses 30 and 30a. A plurality of holes are formed in the printed circuit board for receiving the terminal pins from connector assembly 16. Suffice it say, the holes are arranged in a predetermined pattern or array, generally

designated 46, having holes 46a corresponding to the signal terminal pins of the connector assembly and holes 46b corresponding to the ground pins of the assembly. Of course, appropriate signal and ground circuit traces are provided on the printed circuit board, as is known in the art, and which may lead to a plurality of circuit components 48 mounted on the board.

[0015] Referring to Figure 2 in conjunction with Figure 1, connector assembly 16 generally is in the form of a header connector including a dielectric housing, generally designated 50, unitarily molded of plastic material or the like. The housing forms receptacles 20 described above for insertion through apertures 22 in cover 18 of connector system 10. In essence, connector assembly 16 comprises a plurality (four) of separate connectors defined by receptacles 20 within the single unitarily molded dielectric housing. Each receptacle can receive a separate complementary mating connector. Dielectric housing 50 includes a plurality of unitarily molded mounting posts 52 for insertion into appropriate mounting holes in printed circuit board 14 for mounting the connector assembly onto the board, as will be seen hereinafter. A plurality of signal terminal pins 54 are mounted in housing 50 for each receptacle/connector 20.

[0016] Still referring to Figure 2, connector assembly 16 includes a plurality (four) of flat flexible circuits 56, one flat flexible circuit for each receptacle/connector of the assembly. Each flat flexible circuit has an array of pin-receiving holes 58 for receiving signal terminal pins 54. In comparing Figure 2 with Figure 1, it can be seen that external ends of signal terminal pins 54 can extend through holes 58 in flat flexible circuit 56, while internal ends of the signal terminal pins are exposed within receptacles 20 for engaging female terminals of the complementary mating connectors. Finally, each flat flexible circuit 56 has a hole at each corner thereof for receiving ground terminal pins from a shield of the connector assembly, as described below.

[0017] In particular, an elongated, generally rectangular shield, generally designated 62, substantially surrounds dielectric housing 50 and will be sandwiched between printed circuit board 14 and cover 18 (Fig. 1). The shield is stamped and formed of conductive sheet metal material, such as brass or the like, which includes end wings 34 and notches 32 described above. The shield has inwardly directed latch tabs 64 for latching engaging dielectric housing 50. The shield is integrally formed with a plurality of short ground pins 66 and long ground pins 68 spaced along the opposite longitudinal sides of the elongated rectangular shield for insertion into holes 60 in flat flexible circuits 56. At least the distal ends of the long ground pins 68 are plated with a highly conductive material such as tin or the like.

[0018] Figure 3 shows a pair of the flat flexible circuits 56 mounted to the inside of connector assembly 16, with the short ground pins 66 and the long ground pins 68 of shield 62 projecting through holes 60 in the

flat flexible circuits. Signal terminal pins 54 also can be seen projecting through holes 58 in the circuits.

[0019] Referring to Figure 4 in conjunction with Figure 3, the invention contemplates that at least one of the ground pins on shield 62, such as long ground pins 68, be fabricated with a dual diameter. Specifically, it can be seen that each ground pin 68 has a distal end 68a of a smaller diameter and a proximal end 68b of a larger diameter. Figure 4 specifically shows that the smaller diameter distal ends of the ground pins are inserted into the correspondingly sized ground holes 46b in printed circuit board 14, and the larger diameter proximal ends 68b of the ground pins are located within holes 60 in one of the flat flexible circuits 56. Therefore, it can be understood that when the connector assembly is assembled by mounting housing 50 to flat flexible circuits 56 and printed circuit board 14, distal ends 68a of ground pins 68 are inserted successively through holes 60 in flat flexible circuits 56 with minimal resistance and then into holes 46b in printed circuit board 14 for connection to the circuit traces on the board and/or in the holes. The larger diameter proximal ends 68b of the ground pins end up located in holes 60 in the flat flexible circuits and can have higher insertion resistance therein because of the larger diameters of the proximal ends. With the distal ends of the ground pins being plated, and with the distal ends being insertable through the holes in the flat flexible circuits with minimal insertion resistance, scraping of the plating from the pins is substantially reduced if not totally eliminated.

[0020] It should be understood that the use of dual diameter terminal pins as described herein should not be limited to the disclosed use on a shield of the terminal assembly. The advantages of such dual-diameter pins are equally applicable for other applications whether they be signal terminal pins, ground terminal pins, stand-alone terminal pins or terminal pins which are integral parts of other structures such as the shield. The dual-diameter pins are specifically useful when employed as ground pins for the metal shield, because it is somewhat difficult to post-plate the distal ends of the ground pins after assembly. It is much easier to plate the pins prior to assembly of the shield onto the connector.

[0021] Figure 4 also shows how signal pins 54 extend through holes 58 in printed circuit board 14. Mounting posts 52 of housing 50 also can be seen extending through mounting holes 70 in the printed circuit board.

[0022] Figure 5 shows the proximal end 68b of one of the ground terminal pins 68 inserted through one of the holes 60 in one of the flat flexible circuits 56. The invention contemplates the use of a principle which may be called a "controlled meniscus". In other words, in order to eliminate the use of solder, epoxies and the like, a particular interference is established between the ground pin and the flat flexible circuit in the curved area of the circuit around holes 60 which, in essence, is a

deformed peripheral area of the flexible circuit which applies normal forces to the pin in the direction of arrows "A" when the pin is inserted into the hole in the direction of arrow "B". The flat flexible circuit includes a flat flexible dielectric substrate 72 preferably less than 0.050 inch thick. The substrate may be of various materials, but a polyimide material has proven effective. Other materials, such as a polyester material also could be used. A ductile flat conductor or conductive film 74 is applied to the substrate in an area at least about hole 60. The hole is preformed, such as being prepunched, in order to prevent the substrate material from tearing or "running" when the pin of a diameter larger than the diameter of the hole is inserted into the hole.

[0023] With the above description of the parameters of the flat flexible circuit and the pin in relation to Figure 5, the area and the interference forces about the hole are controlled by controlling the relative diameters of the pin and the hole. It has been found that good electrical connections can be maintained when the difference between the diameter of the pin (larger diameter proximal end 68b) and the diameter of hole 60 is on the order of 5% to 50% of the diameter of the hole. This can be termed the "interference" parameter. By maintaining these parameters, secondary operations such as soldering the pin to the flat conductor of the flat flexible circuit, or using epoxy or other adhesives between the pin and the flexible circuit can be completely eliminated and still maintain a good electrical connection between the pin and the flat conductor of the flexible circuit. This principle is quite applicable for use in an overall combination which includes the dual diameter pin, the flat flexible circuit and the printed circuit board or other connecting device as disclosed herein.

[0024] It will be understood that the invention may be embodied in other specific forms without departing from the spirit or central characteristics thereof. The present examples and embodiments, therefore, are to be considered in all respects as illustrative and not restrictive, and the invention is not to be limited to the details given herein.

Claims

1. A shielded electrical connector system (10), comprising:

- a flat flexible circuit (56) having at least one pin-receiving hole (60) therein;
- a printed circuit board (14) having at least one pin-receiving hole (46b) therein aligned with the hole in the flat flexible circuit;
- an electrical connector (16) including a dielectric housing (50); and
- a conductive shield (62) mounted about at least a portion of the connector housing and including a dual-diameter ground pin (68) having a distal end (68a) of a smaller diameter and a

- proximal end (68b) of a larger diameter whereby, when the connector (16) is mounted to the flat flexible circuit (56) and the printed circuit board (14), the distal end (68a) of the pin (68) can be inserted successively through the hole (60) in the flat flexible circuit with minimal insertion resistance and into the hole (46b) in the printed circuit board for connection to a ground trace on the board and the proximal end (68b) of the pin can be inserted into the hole (60) in the flat flexible circuit (56) with higher insertion resistance.
2. The shielded electrical connector system of claim 1 wherein each of said flat flexible circuit (56) and said printed circuit board (14) includes a plurality of respectively aligned pin-receiving holes (60,46b), and said shield (62) includes a corresponding plurality of said dual-diameter ground pins (68).
 3. The shielded electrical connector system of claim 2 wherein said conductive shield (62) substantially surrounds the dielectric housing (50), and the dual-diameter ground pins (68) are spaced generally along the periphery of the housing.
 4. The shielded electrical connector system of claim 1 wherein said flat flexible circuit (56) includes a flexible dielectric substrate (72) less than 0.050 inch thick with a generally round pin-receiving hole (60) of a given diameter and with a ductile conductive film (74) on the substrate in an area at least about said hole, and the diameter of the proximal end (68b) of said ground pin (68) is greater than that of the hole (60) and wherein the difference between the diameter of the proximal end of the ground pin and the diameter of the hole is on the order of 5% to 50% of the diameter of the hole.
 5. An electrical connector system (10), comprising:
 - a flat flexible circuit (56) having at least one pin-receiving hole (60) therein;
 - a printed circuit board (14) having at least one pin-receiving hole (46b) therein aligned with the hole in the flat flexible circuit;
 - an electrical connector (16) including a dielectric housing (50) and a dual-diameter terminal pin (68) having a distal end (68a) of a smaller diameter and a proximal end (68b) of a larger diameter whereby, when the connector (16) is mounted to the flat flexible circuit (56) and the printed circuit board (14), the distal end (68a) of the pin (68) can be inserted successively through the hole (60) in the flat flexible circuit with minimal insertion resistance and into the hole (46b) in the printed circuit board for connection to a ground trace on the board and the
- proximal end (68b) of the pin can be inserted into the hole (60) in the flat flexible circuit (56) with higher insertion resistance.
6. The electrical connector system of claim 1 wherein each of said flat flexible circuit (56) and said printed circuit board (14) includes a plurality of respectively aligned pin-receiving holes (60,46b), and said connector (16) includes a corresponding plurality of said dual-diameter ground pins (68).
 7. The electrical connector system of claim 5 wherein said flat flexible circuit (56) includes a flexible dielectric substrate (72) less than 0.050 inch thick with a generally round pin-receiving hole (60) of a given diameter and with a ductile conductive film (74) on the substrate in an area at least about said hole, and the diameter of the proximal end (68b) of said ground pin (68) is greater than that of the hole (60) and wherein the difference between the diameter of the proximal end of the ground pin and the diameter of the hole is on the order of 5% to 50% of the diameter of the hole.
 8. A shielded electrical connector system (10), comprising:
 - a first circuit substrate (56) having at least one pin-receiving hole (60) therein;
 - a second circuit substrate (14) having at least one pin-receiving hole (46b) therein aligned with the hole in the first circuit substrate;
 - an electrical connector (16) including a dielectric housing (50); and
 - a conductive shield (62) mounted about at least a portion of the connector housing (50) and including a dual-diameter ground pin (68) having a distal end (68a) of a smaller diameter and a proximal end (68b) of a larger diameter whereby, when the connector (16) is mounted to the first circuit substrate (56) and the second circuit substrate (14), the distal end (68a) of the pin (68) can be inserted successively through the hole (60) in the first circuit substrate (56) with minimal insertion resistance and into the hole (46b) in the second circuit substrate (14) and the proximal end (68b) of the pin can be inserted into the hole in the second circuit substrate with higher insertion resistance.
 9. The shielded electrical connector system of claim 8 wherein each of said first and second circuit substrates (56,14) includes a plurality of respectively aligned pin-receiving holes (60,46b), and said shield (62) includes a corresponding plurality of dual-diameter ground pins (68).
 10. The shielded electrical connector system of claim 9

wherein said conductive shield (62) substantially surrounds the dielectric housing (50), and the dual-diameter ground pins (68) are spaced generally along the periphery of the housing.

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11. An electrical connector (16), comprising:

a dielectric housing (50); and
a conductive shield (62) mounted about at least
a portion of the connector housing and includ- 10
ing a dual-diameter ground pin (68) having a
distal end (68a) of a smaller diameter and a
proximal end (68b) of a larger diameter
whereby, when the connector is mounted suc- 15
cessively on a pair of connecting devices
(56,14) having respective pin-receiving holes
(60,46b), the distal end (68a) of the ground pin
(68) can be inserted successively through a
hole (60) in one of the connecting devices (56) 20
with minimal insertion resistance and into a
hole (46b) in the second connecting device
(14) while the proximal end (68b) of the pin can
be inserted into the hole (60) in the one con-
necting device (56) with higher insertion resist- 25
ance.

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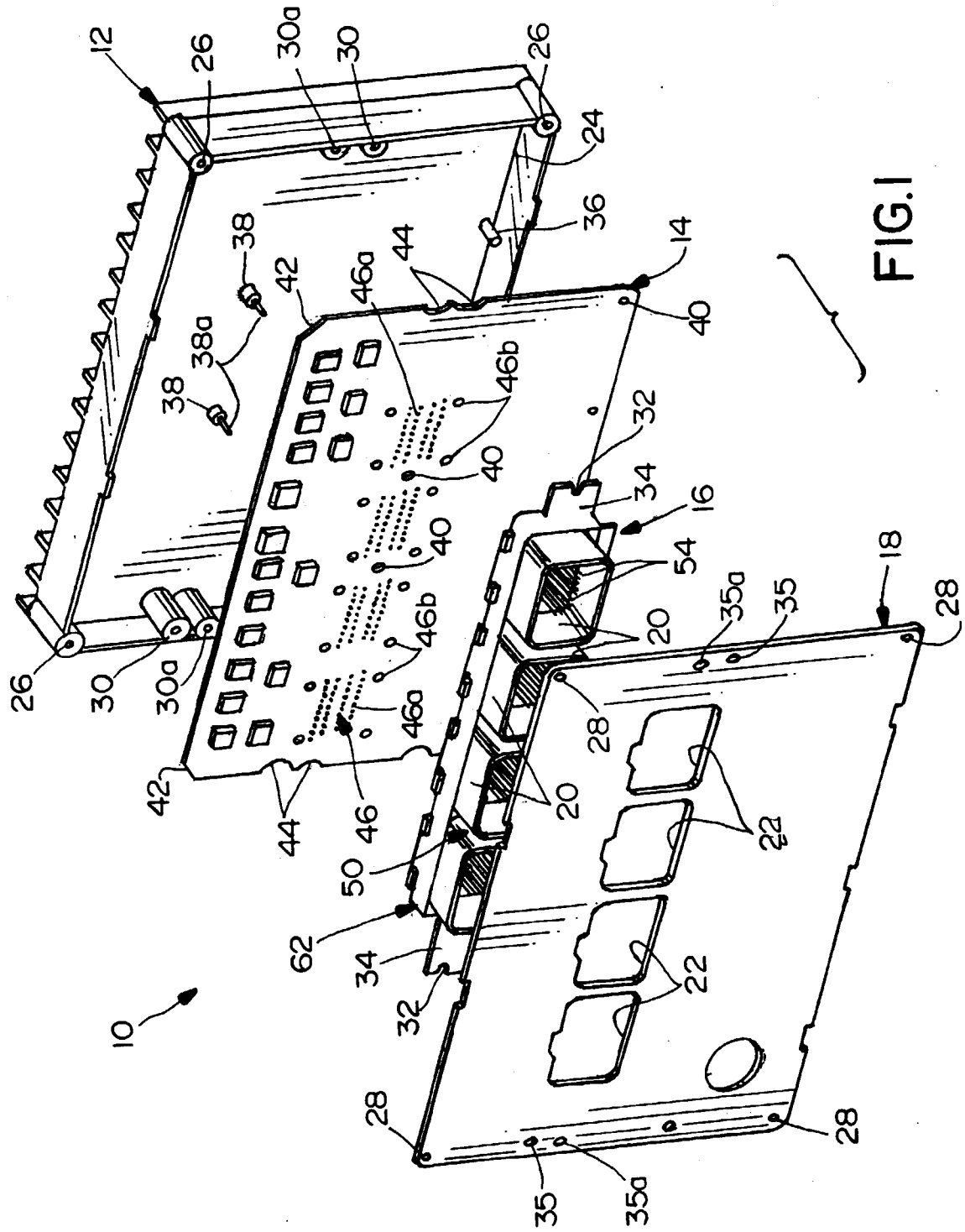


FIG. 1

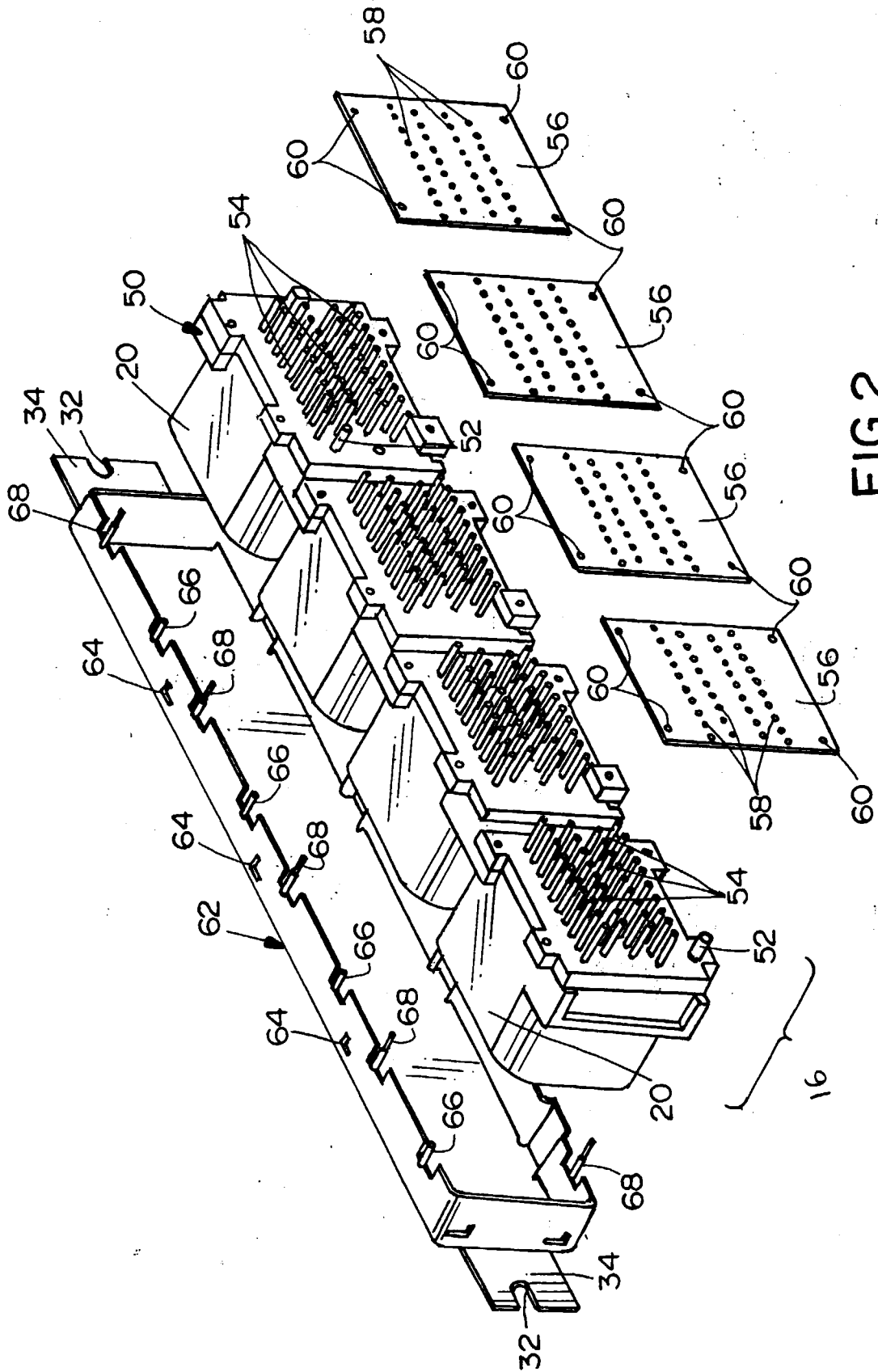


FIG. 2

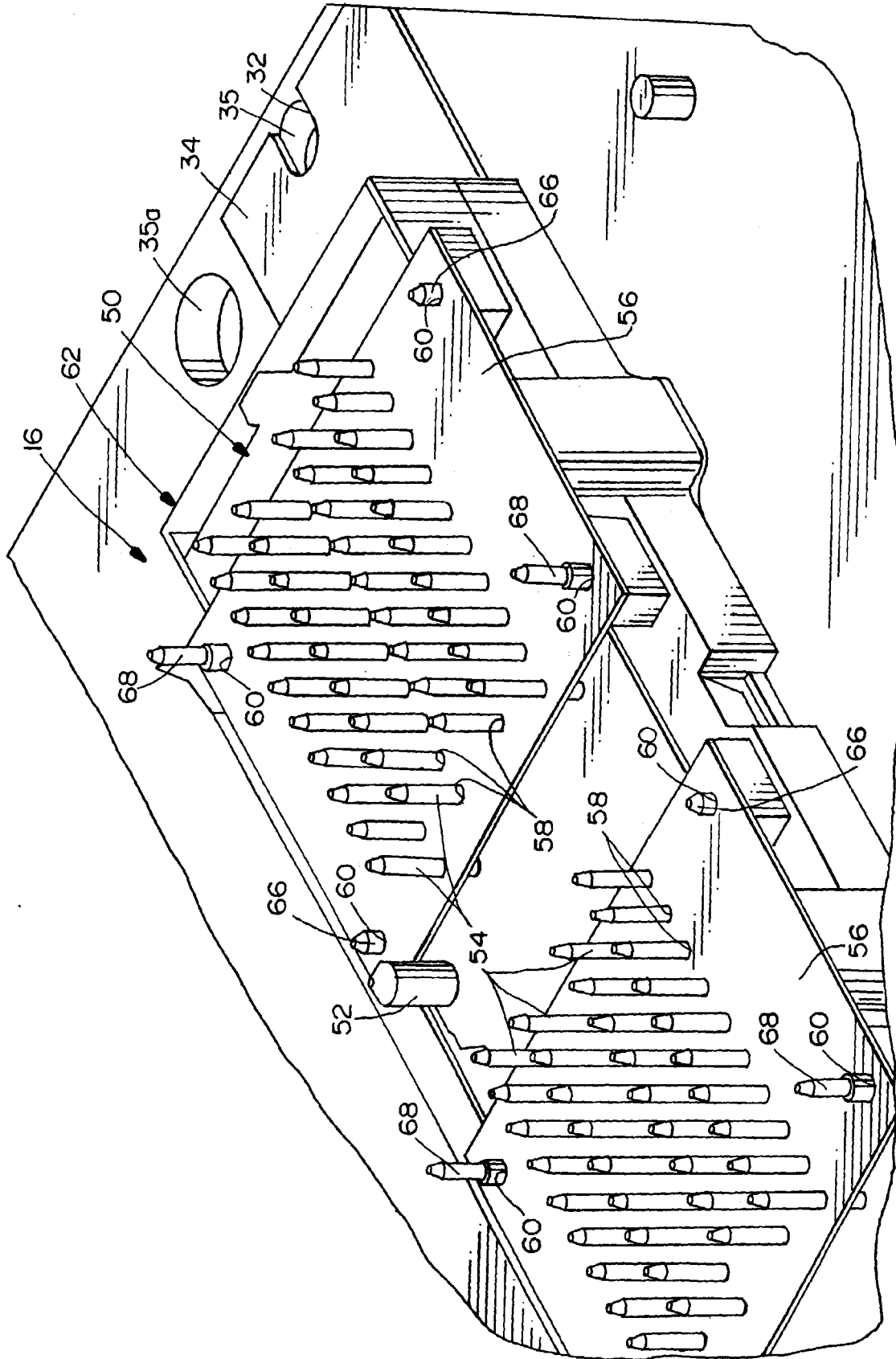
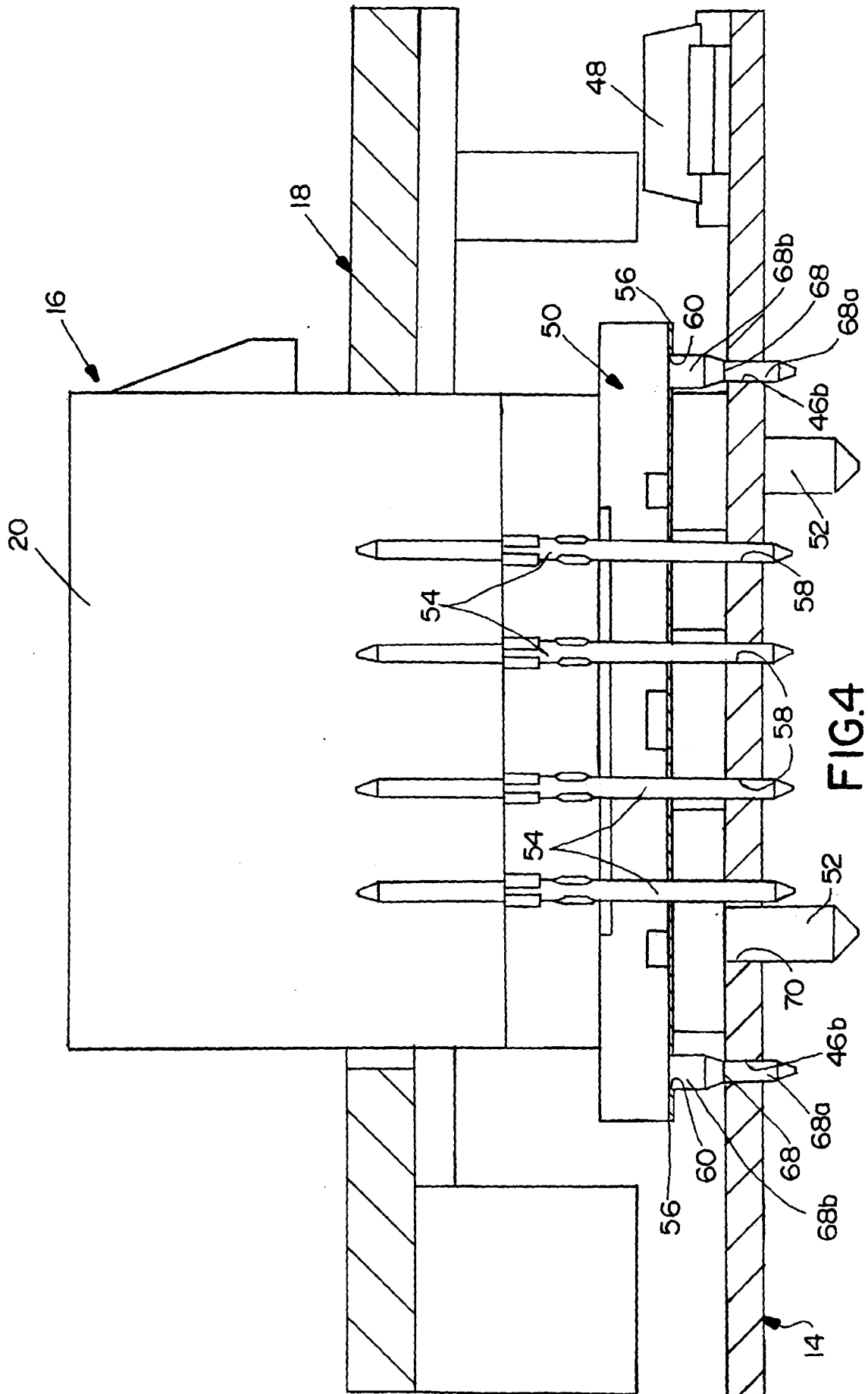


FIG. 3



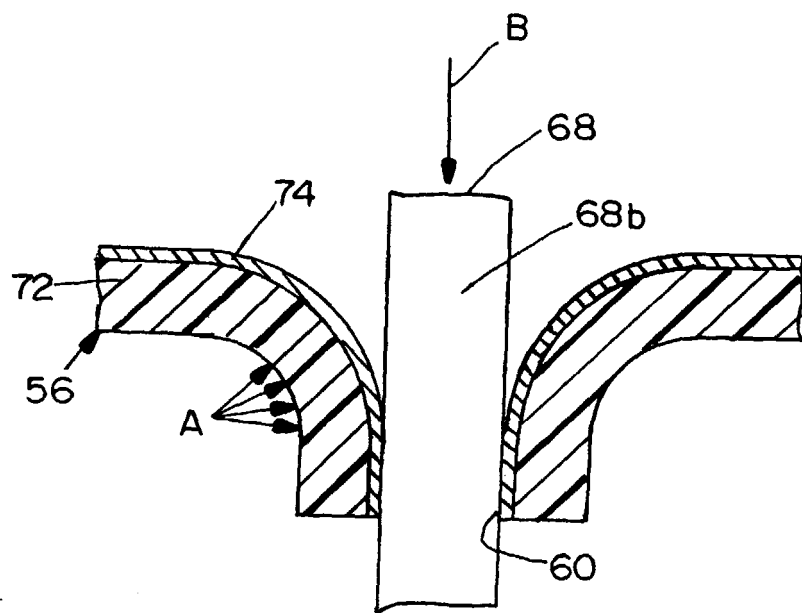


FIG.5



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EUROPEAN SEARCH REPORT

Application Number
EP 00 10 4302

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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A	US 5 384 435 A (R.M.FUERST ET AL) 24 January 1995 (1995-01-24) * column 3, line 11 - line 32 * * column 3, line 63 - column 4, line 12; figure 2 * -----	4,7	
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			H01R
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
BERLIN		9 May 2000	Alexatos, G
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