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(54) Printed circuit board electrical connector.

(57) An electrical connection system is comprised of male and female electrical connector members where the male (60) and female (2) electrical connector are electrically interconnected to printer circuit boards (50,90) where the printed circuit boards (50,90) are intended for parallel mounting relative to one another. To reduce the vertical distance between the facing surfaces of the electrical printed circuit boards, the printed circuit boards include apertures (52,82) at least partly through the facing surface of the printed circuit board, and the male and female electrical connectors (2,60) are recessed into the apertures (52,82) of the printed circuit boards (50,90). This reduces the distance between the upper face of the electrical connector and the corresponding upper surface of the printed circuit board thereby providing a more dense profile between the interconnected opposing printed circuit boards (50,90).

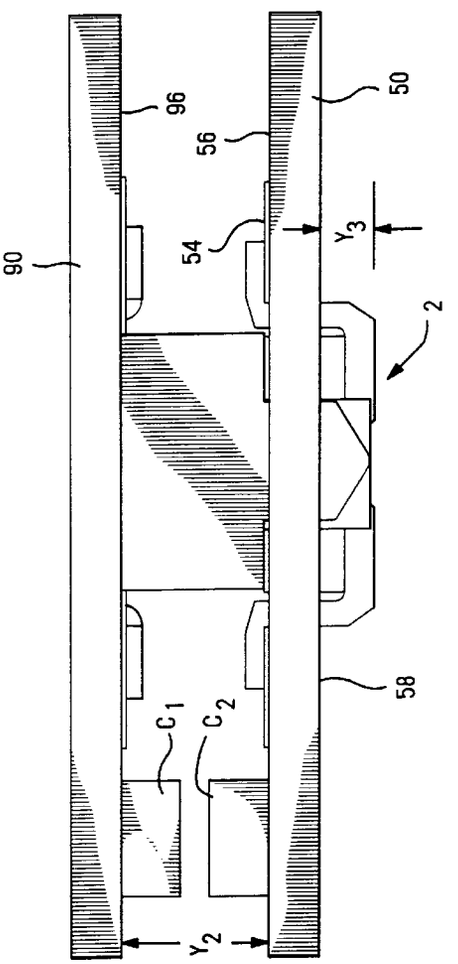

FIG. 11

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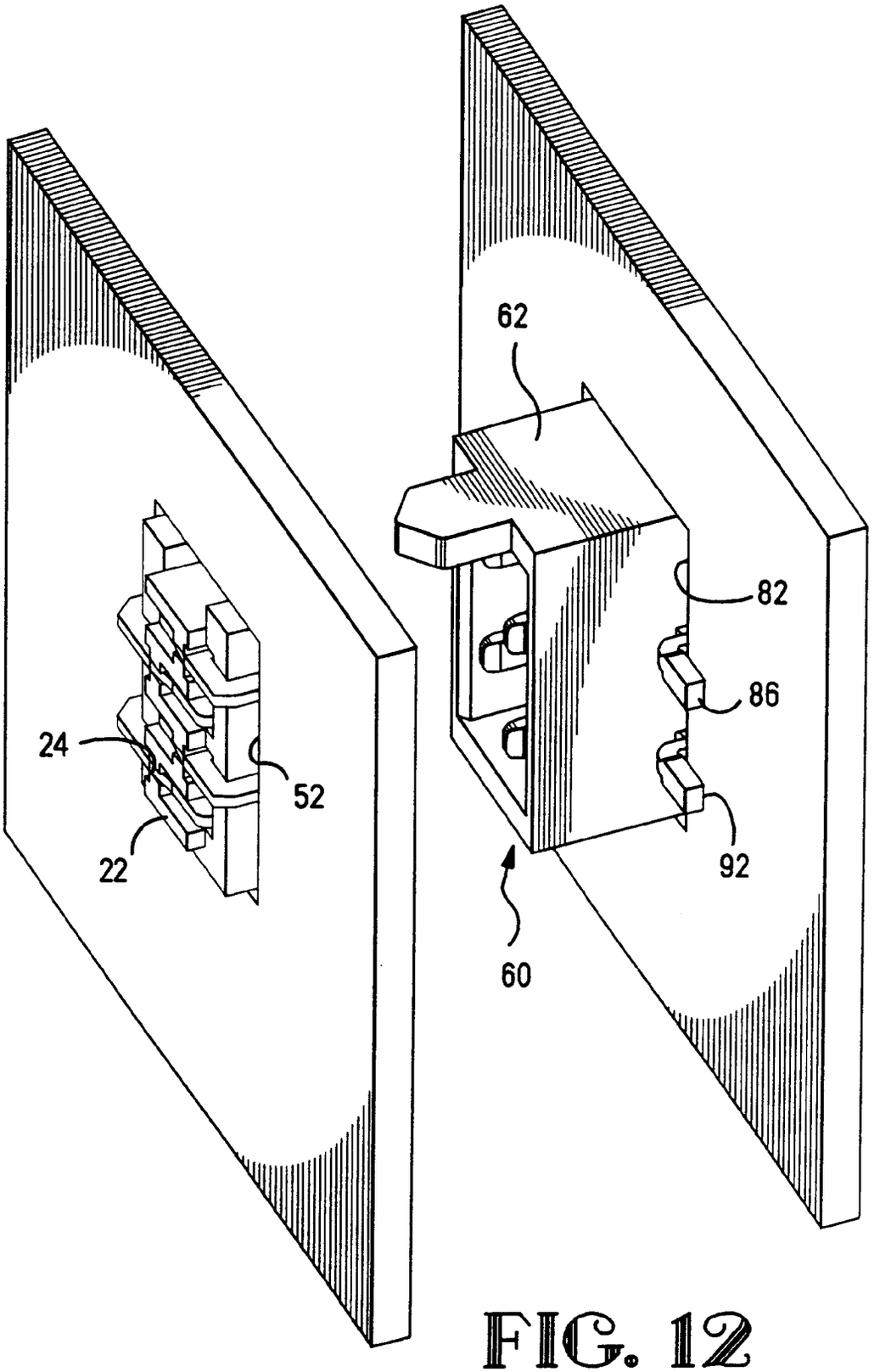


FIG. 12

The subject invention relates to electrical connectors for printed circuit boards, and in particular to an electrical'connector assembly where printed circuit boards may be positioned in parallel spaced arrangement, where the connectors are arranged in close proximity to each other.

With the increased miniaturization of electrical components, particularly with such items as lap top computers, a need has arisen in the market for a means of positioning the printed circuit boards as close as possible to each other, without interfering with the components which are mounted on either board. These printed circuit boards are generally interconnected by way of mating electrical connectors mounted on each board, one half of the electrical connection mounted on one printed circuit board, while the mating half of the electrical connection is mounted to the other printed circuit board. While reducing the height of each corresponding electrical connector will in fact reduce the spacing between the boards, eventually a point is reached, where the height of the connector can no longer be reduced.

The object of the invention then is to provide an electrical connector and an electrical connection whereby two parallel mounted printed circuit boards are electrically connected to each other and spaced as close as possible.

The object of the invention was accomplished by providing an electrical connection comprised of at least two printed circuit boards parallel mounted one to the other with one connection member electrically connected to a first printed circuit board, and a second connection member electrically connected to a second printed board, the first and second connection members being electrically connectable to electrically connect the first and second printed circuit boards.

The connection is characterized in that the first printed circuit board includes a recessed section on an inner surface of the one board, and the first electrical connector member is positioned in the recessed section, with a lower surface of the connection member being positioned below the inner surface of the first printed circuit board. The first printed circuit board has electrical traces on the inner surface and the first electrical connector includes electrical contact terminals extending outwardly of an insulating housing of the first electrical connector, the contact terminals having contact portions positioned above the lower surface of the first electrical connector and the contact portions are electrically connected to the electrical traces.

By providing a recessed section on the inner surface of the one board and by lowering the first electrical connector member into the recessed section, the distance between the top of the electrical and the inner surface of the printed circuit board has been reduced, without sacrificing the size of the electrical connector member housing.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows a three dimensional view of the female portion of the electrical connector of the present invention;

Figures 2 and 3 show alternate embodiments of the present invention to different embodiments for mounting at various depths with.in the printed circuit board;

Figure 4 shows the terminal blank as stamped for use with any of the connectors showing Figures 1 - 3;

Figures 5 - 7 show the terminal modifications to the blank of Figure 4 for use with the connectors of Figures 1 - 3;

Figure 8 shows the male connector adapted for interconnection with any of connectors shown in Figures 1 - 3;

Figure 9 shows an isometric view of the male tab terminal used in the connector of Figure 8;

Figure 10 shows the male and female connector halves mounted to respective printed circuit boards where the male and female connector halves are prepared for electrical connection;

Figure 11 shows the two connector halves in electrical connection;

Figure 12 shows an isometric view of the underside of the two printed circuit boards; and

Figure 13 shows an alternate embodiment for the female electrical terminal.

With reference first to Figure 1 the female connector is shown generally at 2 and includes an insulating housing 4 having an upper mating face 6 with a plurality of terminal passage ways 8. Opposed from each of the terminals passageways 8 are terminal retaining apertures 10 as will be described in greater detail herein. The housing 4 also includes side walls 12 and end walls 14. A flange portion 16 extends around the periphery of the side walls 12 and end walls 14 forming an upper platform surface 18.

It should also be noted as from Figure 1 that the flange portion has a vertical slot therethrough forming edge surfaces 20 as will be described in greater detail herein. As shown in Figure 1, the end faces 14 extend downwardly to a lower surface 22, the lower face 22 being shown most clearly in Figure 12 as having laterally disposed slots 24.

With respect still to Figure 1, the female connector 2 includes a plurality of electrical terminals 30 having opposed contact portions 32 disposed proximate to the upper face 6 and positioned within the passageways 8. As shown in Figure 1, the terminal passageways 8 are cruciform in shape, including portions 8a for receipt of the contact portions 32, and transverse portions 8b for receipt of mating tab portions, as will be described herein. The terminals 30 further

include locking legs 34 disposed in respective apertures 10. Each of the terminals includes a lower leg portion 36 in continuity with a surface mount portion 38 having a lower surface 40 which can be positioned on a circuit pad for soldering the connector to a printed circuit board. With respect now to Figures 4 - 7, the electrical terminal will be described in greater detail.

As shown first in Figure 7, the electrical terminal 30 includes opposed contact portions 32 where each of the contact portions are connected to first and second contact arms 42 and 44 where each of the contact portions are joined along a lower base portion 46. The base portion 46 is continuous with the lower leg portion 36 via a bight portion 48. The locking leg 34 extends vertically upwardly from the lower leg 36 and retains the terminals 30 to the housing 4 as described above with reference to Figure 1. As shown in Figure 7 the surface mount contact portion 38 also extends outwardly from the lower leg portion 36.

As configured in Figure 1, the electrical connector 2 is suitable for mounting to an electrical printed circuit board 50 as shown in either of Figures 10 or 12. As shown in Figure 10, the electrical connector 2 is shown mounted to an electrical printed circuit board 50, where the housing 4 projects through an opening 52 (Figure 12), with the lower surface portions 40 of the surface mount legs 38 electrically interconnected to circuit pads 54 (Figure 10) of the printed circuit board 50.

As shown in Figures 10 and 12, the electrical connector housing 4 is recessed below an upper surface 56 of the printed circuit board which substantially reduces the vertical distance y(1) between the upper mating face 6 of the housing 2 and the upper surface 56 of the printed circuit board. As mentioned above, it is desirable to reduce the distance between parellel mounted circuit boards thus making it desirable to reduce the vertical distance between the upper face of an electrical connector and the upper surface of the printed circuit board. Thus, by recessing the electrical connector into an aperture of the printed circuit board, this distance has been substantially reduced as compared to electrical connectors which have either surface mount or through hole mount electrical terminals extending through a lower face of the electrical connector housing and where the housing is above the surface of the printed circuit board.

As shown in Figures 5 and 6, alternate electrical terminals are shown as 130 and 230 having corresponding features as that described with relation to Figure 7. As shown in Figures 5 - 7, it should be appreciated that the connecting portions 37, 137 and 237 vary in vertical height which also varies the vertical position of the surface mount contact portion 38, 138 and 238. By varying the electrical terminals between those shown in Figures 5 - 7, the electrical connector can be configured as shown in Figures 1 - 3.

For example the terminal shown in Figure 7 corresponds to the resultant connector shown in Figure 1; the terminal shown in Figure 6 corresponds to the resultant connector shown in Figure 2 while the electrical terminal shown in Figure 5 corresponds to the electrical connector shown in Figure 3. It should also be appreciated then that by varying the electrical terminals of the connector 4 as shown in Figures 1 - 3 or between any variation thereof, the vertical distance y(1) as described earlier with respect to Figure 10, which is the distance between the upper surface 6 of the housing and the upper surface 56 of the printer circuit board, can be increased or decreased as desired.

As shown in Figure 4, a uniform terminal stamped blank 31 is shown which can be used to make any of the electrical terminals which correspond to Figures 5, 6 or 7. It should be appreciated that a single terminal can be stamped and the appropriate surface mount leg 38, 138 or 238 can be retained while the other unneeded portion can be discarded by stamping that portion away.

As shown in Figure 8 a corresponding mating male connector is shown as 60 having an insulative housing 62 comprised of end walls 64, side walls 66 and open upper face 68 forming an internal cavity, and a lower surface 70. The housing 60 further includes two outer insulating ribs 72 having openings 74 therethrough, providing an appropriate position for the position of electrical male contacts 80.

As shown most clearly in Figure 9, the electrical male terminals 80 include upper tab portions 82 for electrical connection with the opposed contact portions 32 described above, where the upper tab portions extend vertically upwardly from a lower base portion 84 which in turn are electrically connected to surface mount leg portions 86 via interconnection portions 88. As configured in Figure 8, the lower leg portion 84 is positioned exterior to the housing adjacent to the lower surface 70 of the housing 60 thereby positioning the surface mount leg portion 86 exterior to the housing 60 along side the side walls 66 in a similar nature to the female connector 2 shown in Figure 1. It should be appreciated then that the male tab contacts shown in Figure 9 could be varied as are the terminals shown in Figure 5 - 7 by varying the interconnection portion 88 in length to raise or lower the surface mount contact portion 86.

Thus as shown in Figure 12, the male electrical connector 60 is shown electrically connected to a printed circuit board 90 where the housing 62 is shown recessed within an aperture 82 of the printed circuit board. The surface mount contact legs 86 are electrically connected to circuit pads 92 on the printed circuit board. Thus as shown in the progression of Figures 10 and 11, the electrical connection system as described above can be used to reduce the vertical dimension y(2) shown in Figure 11 between the opposing printed circuit boards 50 and 90.

It should be appreciated that by varying the electrical terminals in accordance with the teaching of the present disclosure that many different variable distances y(2) can be achieved. It should also be appreciated that various printed circuit boards can take on various architectures given the connector designs to complement the connector designs. For example as shown in Figure 11, the female electrical connector 2 is shown recessed below the printed circuit board 50. Thus low height electrical components could be added to the lower surface 58 of the printed circuit board such that the distance is not lost between the lower surface of the printed circuit board 58 and the lower surface of the electrical connector, shown in Figure 11 as y(3). It should also be appreciated that the real estate intermediate the surfaces 56 and 96 could also carry various components such that this volume is not wasted.

Finally with respect to Figure 13, an alternate electrical terminal 330 is shown which can be used in place of the electrical terminal 30 shown in Figures 47 in the event that thermal expansion and retraction could be a problem. As shown in Figure 13 the terminal 330 includes a reverse spring arm 331 which is integral with either of the contact arms 338 or 339. This reverse spring arm 331 allows for more movement of the electrical connector without cracking the solder joint between the electrical terminals and the electrical circuit pad on the printed circuit board. It should be appreciated that this configuration could also be used on the male electrical terminals shown in Figures 8 and 9.

Claims

1. A surface mount electrical connection comprised of a printed circuit board and an electrical connector, the connection being characterized in that:

   the printed circuit board (50,90) includes a recessed section (52,82) on an inner surface (56,96) of said board, and said electrical connector member (2,60) is positioned in said recessed section, with a lower surface (22,72) of said connector member (2,60) being positioned below said inner surface (56,96) of said printed circuit board (50,90), said first printed circuit board (50,90) having electrical traces (54,94) on said inner surface (56,96), and said electrical connector (2,60) including electrical contact terminals (37,137,237,337,88) extending outwardly of an insulating housing (4,62) of said electrical connector (2,60), said contact terminals (37,137, 237,337,88) having contact portions (38,138, 238,338,86) positioned above said lower surface (22,72) of first electrical connector (2,60), said contact portions (38,138,238,338,86) being electrically connected to said electrical traces (54,94).

2. An electrical connection in accordance with claim 1, characterized in that said recessed section (52,82) is defined by an opening positioned completely through said printed circuit board (50,90).

3. An electrical connection in accordance with claims 1 or 2, characterized in that said connection includes two printed circuit boards (50,90), each having a connector member (2,60) electrically connected thereto, both said first (50) and second (90) printed circuit boards (50,90) have recessed sections, and both said first and second connector members (2,60) have lower surfaces (22,72) positioned below inner surfaces (56,96) of respective first and second printed circuit boards (50,90).

4. An electrical connection in accordance with claim 3, characterized in that said first and second electrical connector members (2,60) have printed circuit board contact portions extending from said lower surface (22,72), having upstanding leg portions extending upwardly along side edges of said insulative housings, said leg portions extending into foot portions which form the surface mount electrical connection portions (38,138, 238,338;86).

5. An electrical connection in accordance with claim 1, characterized in that said electrical connector members (2,60) each include electrical terminals, where the electrical terminals include mating contact portions (32,132,232;82) positioned within the insulative housing (4,62), said electrical terminals extending through a lower surface of said housing, said terminals including upstanding leg portions flanking side walls of said housing, and feet portions extending from said leg portions, said feet portions being adapted to overly said inner surface (56,96) of said printed circuit board (50,90), said feet portions having edges (40) in contact with said electrical traces (54,94).

6. An electrical connection in accordance with any of claims 1-5, characterized in that electrical components (C_1,C_2) are mounted to said inner surface of said printed circuit board.

7. An electrical connection in accordance with claim 6, characterized in that electrical components (C_1,C_2) are also electrically mounted on an inner surface of said second printed circuit board.

8. An electrical connection in accordance with claim 7, characterized in that said lower surface of said first electrical connection member (2,60) extends entirely through said first printed circuit board.

9. A method of making the electrical terminals of claim 5, characterized by the steps of:

(a) forming each electrical terminal with an elongate leg portion (37,137,237,337;88)and a plurality of feet portions (38,138,238,338, 339;86) extending from said elongate leg portion, said leg portions extending horizontally from said leg portion at various vertical positions along said leg portion, and

(b) selecting one of said vertical positions for said foot portions while selectively removing said undesired foot portions, whereby the clearance between said first and second printed circuit boards when in the connected position can be selectively varied.

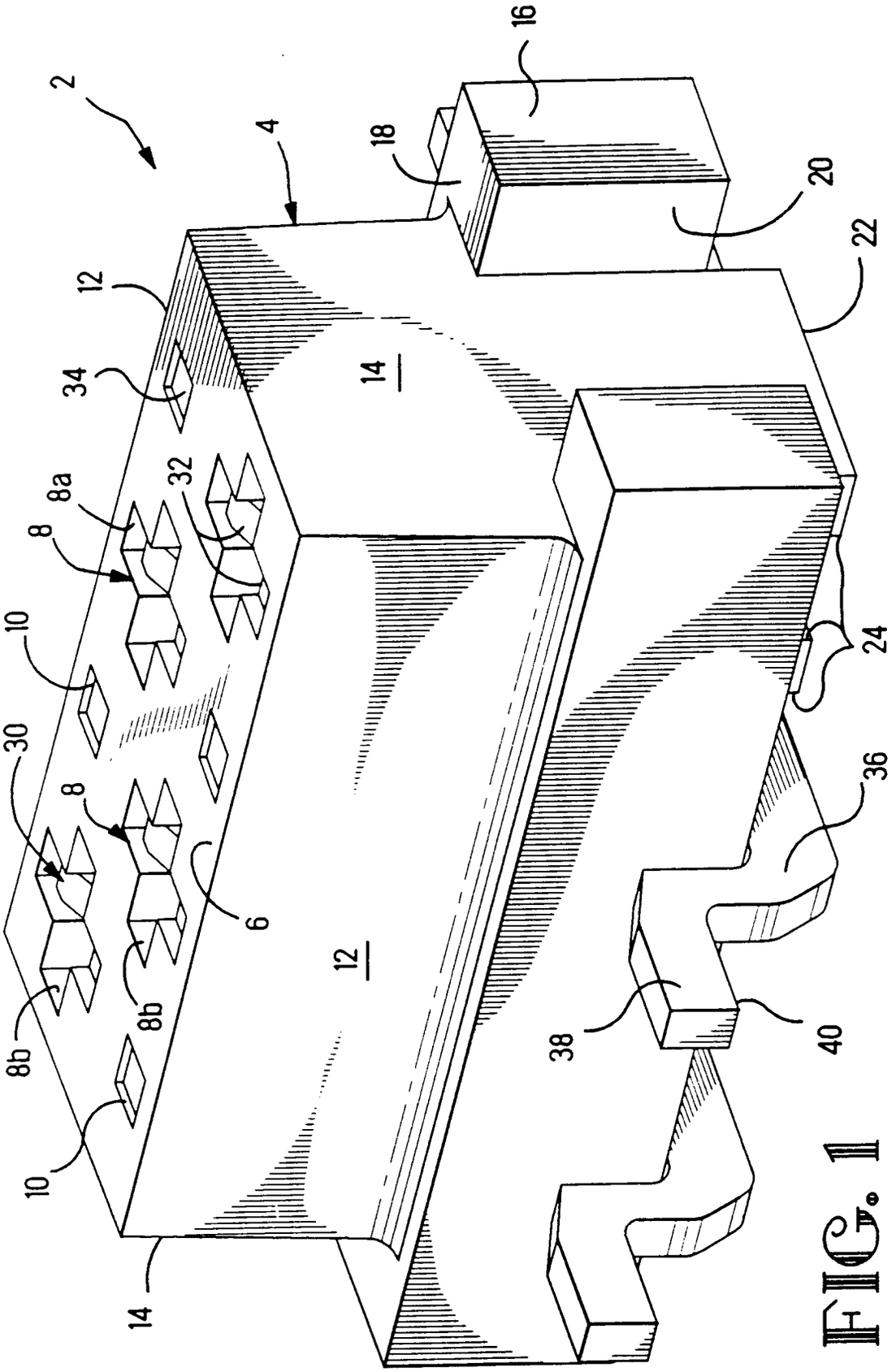
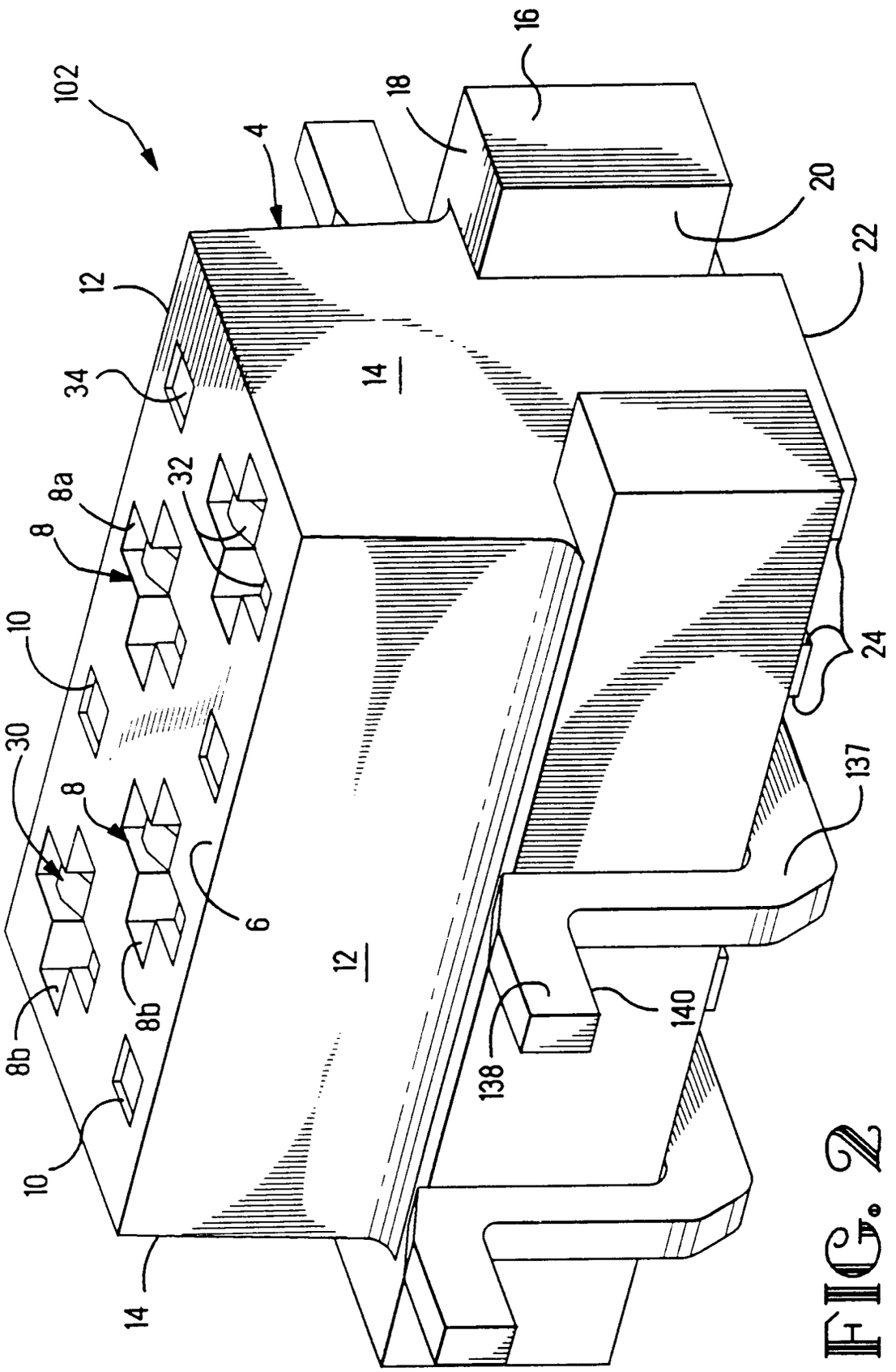


FIG. 11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4
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22
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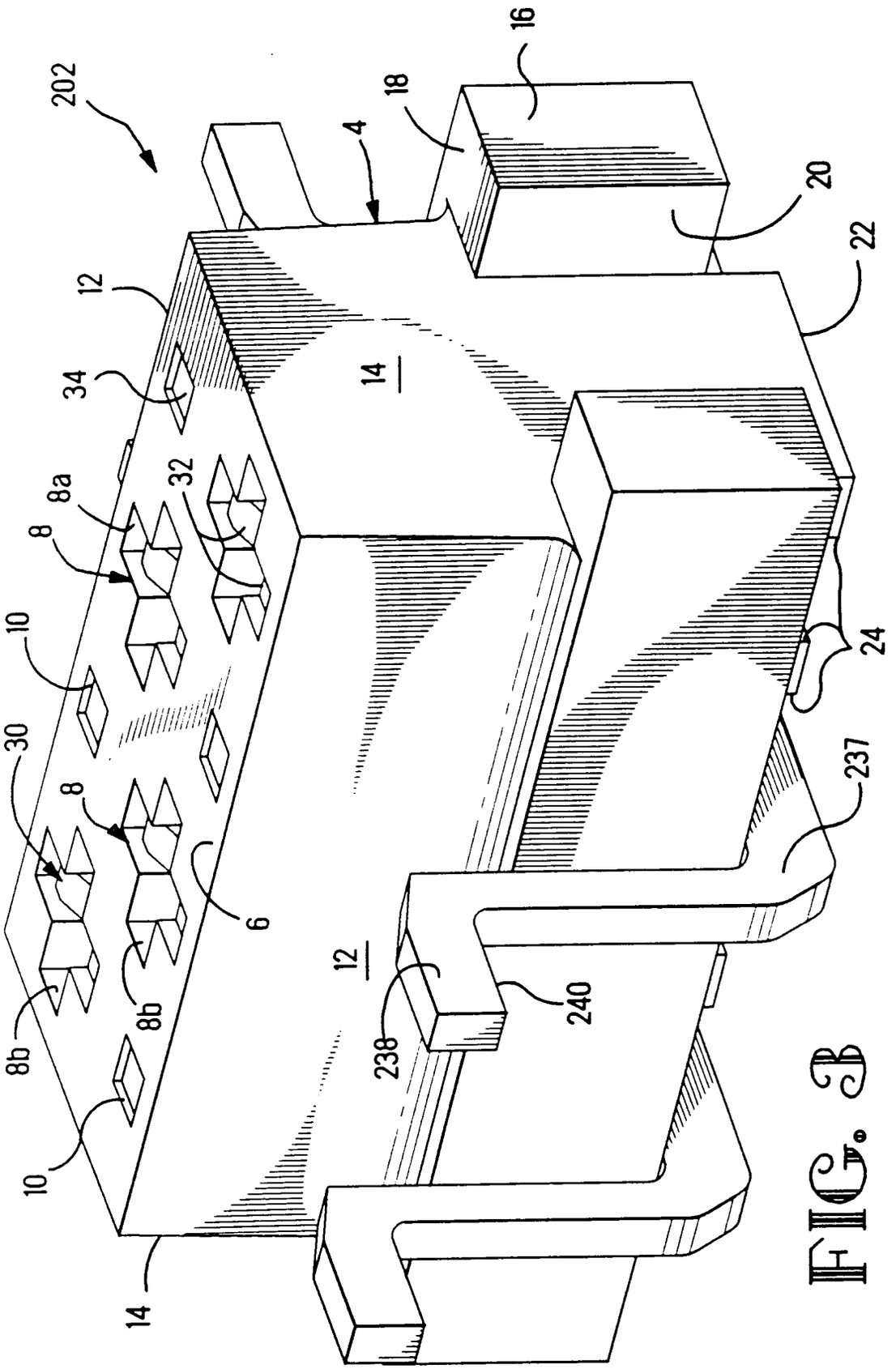
140
14

FIG. 2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8b
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238
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14

FIG. 8B

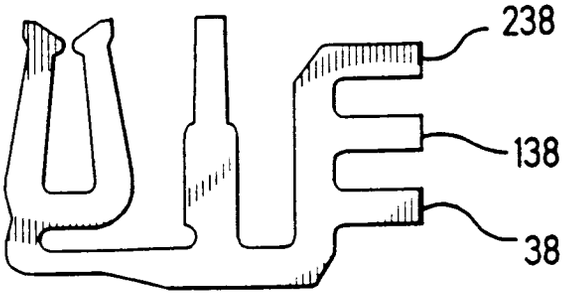

FIG. 4

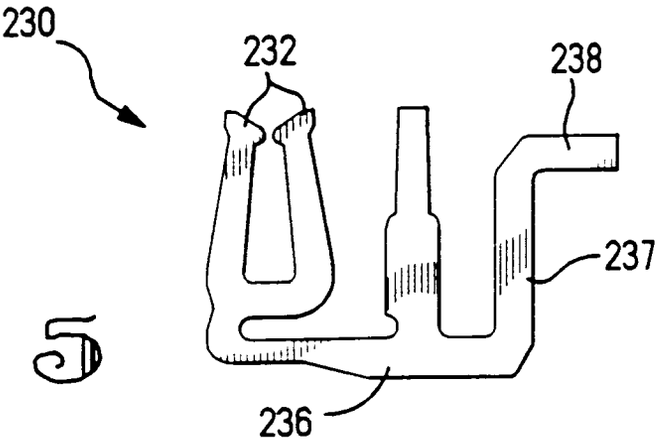

FIG. 5

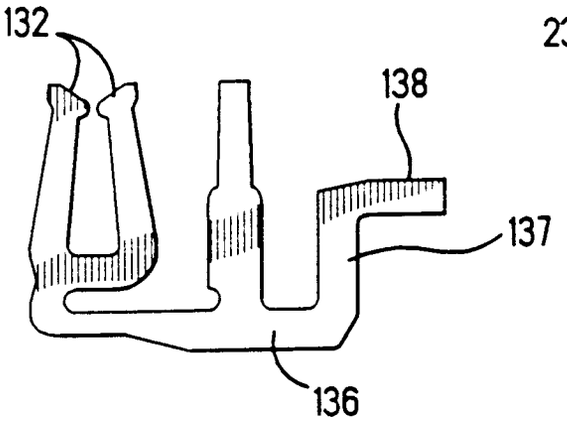

FIG. 6

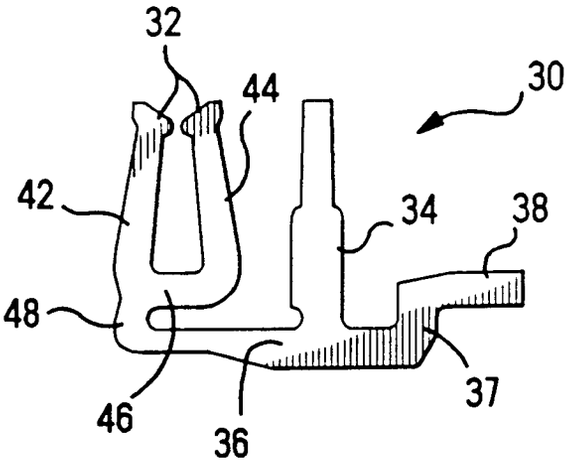

FIG. 7

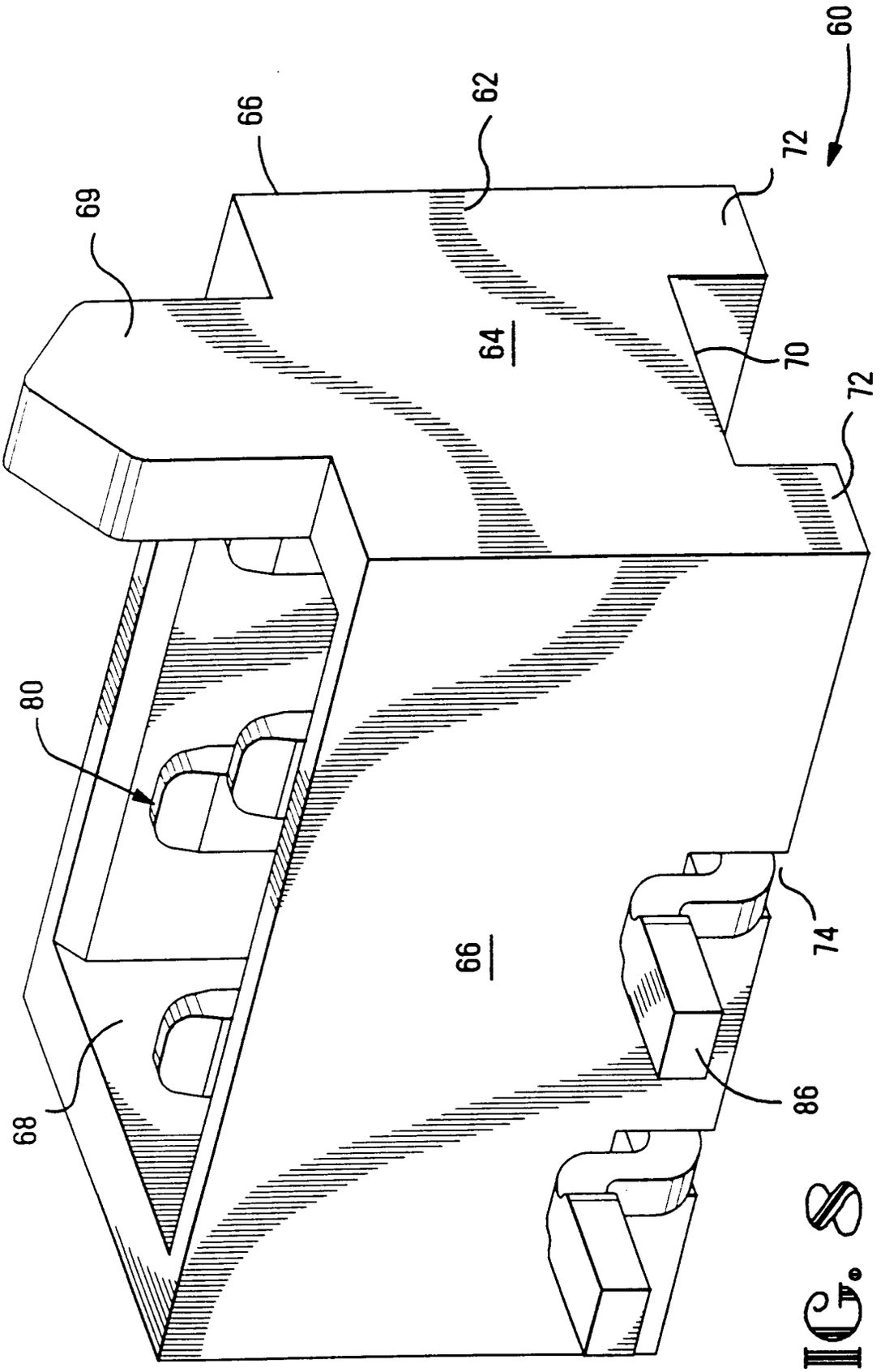

FIG. 8

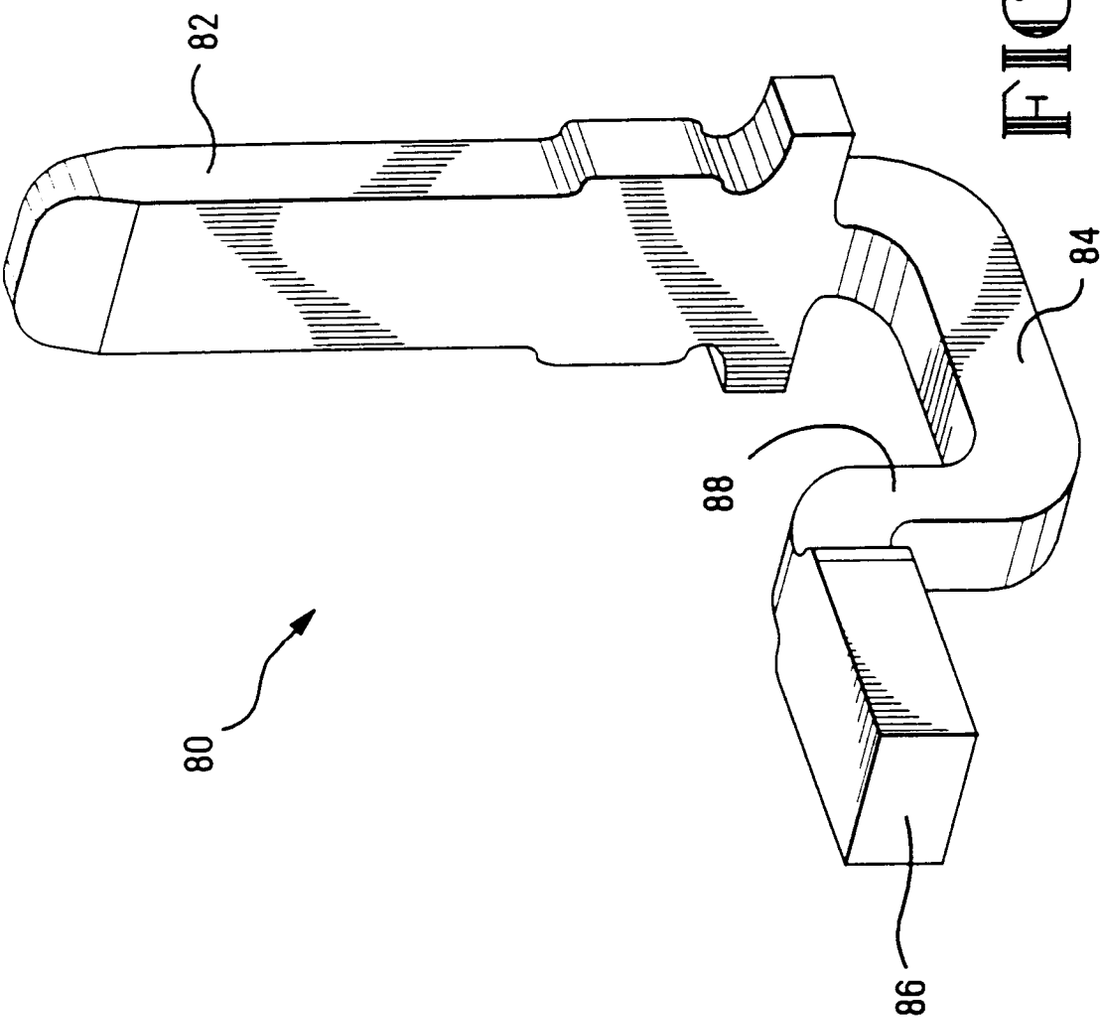

FIG. 9

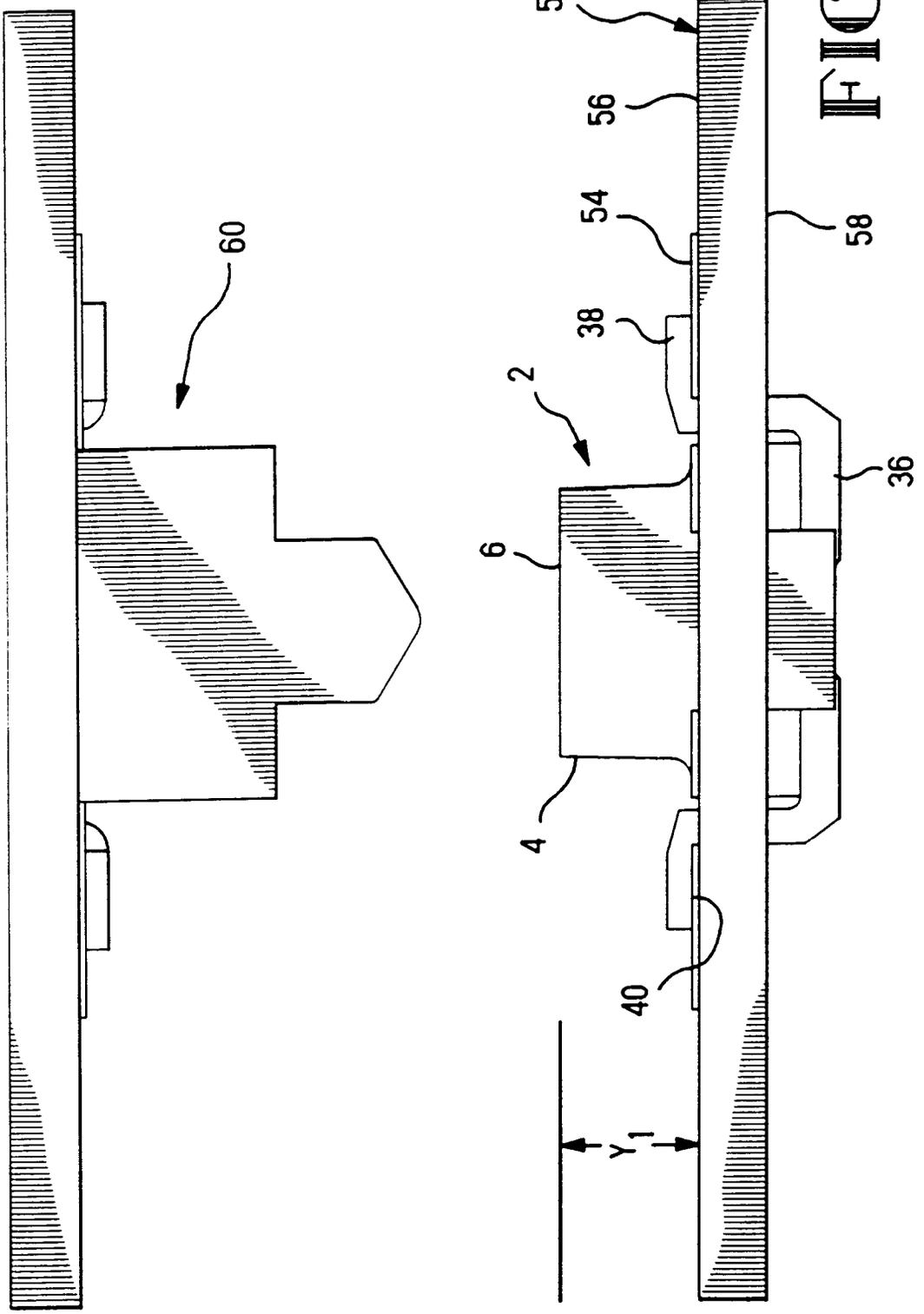

FIG. 10

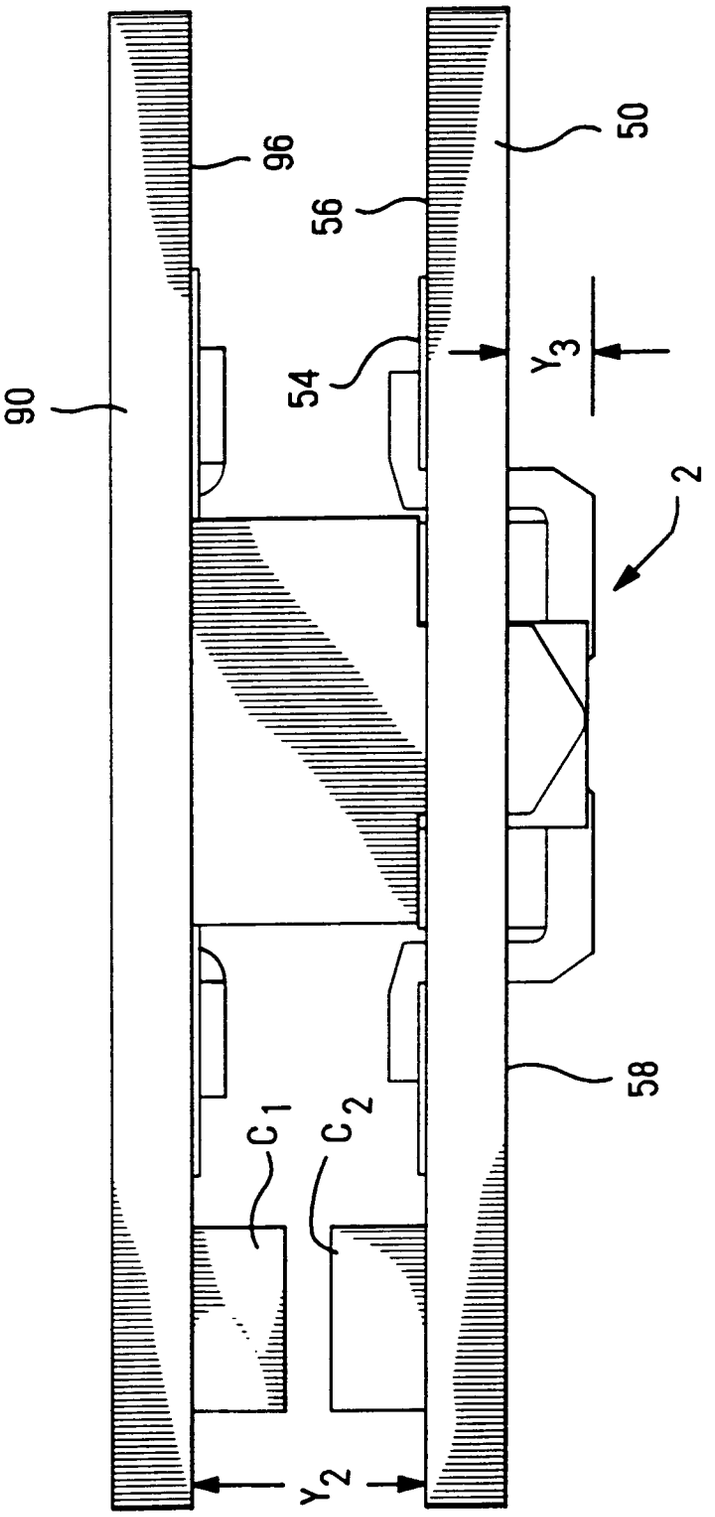

FIG. 11

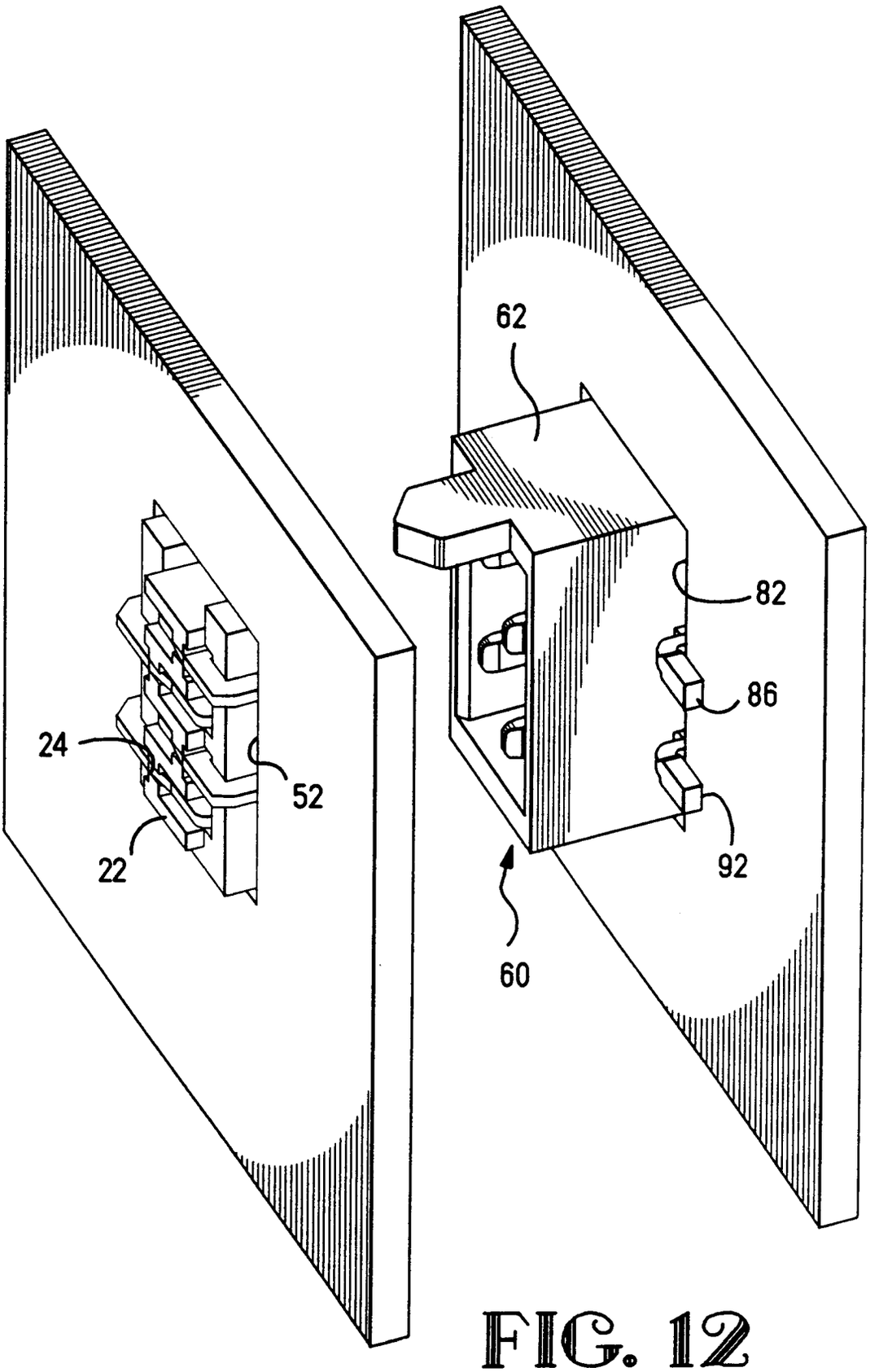

FIG. 12

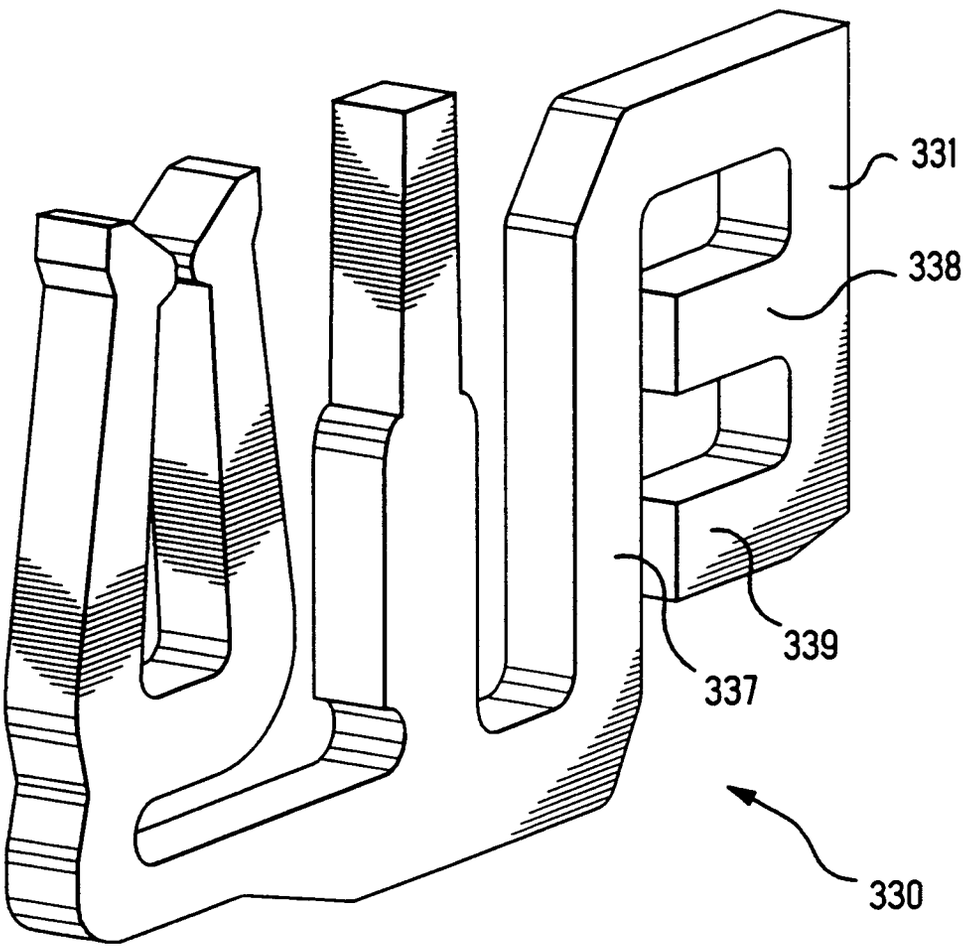

FIG. 13