

June 27, 1967

B. S. HOAGLAND ETAL

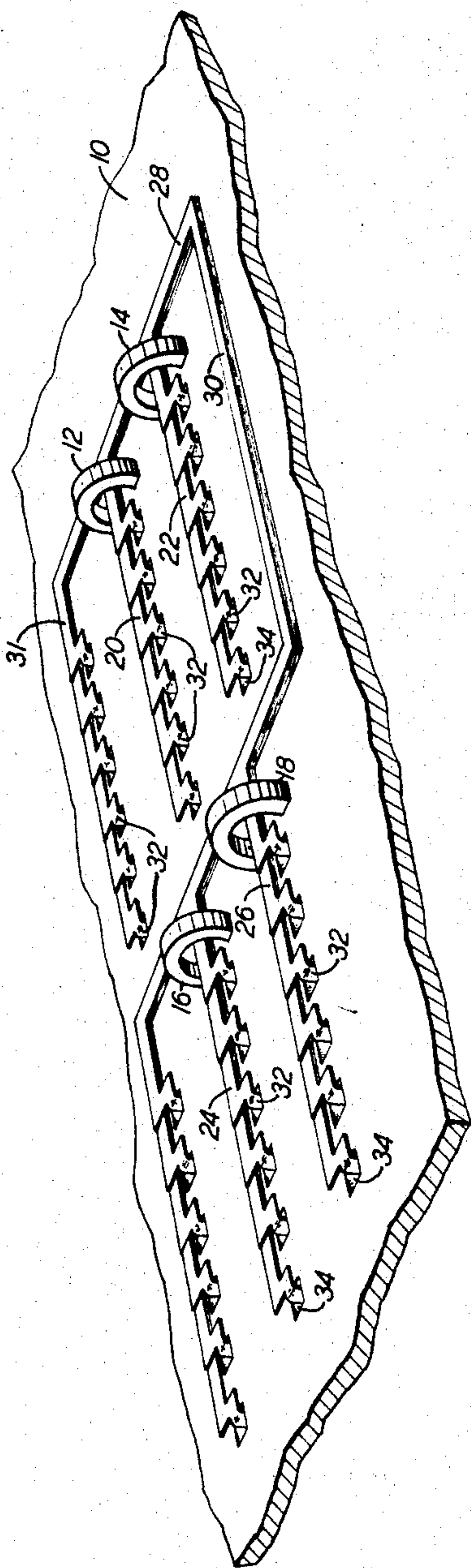
3,328,782

MAGNETIC MEMORY ASSEMBLY

Filed May 3, 1965

9 Sheets-Sheet 1

FIG. 1



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FIG. 2

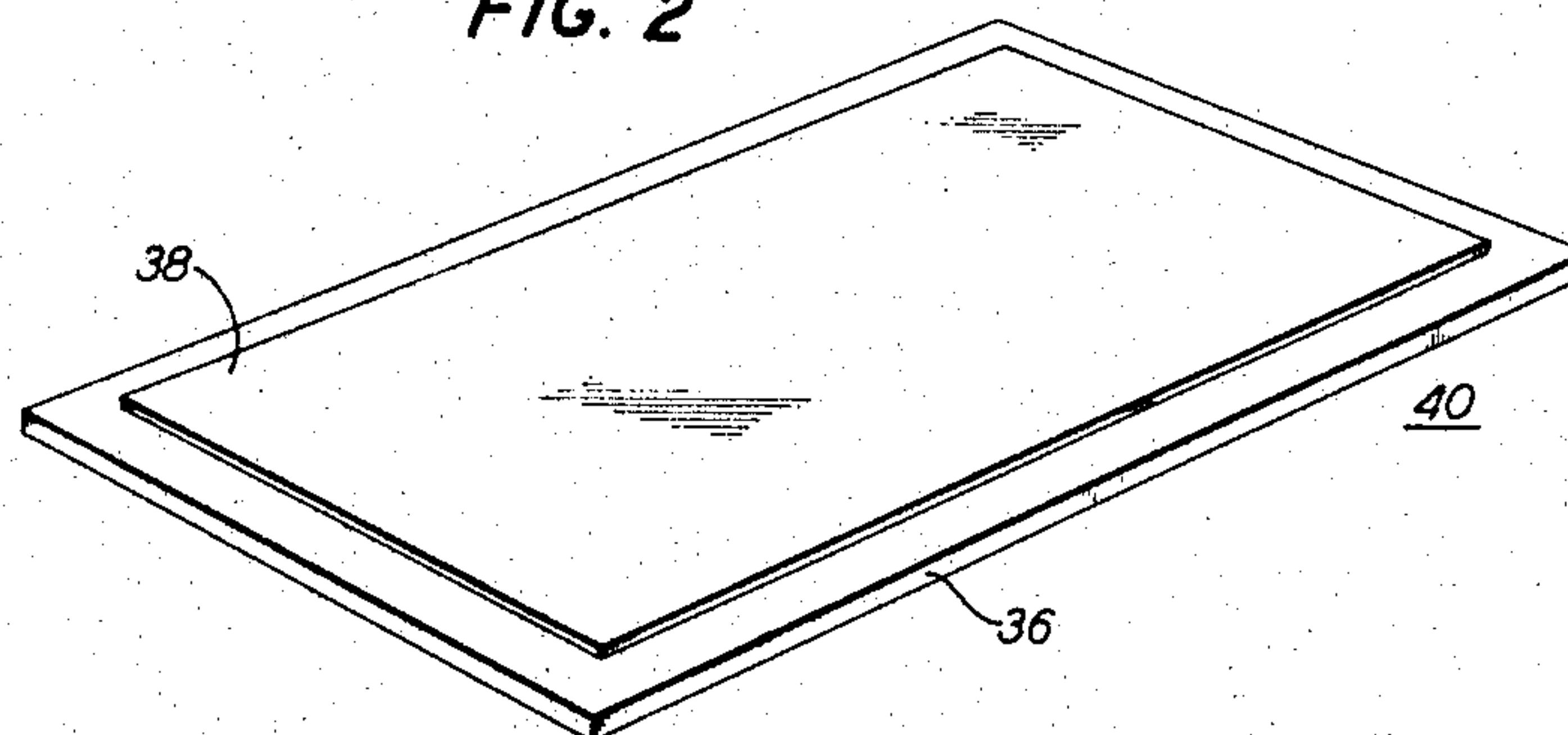


FIG. 3

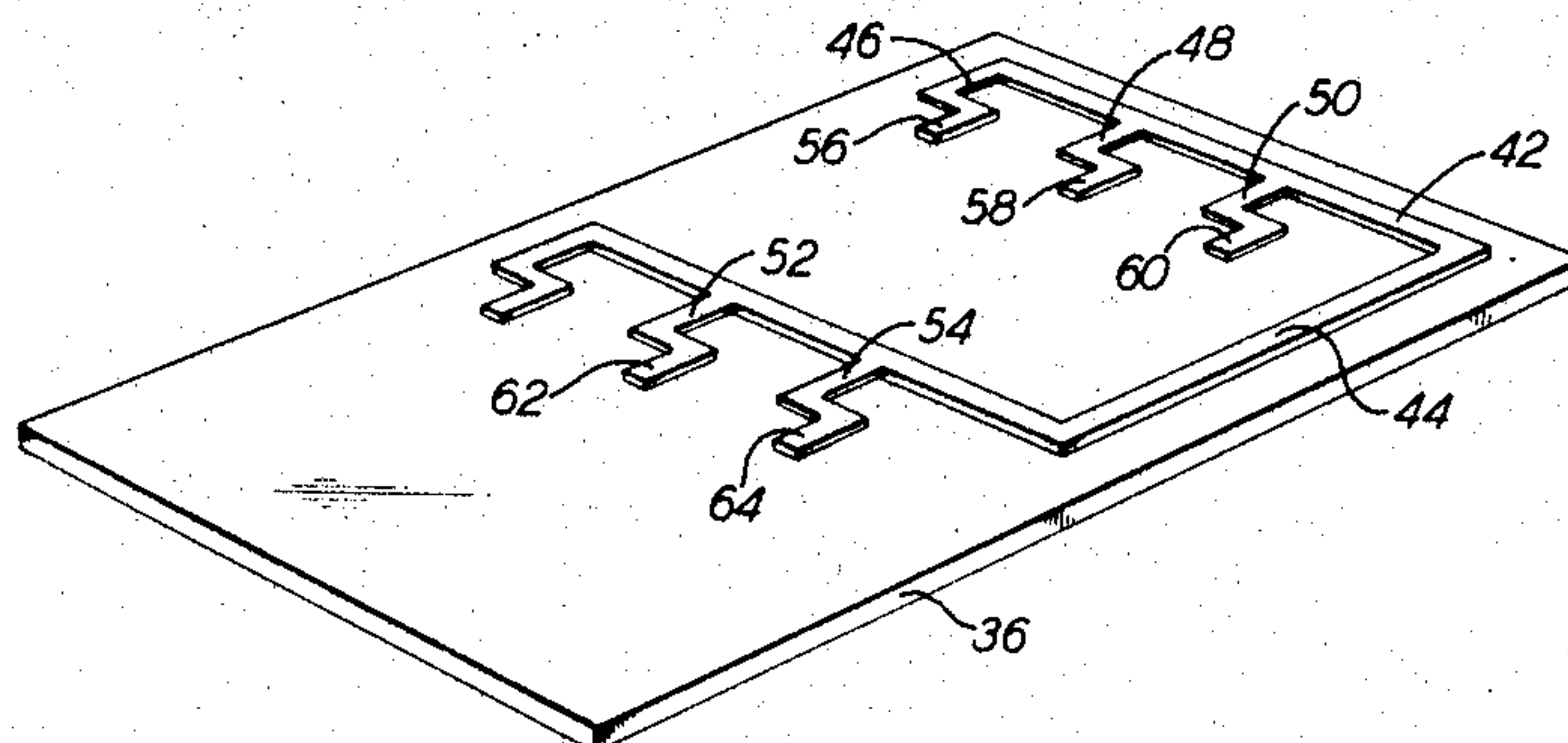
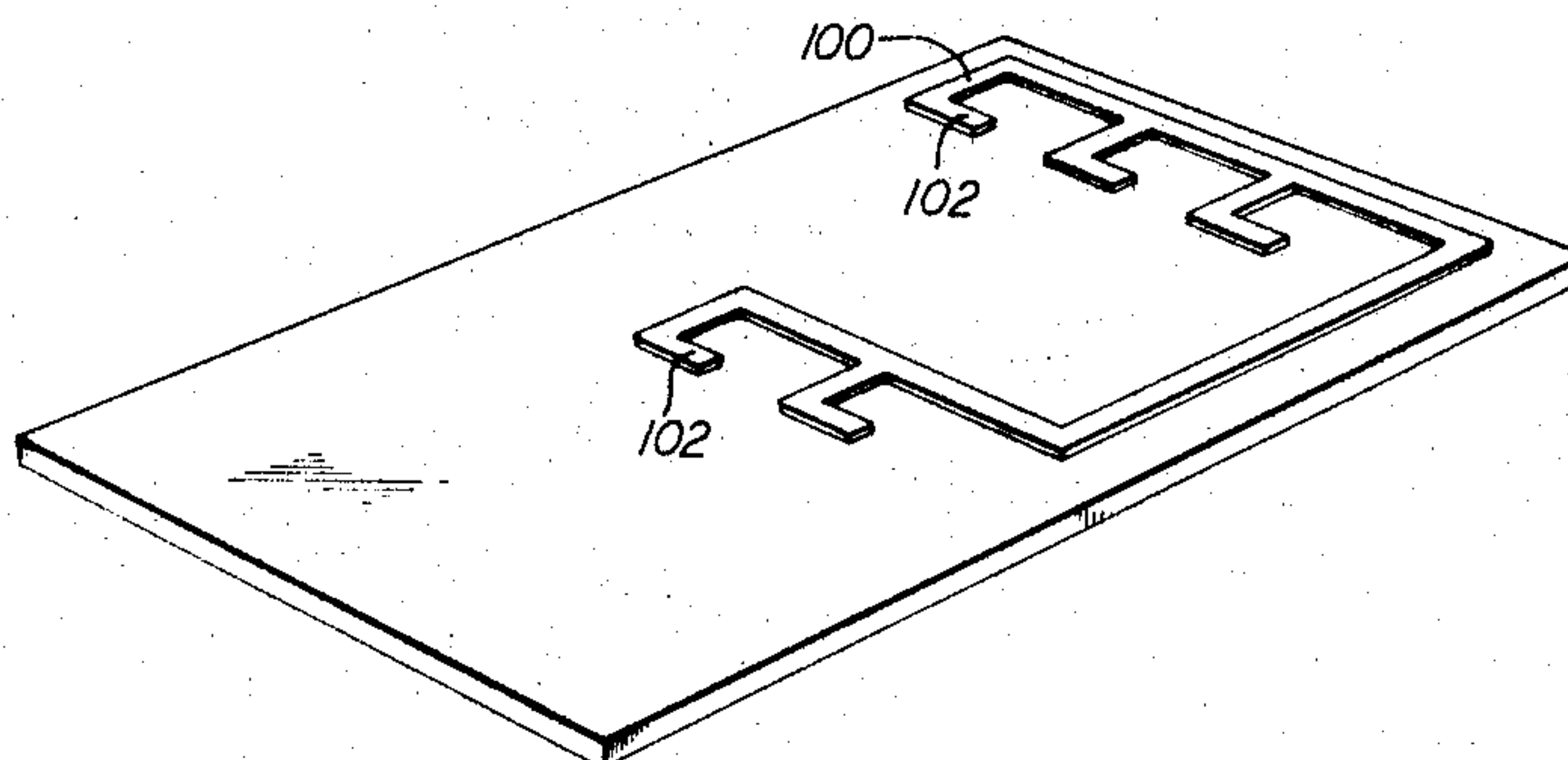


FIG. 11



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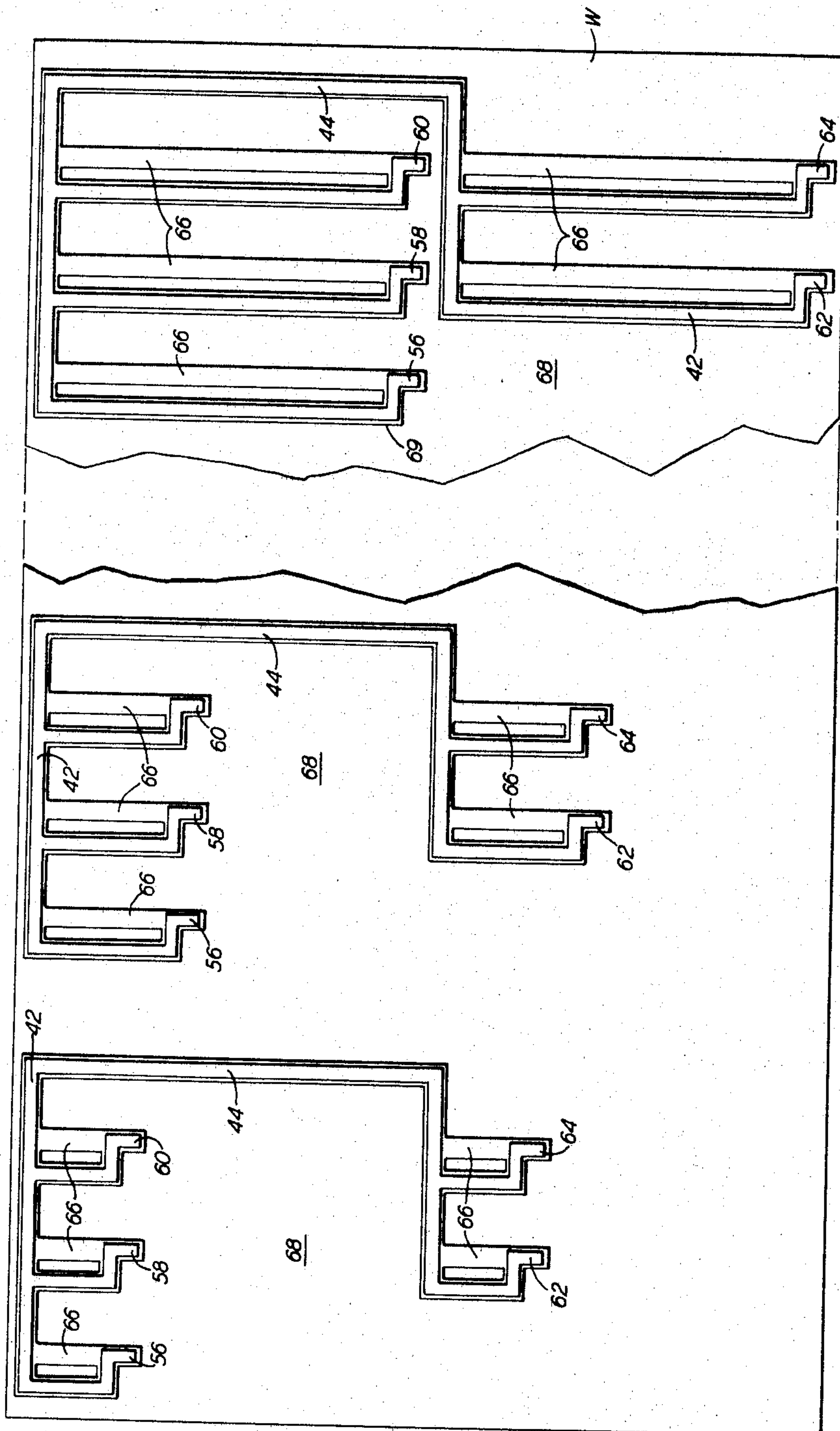


FIG. 4

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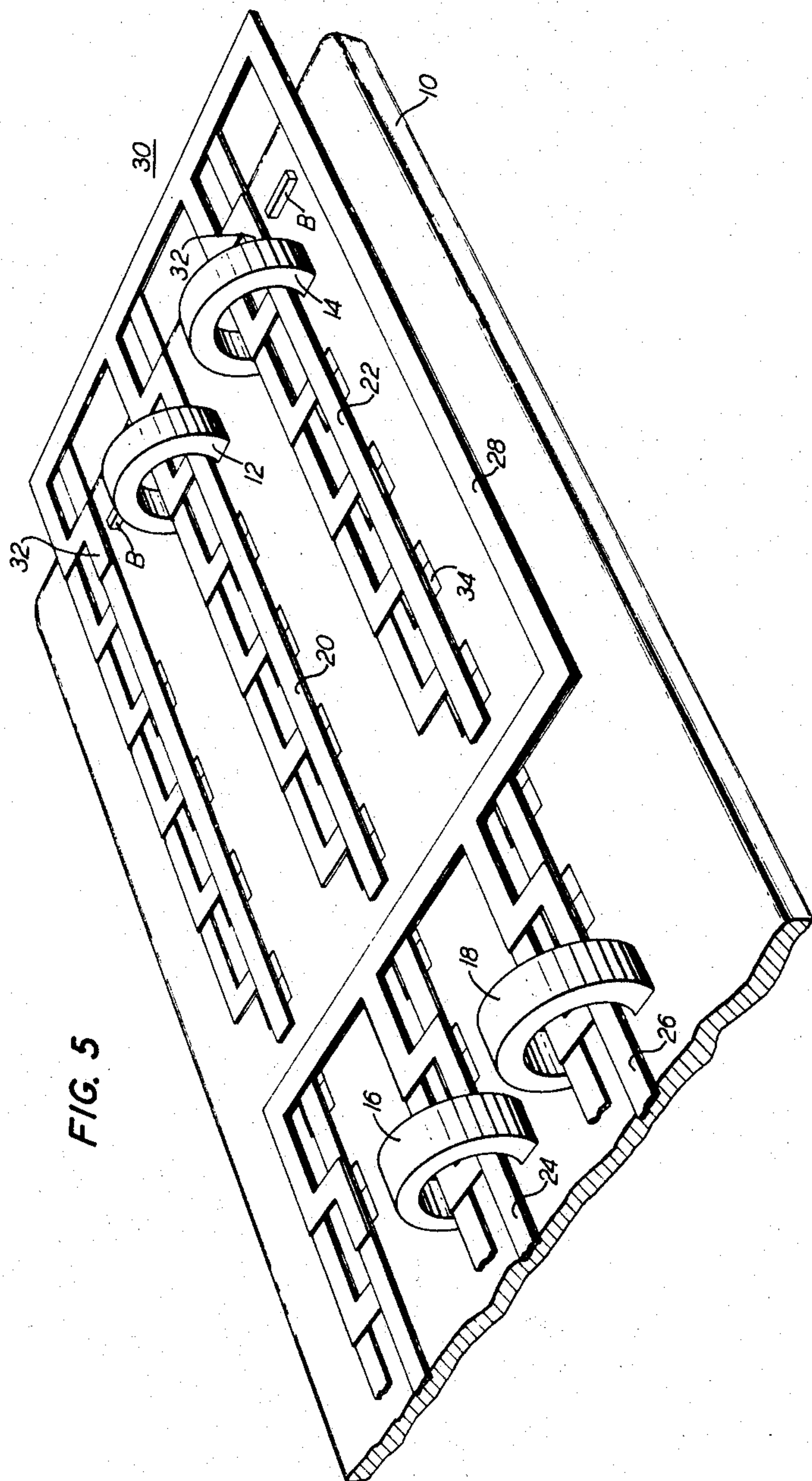
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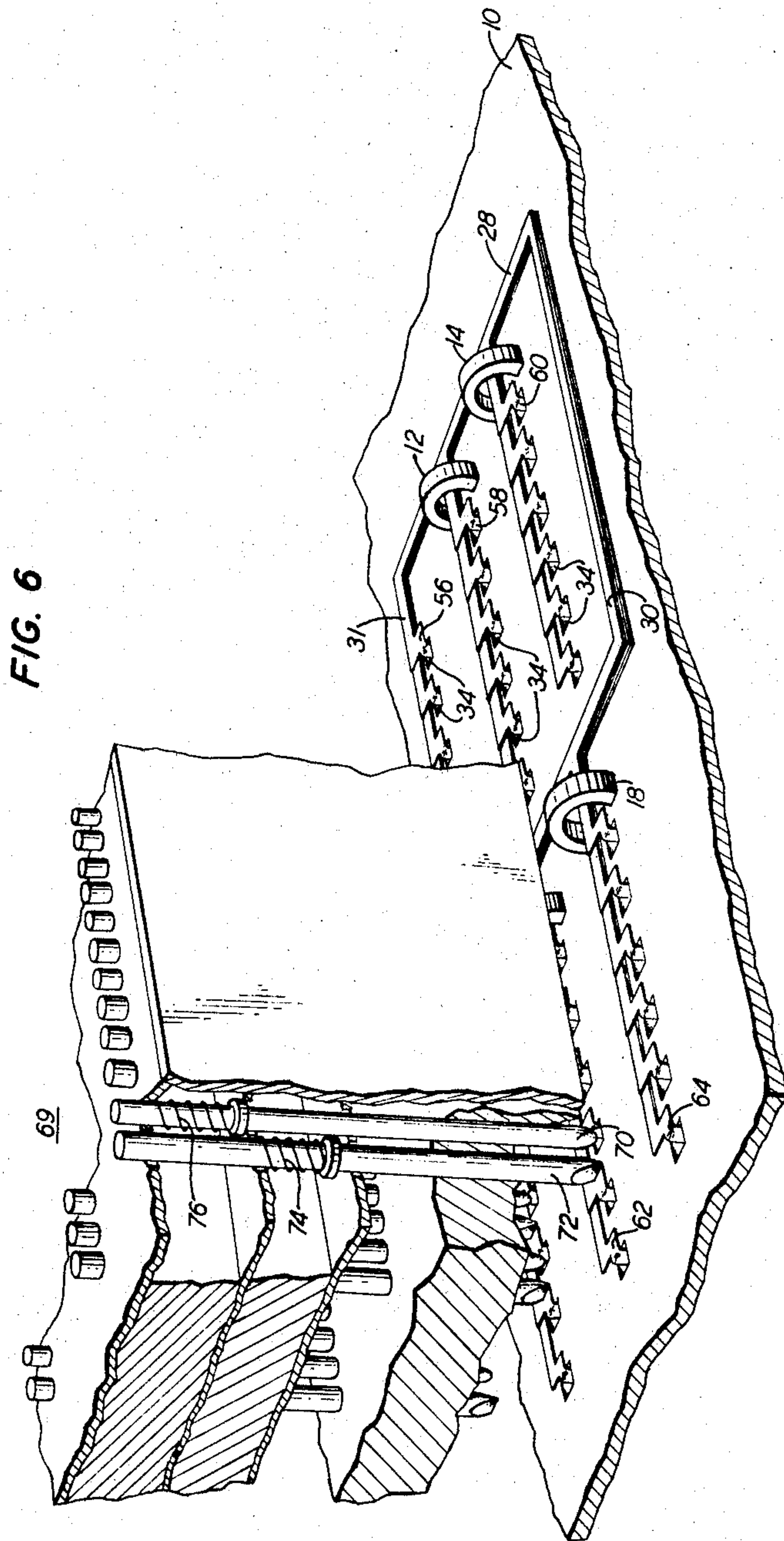
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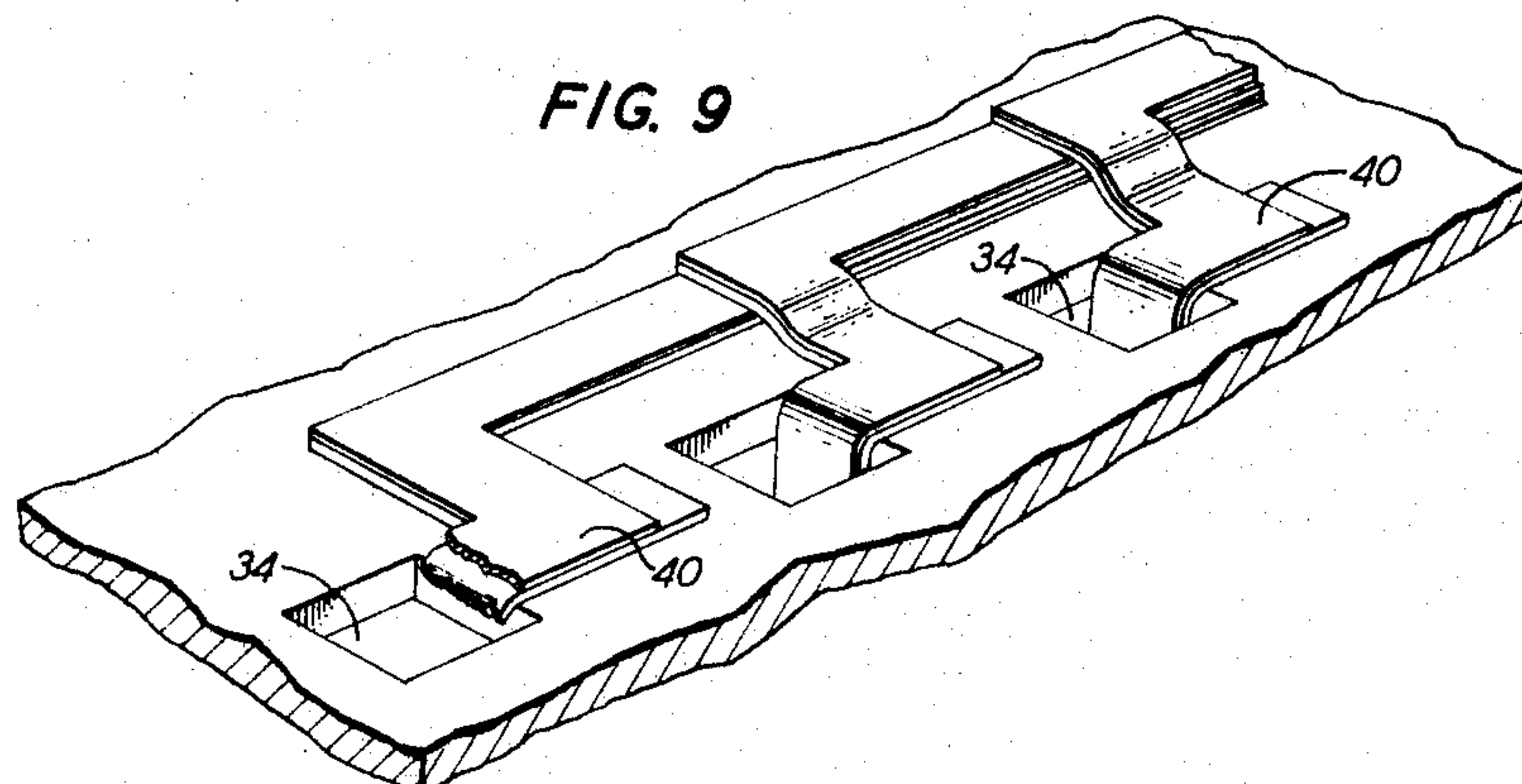
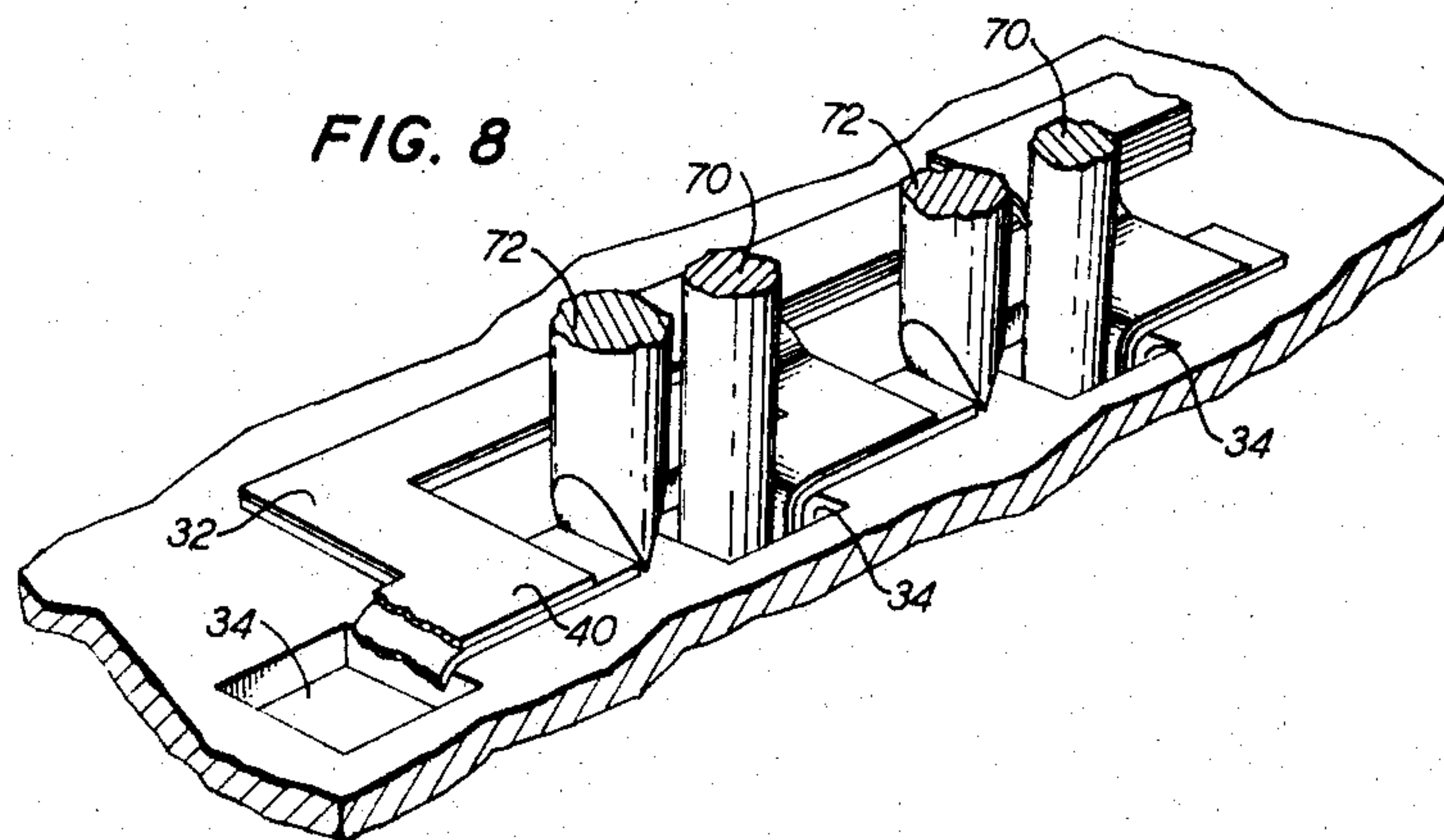
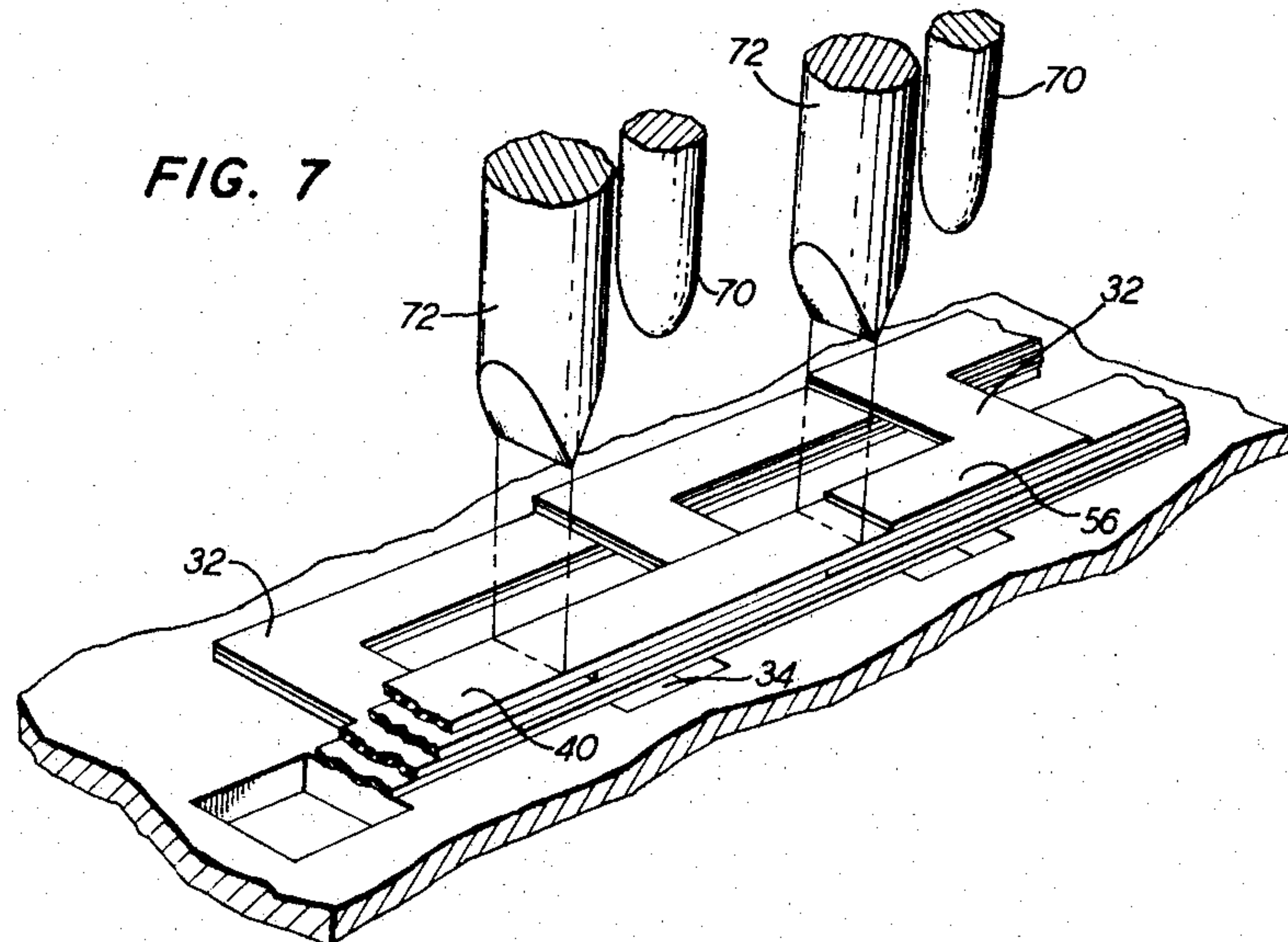
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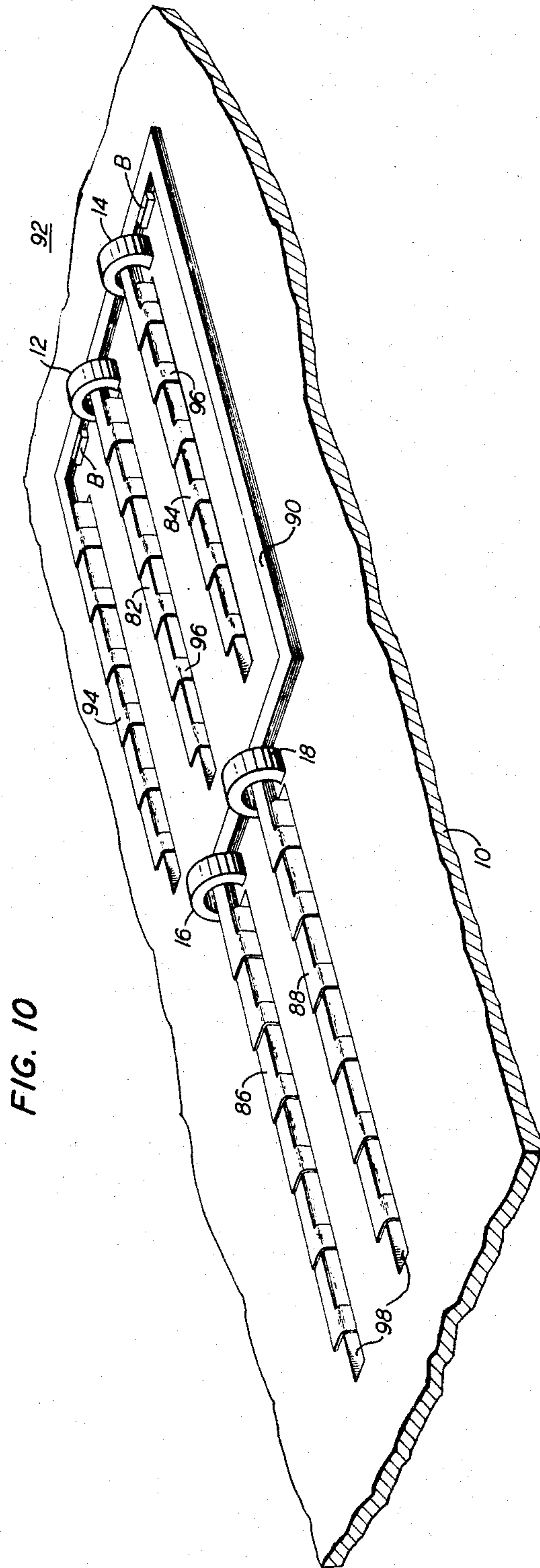
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FIG. 12

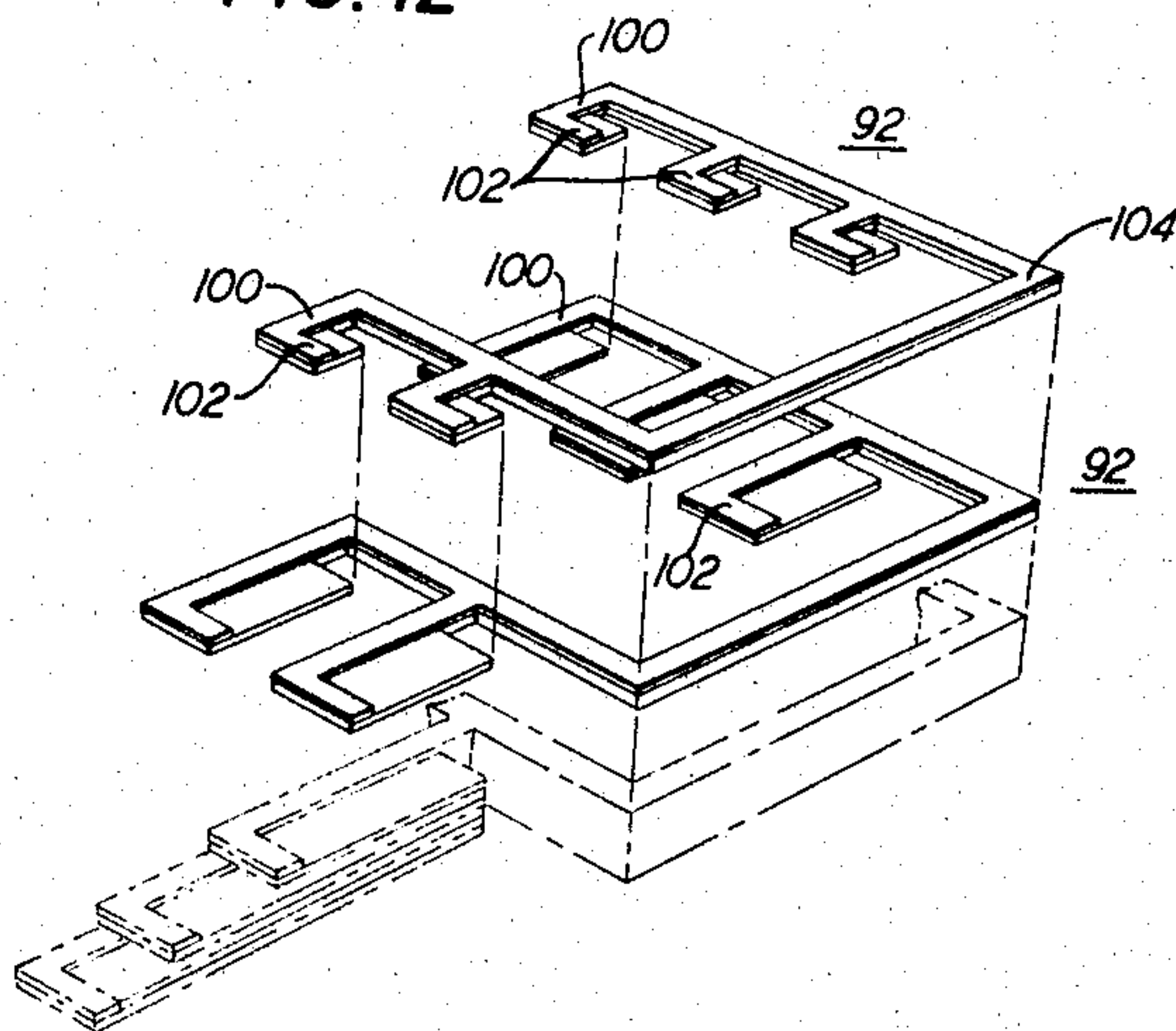
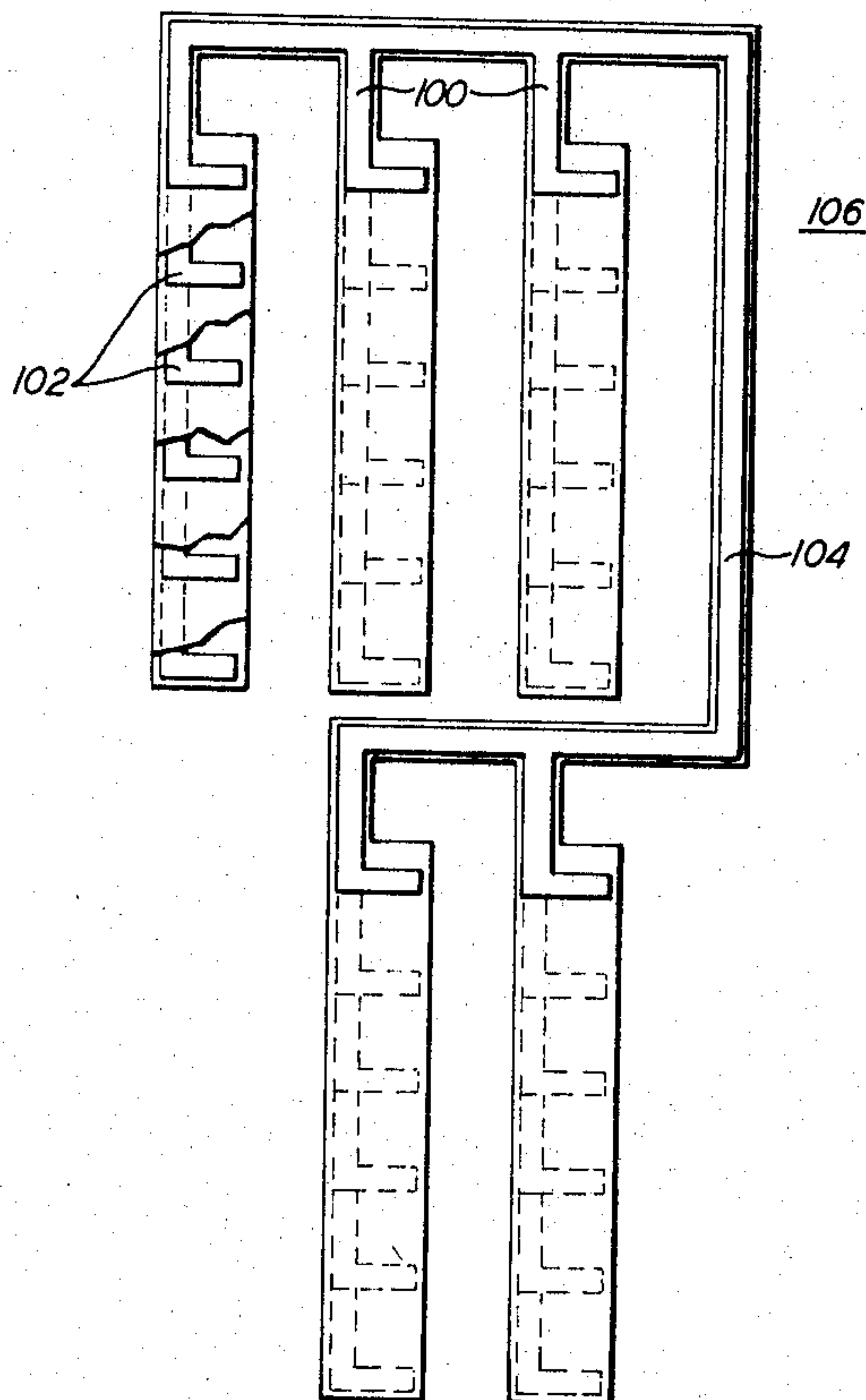


FIG. 13



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FIG. 14

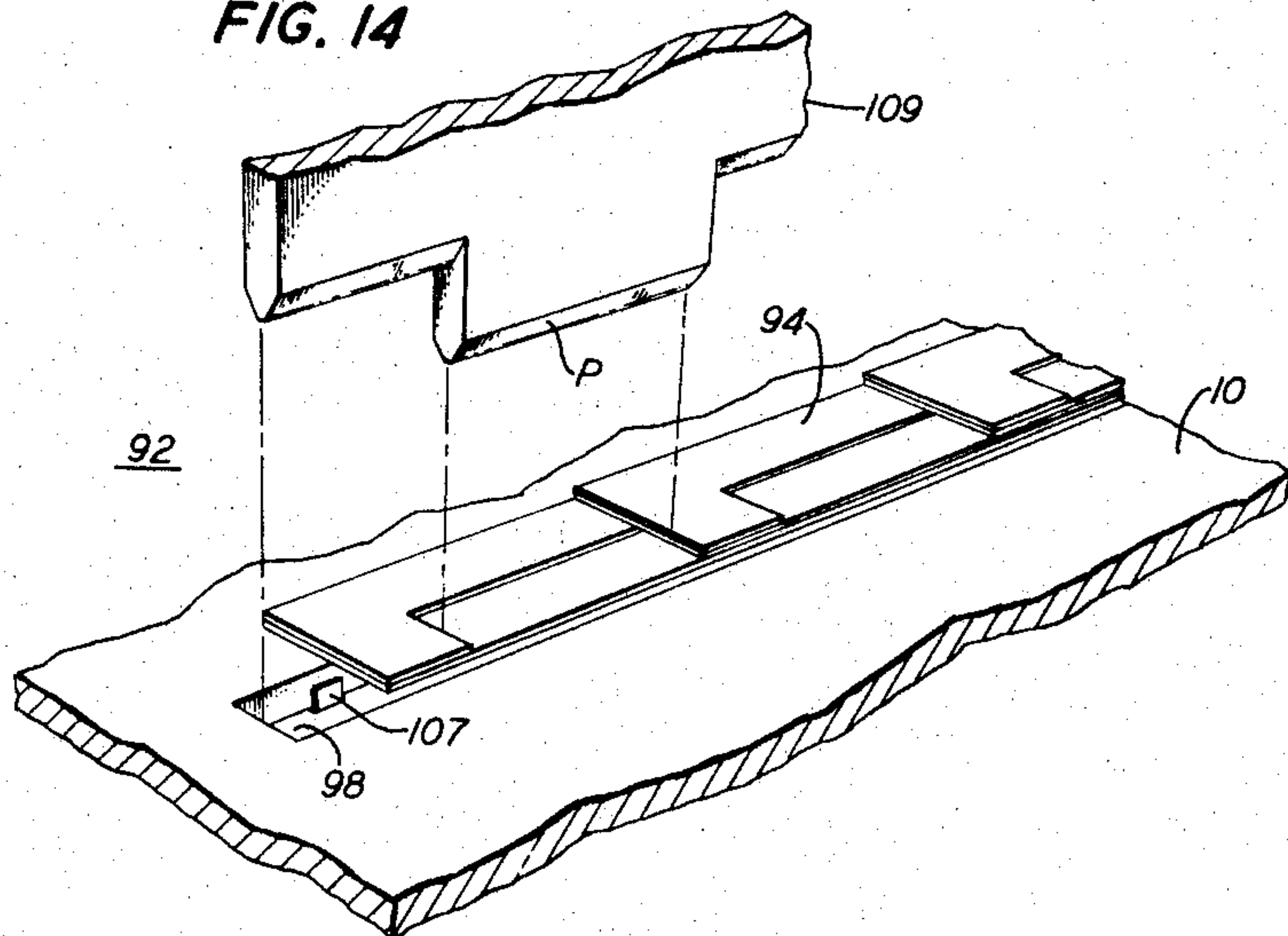
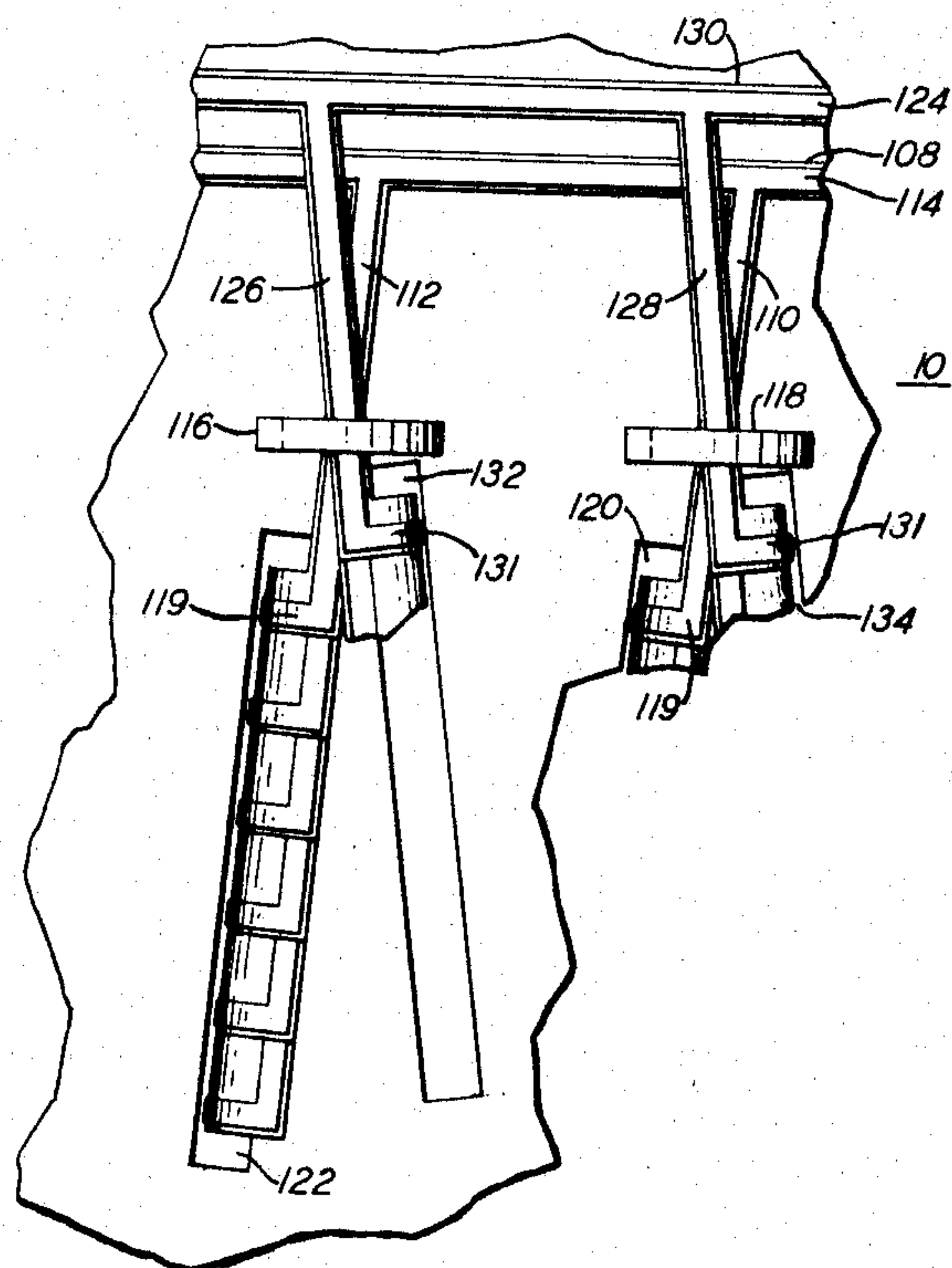


FIG. 15



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MAGNETIC MEMORY ASSEMBLY

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Filed May 3, 1965, Ser. No. 452,773

14 Claims. (Cl. 340—174)

This invention relates to magnetic memories using apertured magnetic cores, particularly disk-shaped cores having central apertures and forming parts of printed circuits, and has the object of improving and simplifying the winding arrangements on such apertured cores.

Apertured magnetic cores, for example disk-shaped ferrite cores having holes and exhibiting predetermined hysteresis characteristics, serve exceptionally well as memories for storing the information imparted to them by conductive windings to which they are magnetically linked. However, threading such apertured cores with the necessary conductive windings usually requires a manual operation. Naturally this constitutes a time-consuming and expensive fabricating step, especially in manufacturing printed circuit memories, where hand-threading represents a large labor and time expenditure as compared with printing the remainder of the wiring. The many techniques for overcoming these difficulties involve complex equipment or fabricating steps or require abandoning the use of apertured cores.

The disadvantages of manually threaded apertured cores are compounded in complicated memories where the number of cores and the number of windings linking each core is large. For example, in an automatic-number-identification (ANI) system of a private branch telephone exchange (PBX) there are a number of ferrite magnetic cores, and as many as seventeen windings must link each core.

An object of this invention is to overcome these difficulties, particularly by improving the windings linking apertured cores.

Another object is to simplify and improve printed circuit boards having a plurality of memory cores, as well as to improve the methods for threading toroidally-shaped cores.

These objects are achieved, in whole or in part, by supporting each core upon the printed circuit board with its axis parallel to the board while exposing its opening, and threading each core with an elongated multilayer conductor-insulator laminate whose conductors connect to respective terminals. According to another feature of the invention, many cores can be threaded simultaneously by shaping the multilayer laminate into elongated fingers and arranging the core axes to register with the fingers. For connection to respective terminals on the board each of the plurality of conductive layers in each finger includes an offset near one of the terminals.

These and other features of the invention are particularly pointed out in the claims forming a part of this specification. Other objects and advantages of the invention will be pointed out or will become obvious from the following detailed description when read in light of the accompanying drawings, wherein:

FIG. 1 is a perspective, partially cut-away view showing part of a printed circuit board having magnetic core devices threaded according to principles of the invention;

FIG. 2 illustrates perspective a portion of the parts from which the laminate windings of FIG. 1 are manufactured;

FIG. 3 is a perspective view of one laminate layer from which the laminae of FIG. 1 are etched;

FIG. 4 is a plan view of the individual, etched, laminate

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layers which together form the laminate structure of FIG. 1;

FIG. 5 is a perspective view illustrating threading of the cores in FIG. 1;

FIG. 6 illustrates perspective the printed circuit board of FIG. 1 and a view of a machine adapted to help connect the threaded conductors;

FIG. 7 is a detailed view illustrating operation of the machine in FIG. 6;

FIG. 8 is a detailed perspective view also illustrating operation of the machine in FIG. 6;

FIG. 9 is a detailed perspective view of FIG. 1 showing the results of the machine in FIG. 6;

FIG. 10 is a perspective view illustrating another embodiment of the invention;

FIGS. 11 and 12 are perspective views of some of the individual, etched layers forming the laminar structure in FIG. 10;

FIG. 13 is a plan view of some of the individual, etched layers suitable for the laminate structure in FIG. 10 but according to another embodiment of the invention;

FIG. 14 is a perspective view of a step in connecting the laminate in FIG. 10; and

FIG. 15 is a plan view showing details of another embodiment of the invention.

In FIG. 1 a printed circuit board 10 holds four apertured, disk-shaped cores 12, 14, 16, and 18 by portions of their peripheries and so that their central holes are exposed but dip slightly below the top surface of the board. The cores are made of ferrite having predetermined, for example rectangular, hysteresis characteristics. Preferably the board comprises a metal substrate covered completely with an insulating layer of epoxy resin. The cores 12, 14, 16, and 18 are mounted on the board as described in the copending application of Dinella, Kirschenbaum, and Schutz, Ser. No. 452,532, filed May 3, 1965, filed concurrently herewith. This type of mounting involves press fitting a portion of each core periphery into a rectangular opening in the bare metal substrate of the board 10 before coating the board 10 and the cores with epoxy resin in a fluidized bed. The epoxy then coats the metal substrate as well as the exterior and interior surfaces of cores 12, 14, 16, and 18, thus leaving exposed the openings in the cores.

Passing through each of the cores 12, 14, 16, and 18 are four parallel fingers 20, 22, 24, and 26 that extend from a C-shaped trunk 28 and form therewith a single laminate structure 30. An extra finger 31 passing through no core also extends from the portion 28 to form part of the structure 30. The laminate structure 30 comprises six overlying layers bonded together. Each layer in turn comprises one conductive metallic foil and one insulating Mylar film to which it is bonded. Each foil-Mylar layer extends throughout the trunk 28. Each foil-Mylar layer terminates in the fingers 20, 22, 24, 26, and 31 at respective rectangular offsets 32. The offset 32 on each layer projects through respective holes 34 on the printed circuit board 10 to the other face of the board, where the metallic foil is solder connected to terminals on the printed wiring on the other face of the board 10.

The printed wiring contacting the conductive foils in fingers 20, 22, 24, and 26 through the offsets 32 connects to separate, control, signal, inhibit or other information sources that pass suitable currents through these conductive foils to the respective foils in finger 31. Here the circuit terminas contacting the offsets 32 in finger 31 complete the respective control, signal, inhibit, and other information circuits. Currents through the foils produce fluxes that magnetically link the cores 12, 14, 16, and 18 and magnetize or demagnetize them in accordance with the signals determined by the printed circuit configuration. The structure 30 thus constitutes the windings threading the cores 12, 14, 16, and 18.

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The epoxy coating on the cores 12, 14, 16, and 18 helps prevent electrical contact between the cores themselves and the foils in the fingers passing through them. The direct contact between the cores and the metal substrate of board 10 affects the magnetic characteristics only slightly.

The structure 30 is formed and connected as shown in FIGS. 2 to 7. First, as in FIG. 2, an adhesive bonds a Mylar sheet 36 to a copper foil 38 and forms therewith a laminate layer 40. Preferably, a machine prefabricates many such layers 40 simultaneously. Six different layers 40 are then selected to make up the laminate structure 30. For clarity, some of the dimensions, particularly the thicknesses, in FIG. 2 and the other figures are exaggerated.

Each of the six selected layers 40 is then etched to remove all the copper of foil 38 but that required to form one of the foils in the laminate structure 30 of FIG. 1. The foil shape is determined by the desired circuit connections; namely, the terminals on the board which the particular foil must contact. The result of etching the first or top foil 38 is shown in FIG. 3. Here the Mylar sheet 36 supports the copper foil 42 remaining after etching. The foil 42 includes a C-shaped handle 44 and five blades 46, 48, 50, 52, and 54. The blades 46, 48, 50, 52, and 54 terminate in offset leaves 56, 58, 60, 62, and 64.

The foil 38 in the second of the six layers 40 is etched to leave a copper foil 42 whose handle 44 and offset leaves 56, 58, 60, 62, and 64 are identical with those of the first layer 40, but whose blades 46, 48, 50, 52, and 54 are longer.

The offset leaves 56, 58, 60, 62, and 64 in each of the remaining selected layers are identical. Similarly, the handles 44 are all identical. However, the length of the blades corresponding to 46, 48, 50, 52, and 54 on each layer 40 increases from layer to layer.

Shaping of the foils 38 is followed by etching or cutting of each of the six Mylar sheets 36 to form six laminate layers 68, of which three are shown in FIG. 4. For clarity, these layers 68 appear side by side on a workface W. In each Mylar sheet the Mylar generally follows the outline of the copper foil 42 but extends slightly beyond the foil edges to form insulating ridges 69. In addition there remains of the etched sheet 36 five Mylar extension strips 66 under respective offsets 56, 58, 60, 62, and 64 of each sheet. Here the extension strips 66 all project integrally from the Mylar below the handle 44 in foil 42, beyond the ends of the offsets 56, 58, 60, 62, and 64, until they project as far as the longest blade in all layers 68. The insulating ridges 69 protect the foil from electrical shorts. While the layers 68 and their parts differ slightly from each other, they nevertheless, for simplicity, carry the same general reference numeral.

The six etched laminate layers 68 are then assembled and aligned so that the identical C-shaped handles 44 and strips 66 lie one over the other. The layers 68 having the shorter blades are placed over the layers having the longer blades. In each of the laminate layers 68 the blades are long enough to assure that their offset leaves 56, 58, 60, 62, and 64 clear the offset leaves of every other layer. The six layers 68 are bonded to each other to form the laminate structure 30 with fingers 20, 22, 24, 26, and 31 shown in FIG. 1.

An operator or machine simultaneously inserts the fingers 20, 22, 24, and 26 of the laminate 30 into the cores 12, 14, 16, and 18 as shown in FIG. 5. The finger 32 slides over the board 10. A pair of bosses B and B' in the path of the trunk 28 stops the inserting motion and effectively aligns the lateral angular positions of the fingers 20, 22, 24, 26, and 31 on the board. This alignment is assured by the fact that the fingers are flat and move with only one degree of freedom. They cannot move independently from side to side.

When the laminate structure 30 has been completely inserted and rests against the bosses B and B', each of the

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offset leaves 56, 58, 60, 62, and 64 on each layer 68 overlies one of the prepunched holes 34 in the printed circuit board 10. The position of the holes 34 conforms to the lengths of the blades in each layer. Suitable printed wiring on the other side of the board terminates at each hole 34. The fingers 20, 22, 24, 26, and 31 are now glued lightly into position on the board 10.

In FIG. 6 a machine 69 serves the extension strips 66 behind and ahead of each offset leaf 56, 58, 60, 62, and 64 and pokes the end of each offset leaf through the hole 34 below it. The machine 69 includes a plurality of aligned and alternate poking rods 70 and cutting chisels 72. In operation the board 10 is placed in a jig to align the holes 34 with the rods 70. The machine 69 then descends and by means of suitable springs 74 and 76 assures that only proper force is applied to the rods and chisels.

The operation of the rods 70 and chisels 72 appears in detail in FIGS. 7, 8, and 9 with respect to finger 31. The operation is simultaneous and identical with that of the other fingers 20, 22, 24, and 26, not shown in FIGS. 7, 8, and 9. In FIG. 7 the poking rods 70 approach the respective holes 34 while the knife edges of chisels 72 approach the Mylar strips 66 supporting the offset leaves 56, forming part of the offsets 32. In FIG. 8 the chisels 72 and the poking rods 70 descend and simultaneously cut the strips 66 while poking the offset leaves 56 through the holes 34, as shown in FIG. 8. When the machine 69 withdraws, the result appears as in FIG. 9, the latter being a detail of FIG. 1.

The offset leaves 56, 58, 60, 62, and 64 forming part of the respective offsets 32 are connected to the circuit terminals at the respective holes 34 by dipping the underside of board 10 into a molten solder bath according to well-known mass solder techniques. The molten solder first strips the conductive foils of the Mylar insulation in the vicinity of the terminals by vaporizing the Mylar. The solder then contacts the terminals and the offset leaves 56, 58, 60, 62, and 64. When the solder bath is removed, the solder connecting the leaves and terminals remains. The solder now cools and conductively bonds the leaves 56, 58, 60, 62, and 64 to the terminals at the holes.

The laminate structure 30 permits threading a number of cores with many windings simultaneously. Whereas the drawings illustrate threading of only four cores at one time, the invention affords the opportunity of threading several dozen cores simultaneously with a simple technique to accomplish a result that hitherto required considerable manual labor. A particular advantage accruing from the flat structure of the laminate offsets arises in the fact that the fingers 20, 22, 24, 26, and 31 and the leaves 56, 58, 60, 62, and 64 of the offsets 32 have freedom of movement in only one plane and are restricted from moving from side to side. Thus, the poking rods 70 are always assured of finding their targets, i.e., the leaves 56, 58, 60, 62, and 64, in proper position.

Another embodiment of the invention appears in FIG. 10. Here the board 10 again supports four cores 12, 14, 16, and 18. Passing through these cores are four laminate fingers 82, 84, 86, and 88, each projecting from a C-shaped trunk 90 similar to the trunk 28 of FIG. 1 to form a laminate structure 92 that also includes a fifth finger 94. As in FIG. 1, the laminate structure 92 comprises six overlying layers, each layer comprising a conductive metal foil supported from below by Mylar insulation. Again each foil Mylar layer extends throughout the trunk 90. Each layer terminates in the fingers 82, 84, 86, 88, and 94 at respective tabs 96 that project through four parallel slots 98. The foil in each tab 96 connects to suitable terminals that meet the tabs at positions along the slots 98 on the opposite side of the board 10.

As in FIG. 1, the terminals on the opposite side of the boards form part of a printed circuit contacting the foils in fingers 82, 84, 86, 88, and 94 to pass suitable currents through the foils. Currents through the foils link the cores magnetically to magnetize or demagnetize them accord-

ing to the signals determined by the printed circuit configuration.

The laminate structure 92 is formed in a manner similar to that of the structure 30. As in FIG. 2, six foils 38 are bonded to six Mylar sheets 36 to form six layers 40. However, in FIG. 11 etching the foils 38 produces resulting blades 100 that terminate only in transverse projections 102. The C-shaped handle 104 corresponds to the handle 44 of FIG. 3. Each transverse projection 102 of the blades 100 in every layer extends the same distance from its blade 100. The lengths of all the blades 100 on any one layer are the same. However, the lengths increase from the first to the sixth layer.

As explained in connection with FIG. 4, the operation proceeds by etching the sheet 36 to follow just beyond the outline of the etched foil about the handle 104 and the left side of the blades 100. However, at the projections 102 the Mylar continues beyond the projections toward the C-shaped main portion so that it will support not only the foil on its layer but all the projections on the layers above. The six layers are now aligned and laminated so that each C-shaped handle 104 overlies the other handles and the shanks of the blades are in alignment, as shown in the exploded view in FIG. 12.

Instead of etching the Mylar immediately after etching the foil it is possible to proceed by laminating the six etched-foil full-Mylar layers together and then punching the resulting structure so that each Mylar sheet in each finger is as long as the longest finger and as wide as each blade 100 and each projection 102 combined. This is shown in FIG. 13. With this structure 106 the remaining operation is the same as with that shown in FIG. 12.

The laminate structure 92 or 106 is then passed through the cores 12, 14, 16, and 18 until the trunk 90 abuts two bosses B and B' on the board 10. Each finger on the structure 92 or 106 now assumes the position above a slot 98 as shown in FIGS. 10 and 14. When the laminate 92 has been completely inserted, each of the projections 102 on each layer overlies an elongated slot 98 in the printed circuit board 10.

Suitable printed wires 107 on the other side of the board 10 pass upwardly through the slot 98 at longitudinal points along the 98. They terminate as they reach the top side of the board just below the respective projections 102. On the inside wall of each slot 98 and opposite each wire termination is an unconnected printed wire spot that serves as an anchor for solder flow.

The fingers 82, 84, 86, 88, and 94 are now glued lightly into the position shown for one finger 94 in FIG. 14. The tabs 96 are now passed to the opposite side of the board 10 by placing the board in a jig, not shown, and pushing the tabs 96 through the slots 98 with elongated mandrels 109 that fit into slots 98. The mandrels 109 lead with protuberances P that fit between the foil projections 102.

The foil projections 102 in the tabs 96 are connected to the circuit terminals at the respective slots 98 by dipping the underside of the board into a molten solder bath according to the well-known mass solder techniques. Preferably this is done at a time when the protuberances P of mandrels 109 are still in the slots 98. The molten solder first strips the conductive foil projections 102 of their Mylar insulation in the vicinity of the terminals by vaporizing the Mylar. Solder pools then join the foil projections 102 with the respective wire terminations and printed spots in the slots. When the board is removed from the solder bath and the mandrels withdrawn, the solder pools cool and join the foil projections 102 with the respective wire terminations and spots.

The purpose of leaving the protuberances P of the mandrels 109 in the slots 98 during the mass soldering operation is to prevent a single solder pool from forming and joining each of the foil projections 102 passing through each slot 98 to each other. With proper soldering

techniques no protuberances P are necessary on the mandrel 109.

This embodiment, as the first, permits threading many conductive windings through each core while simultaneously threading the other cores while at the same time placing the conductors in such a position as to assure accurate connection to the proper terminals.

Another embodiment of the invention affording the possibility of threading the cores with more windings within a limited space is illustrated in part in FIG. 15. Here in a detail plan view of a circuit board, a laminate structure 108 possesses fingers 110 and 112 extending angularly from a trunk 114 and through two cores 116 and 118 corresponding to the cores 16 and 18. Six tabs 119 in the fingers 110 and 112 pass through angular slots 120 and 122 in the manner corresponding to the tabs 96 passing through the slots 98 in the board 10. The foils of the tabs 110 connect to terminals (not shown) on the underside of the board 10. A laminate structure 124 also corresponding to the laminate structure 92 possesses fingers 126 and 128 projecting angularly from a trunk 130 in the direction opposite to the fingers 110 and 112 and overlying the fingers 110 and 112 while passing through the cores 116 and 118. Again, here, tabs 131 on the fingers 126 and 128 corresponding to the tabs 96 pass through slots 132 and 134. These slots extend angularly to the slots 120 and 122. The conductive foils in the tabs 129 connect to terminals (not shown) on the other side of the printed circuit board 10. This structure furnishes additional windings without excessive use of space on the board 10.

While only a limited number of cores are illustrated in FIG. 15, the invention contemplates a larger number of cores, the ones shown being merely exemplary and a detail of a larger circuit board.

In FIG. 15 the operation is substantially the same as for the structure 92 in FIG. 10, and the mass soldering techniques can also be the same. For clarity the angles at which the fingers project from the trunks have been exaggerated in FIG. 15.

While embodiments of this invention have been described in detail, it will be obvious to those skilled in the art that the invention may be embodied otherwise without departing from its spirit and scope.

What is claimed is:

1. A magnetic memory assembly comprising a plurality of magnetic cores having interior openings passing there-through, each of said cores forming a single integral structure, support means for holding said cores with the openings exposed from both ends, a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said laminate forming a plurality of spaced fingers each having a plurality of layers, each of said fingers extending through the opening of one of said cores, and a plurality of spaced terminal means for each core on said support means, one of said conductive layers in each of said fingers having a lateral offset near one of said terminal means for contacting the one of said terminal means.

2. A printed circuit comprising an insulating support board having two faces, a plurality of conductive paths printed on each face of said board, a plurality of cylindrical magnetic cores having interior openings passing there-through and being mounted on said board so as to expose said openings from both sides on one of said faces, and a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said laminate forming a plurality of spaced fingers each having a plurality of layers, each of said fingers extending through the opening of one of said cores with its insulating and conductive layers, said insulating layers which extend with one of said fingers through the opening in one of said cores joining the insulating layers which extend with another of said fingers through another of said cores only on one side of the core through which it

extends, said conductive paths having a plurality of terminal points for each core, one of said conductive layers in each of said fingers having a lateral offset near one of said terminal points and contacting the one of said terminal points with said offset.

3. A magnetic memory assembly comprising a plurality of magnetic cores having interior openings passing there-through, support means for holding said cores with the openings exposed from both ends, a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said conductive layers being connectable to a plurality of respective current sources, said laminate forming a plurality of spaced fingers each having a plurality of layers, each of said fingers extending through the opening of one of said cores with its insulating and conductive layers, said insulating layers which extend with one of said fingers through the opening in one of said cores joining the insulating layers which extend with another of said fingers through another of said cores only on one side of the core through which it extends, and a plurality of spaced terminal means for each core on said support means, a multiplicity of said conductive layers in each of said fingers having a lateral offset near a respective one of said terminal means and contacting the respective terminal means with said offset.

4. A printed circuit comprising an insulating support board having two faces, a plurality of conductive paths printed on each face of said board, a plurality of cylindrical magnetic cores having interior openings passing therethrough and being mounted on said board so as to expose said openings from both sides on one of said faces, said cores each forming a single integral structure, and a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said laminate forming a plurality of spaced fingers each having a plurality of layers, each of said fingers extending through the opening of one of said cores, said conductive paths having a plurality of terminal points for each core, a multiplicity of said conductive layers in each of said fingers each having a lateral offset near a respective one of said terminal points and contacting the respective terminal point with said offset.

5. A printed circuit comprising an insulated support board having two faces, a plurality of conductive paths printed on each face of said board, a plurality of cylindrical magnetic cores having interior openings passing there-through about respective axes and being mounted on said board so as to expose said openings from both sides on one of said faces and so that said axes are parallel to the board, a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said laminate forming a plurality of spaced fingers each having a plurality of said layers, each of said fingers extending through the opening of one of said cores and lying on one face of said board, said board being apertured near each core, a plurality of said conductive layers in each of said fingers each having a lateral offset, said lateral offsets being bent and passing through said board where it is apertured, and terminal means on the other face of said board for contacting said bent offsets.

6. A printed circuit comprising an insulated support board having two faces, a plurality of conductive paths printed on each face of said board, a plurality of cylindrical magnetic cores having interior openings passing therethrough about respective axes and being mounted on said board so as to expose said openings from both sides on one of said faces and so that said axes are parallel to the board, a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said laminate forming a plurality of spaced fingers each having a plurality of layers, each of said fingers extending through the opening of one of said cores and lying on one face of said board, said board defining a plurality of holes therethrough near each core, a

plurality of said conductive layers in each of said fingers each having a lateral offset near a respective one of the holes, said lateral offset being bent and passing through the hole, and terminal means on the other face of the board for contacting said bent offsets.

7. A magnetic memory assembly comprising a plurality of magnetic cores having interior openings passing there-through about respective axes, support means for holding said cores by portions of their respective peripheries and with the openings exposed from both ends, said support means having two flat sides, a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said conductive layers being connectable to a plurality of respective current sources, said laminate forming a plurality of spaced fingers each having a plurality of layers, each of said fingers extending through the opening of one of said cores and lying on one side of said support means, said support means defining an elongated slot near each of said cores and parallel to each finger, a plurality of said conductive layers in each of said fingers each having a lateral offset, said lateral offsets being bent and passing through said slots, and terminal means on the other side of said support means and along said slots for contacting said bent offsets.

8. A printed circuit comprising an insulated support board having two faces, a plurality of conductive paths printed on each face of said board, a plurality of cylindrical magnetic cores having interior openings passing therethrough about respective axes and being mounted on said board so as to expose said openings from both sides on one of said faces and so that said axes are parallel to the board, a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said laminate forming a plurality of spaced fingers each having a plurality of both of said layers, each of said fingers extending through the opening of one of said cores and lying on one face of said board, said board defining an elongated slot near each of said cores and parallel to the respective fingers, a plurality of said conductive layers in each of said fingers each having a lateral offset, said lateral offsets being bent and passing through the slots, and terminal means along said slots on the other face of said board for connection to said bent offsets.

9. A magnetic memory assembly comprising two sets of toroid-like magnetic cores having central openings, support means for holding said cores of each set adjacent to each other and about separate parallel axes, a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said conductive layers being connectable to a plurality of respective current sources, said laminate forming two groups of spaced fingers each having a plurality of said layers, each finger of one group passing through the respective cores of said cores in one set, and each finger of the other group passing through the respective cores of the other set, with its insulating and conductive layers, said insulating layers which extend with one of said fingers through the opening in one of said cores joining the insulating layers which extend with another of said fingers through another of said cores only on one side of the core through which it extends, and a plurality of spaced terminal means for each core on said support means, one of said conductive layers in each of said fingers having a lateral offset near one of said terminal means for contacting the one of said terminal means.

10. A printed circuit comprising an insulating support board having two faces, a plurality of toroid-like magnetic cores having central openings and mounted on said board by a portion of its periphery so that the openings at both ends are all exposed above one face of the board, said cores being divided into two sets, the cores of the first sets being aligned side by side separate axes parallel to one of said faces, the cores of said second set being

aligned side by side about separate axes parallel to said one face, a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said laminate forming two groups of spaced fingers each having a plurality of said layers, each finger of one group passing through respective cores of said cores in one set, each finger of the other group passing through the respective cores of the other set, said fingers lying on one face of said board, said board being apertured near each of said cores, a lateral offset on each of a plurality of said conductive layers on said fingers, and a plurality of conductive paths printed on said second face of said board and having terminals where said board is apertured, said offsets being bent through said board where said board is apertured and contacting said terminals.

11. A printed circuit comprising an insulating support board having two faces, a plurality of toroid-like magnetic cores having central openings and mounted on said board by a portion of its periphery so that the openings at both ends are all exposed above one face of the board, said cores being divided into two sets, the cores of the first set being aligned side by side about separate axes parallel to one of said faces, the cores of said second set being aligned side by side about separate axes parallel to said one face, a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said laminate forming two groups of spaced fingers each having a plurality of said layers, each finger of one group passing through respective cores of said cores in one set, and each finger of the other group passing through the respective cores of the other set, said fingers lying on one face of said board, a plurality of holes in said board aligned near each of said fingers, a plurality of said conductive layers in each of said fingers each having a lateral offset near a respective one of said holes, and a plurality of conductive paths printed on the second face of said board and having terminals at said holes, said offsets being bent through said holes to contact the terminals.

12. A printed circuit comprising an insulating support board having two faces, a plurality of toroid-like magnetic cores having central openings and mounted on said board by a portion of its periphery so that the openings at both ends are all exposed above one face of the board, said cores being divided into two sets, the cores of the first set being aligned side by side about separate axes parallel to one of said faces, the cores of said second set being aligned side by side about separate axes parallel to said one face, a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said laminate forming two groups of spaced fingers each having a plurality of said layers, each finger of one group passing through respective cores of said cores in one set, and each finger of the other group passing through the respective cores of the other set, said fingers lying on one face of said board, said board having near each of said cores a slot extending along each of said fingers, a lateral offset on each of a plurality of said conductive layers on said fingers, and a plurality of conductive paths printed on said second face of said board and having a plurality of terminals along said slot, said offsets being bent through said slots and contacting said terminals.

13. A printed circuit comprising an insulated support board having two faces, a plurality of conductive paths printed on each face of said board, a plurality of cylindrical magnetic cores having interior openings passing therethrough about respective axes and being mounted on

said board so as to expose said openings from both sides on one of said faces and so that said axes are parallel to the board, a laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said laminate forming a plurality of spaced parallel fingers each having a plurality of said layers, said fingers each extending through the opening in respective ones of said cores and lying on one face of said board, said board being apertured near each core, a plurality of said conductive layers in each of said fingers each having a lateral offset, said lateral offsets being bent and passing through said board where it is apertured, and a second laminate having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said second laminate forming a plurality of spaced fingers each having a plurality of said layers in said second laminate, said laminate overlying said first laminate, each of said fingers of said second laminate overlying the fingers of said first laminate and extending through the opening of respective ones of said cores, a plurality of said conductive layers in each of said fingers of the second laminate each having a lateral offset that is bent and passes through the board where it is apertured but at a location different from the offsets at the offsets of said first laminate, and terminal means on the other face of said board for contacting said bent offsets.

14. A printed circuit comprising an insulated support board having two faces, a plurality of conductive paths printed on each face of said board, a plurality of cylindrical magnetic cores having interior openings passing therethrough about respective axes and being mounted on said board so as to expose said openings from both sides on one of said faces and so that said axes are parallel to the board, two laminates each having a plurality of conductive layers and a plurality of insulating layers separating said conductive layers, said laminates each forming a plurality of spaced fingers, each of said fingers having a plurality of both of said layers, each of said fingers on one of said laminates extending through the opening of one of said cores and lying on one face of said board, each of said fingers on the other laminate passing through the opening of the core through which a finger of the other laminate passes and overlying the finger of the other laminate, said board defining two elongated slots near each of said cores and parallel to the respective fingers passing through the cores, a plurality of said conductive layers in each of said fingers each having a lateral offset, said lateral offsets being bent and passing through the slots, and terminal means along said slots on the other face of said board for connection to said bent offsets.

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