United States Patent [19]

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[11] **3,718,936**

[45] **Feb. 27, 1973**

[54] ELECTROSTATIC MATRIX HEAD CONSTRUCTION

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[22] Filed: **June 16, 1971**

[21] Appl. No.: **109,072**

[52] **U.S. Cl.**.....**346/74 ES**, 178/25, 346/74 S, 346/139 C

[51] **Int. Cl.**.....**G01d 15/08**

[58] **Field of Search** ...346/74 CH, 74 ES, 74 E, 74 S, 346/74 SC, 74 SB, 74 EB, 139 C; 178/25, 30; 317/101 CM, 101 D

[56] **References Cited**

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3,267,485	8/1966	Howell et al.	346/74 ES

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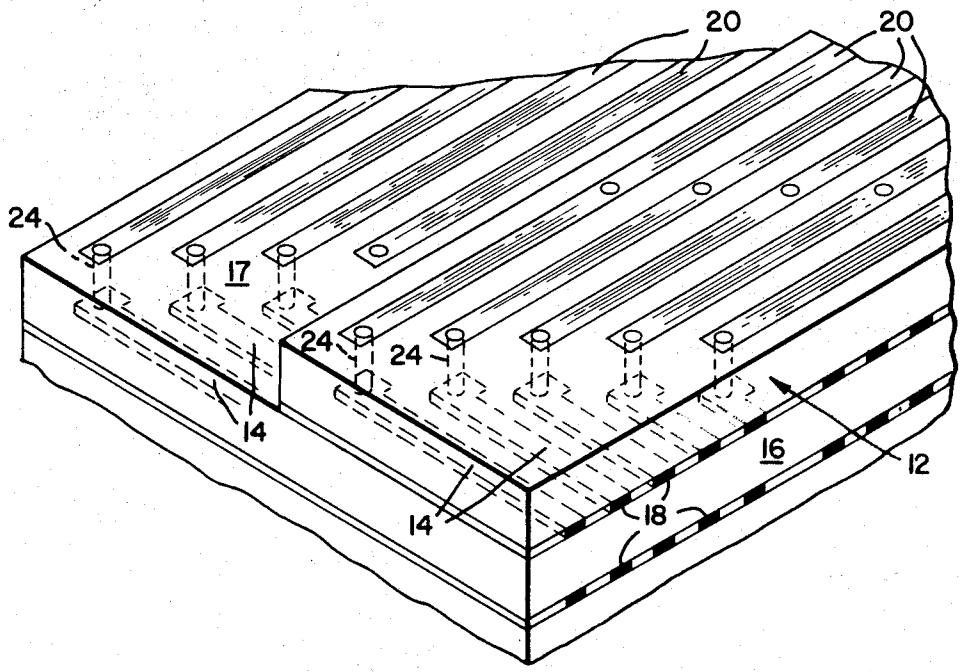
Brown, A. V. Fabricating Miniature Strip Lines. IBM Technical Disclosure; Vol. 12, No. 10, March 1970; pp 1637–1681.

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[57] **ABSTRACT**

A matrix head for use in electrostatic printing is formed from a plurality of stacked printed circuit boards. Each circuit board is printed on both sides with conductive strips, the strips on one side being perpendicularly aligned to the strips on the other side. The conductive strips on one side terminate at a common edge to form a plurality of printing elements, i.e., discharge points. Each strip is electrically connected to a conductive strip on the other side of the board by means of a front-to-back conductively plated hole. The stacked boards provide along one side an array of character printing areas, the discharge points of each area are controlled by electrical leads to the conductive strips on the circuit board.

9 Claims, 3 Drawing Figures



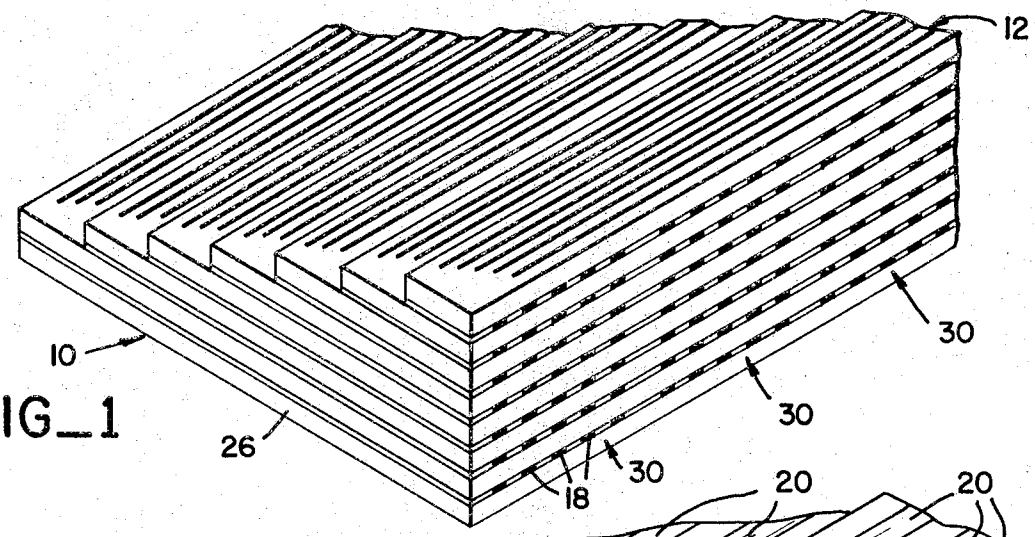


FIG_1

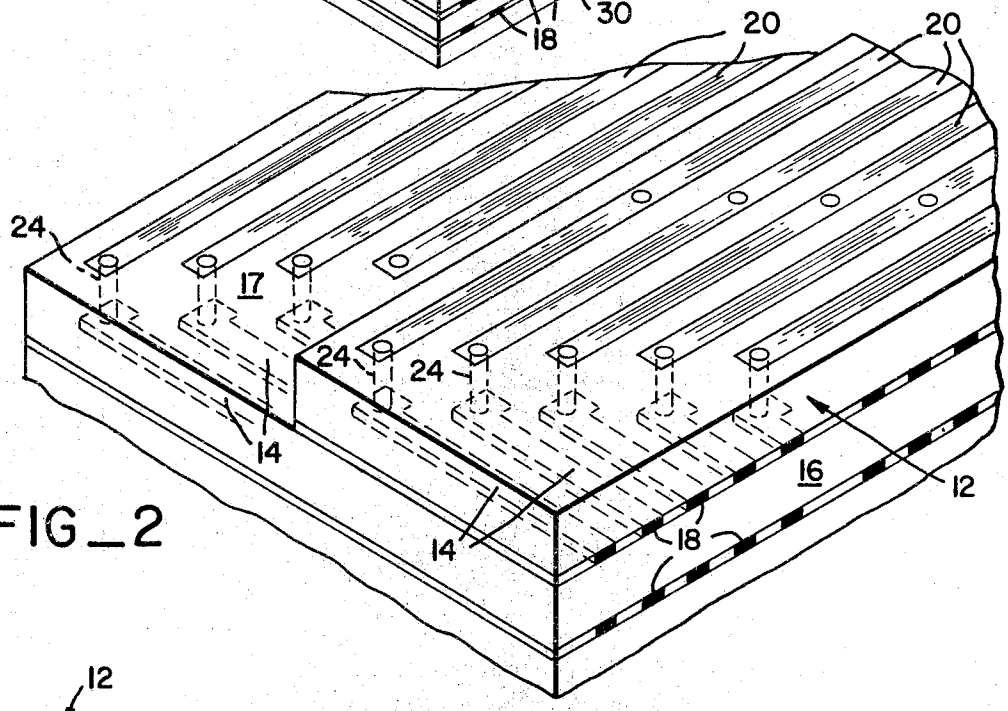


FIG_2

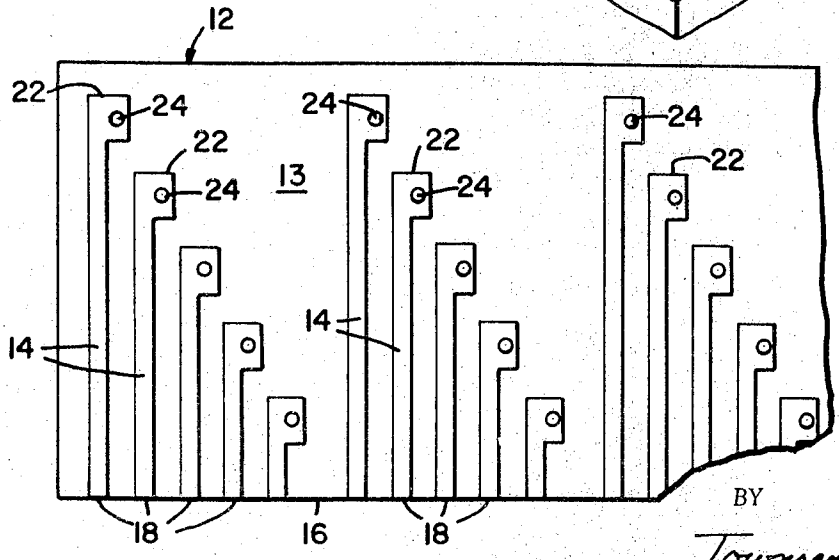


FIG_3

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ELECTROSTATIC MATRIX HEAD CONSTRUCTION

This invention relates to electrostatic matrix printing heads, and more particularly, to a novel construction for such a matrix printing head.

A typical matrix head for use in electrostatic printers normally comprises an array of wires. The points of these wires are arranged in a common plane and spaced opposite from a back plate or counter electrode. Dielectric paper is inserted between the points of the wires and the back plates and a voltage applied to select wires in the configuration of a character or numeral to be printed. When the voltage exceeds a predetermined threshhold value, the resultant voltage discharge from the selected wires establishes an electrostatic latent image on the paper which is thereafter toned and fixed according to well known xerographic techniques.

In a typical matrix-type character printer, the matrix printing assembly consists of 72 groups of wires, each group being the size of one alphanumeric character and comprising 35 closely spaced individual electrodes in a rectangle 5 wires wide by 7 wires high. All of these 2,520 wires are in contact with the dielectric side of the paper in a horizontal line. Behind the paper and in contact with the conducting side opposite each 5 by 7 group is a single counter electrode. The counter electrodes may individually be pulsed electrically. Within the matrix printing assembly comprising the array of 72 5×7 groups, like elements of the 72 character groups are electrically connected together. For example, a single wire connects the upper left hand element of each of the 72 groups. Similar wires are connected to appropriate elements in each of the groups. When a letter is to be printed, the wires corresponding in the matrix head to said letter are activated in all the printing heads. A circuit is established between the activated printing heads and a single selected back plate such as by connection to ground or application of a half amplitude wave. By sequentially selecting and completing a circuit between the printing head assembly and a given back plate in accordance with the rate in which the characters are received, characters can be electrostatically established on a line across the paper.

In U.S. Pat. No. 3,267,485, a complex matrix printing head assembly is described for incorporation into a matrix printer. Each printing head is constructed from a stack of thin circuit boards having a plurality of mutually spaced electrodes coated thereon. The electrical leads for each of the electrodes terminate short of the respective electrode so as to be physically disconnected therefrom, and a resistor is connected between the electrode and electrical lead. On the opposite surface of the insulating board is an auxiliary electrode. All the electrodes terminate in a common plane on one surface of the assembly to form an array of writing stylii with auxilliary electrodes spaced therefrom. Assembly of a plurality of these electrode printing units to form a matrix printing head requires connection of the units one to another through wiring external of the matrix head.

An object of this invention is to provide a novel construction for a matrix printing head and matrix printing assembly.

Another object of this invention is to provide a matrix head and assembly of simplified, and less costly construction.

A further object of this invention is to provide a more rugged printing head assembly containing no external wiring.

In accord with these above objects, a simplified matrix head construction is contemplated which comprises a plurality of printed circuit boards superposed one atop another. For the 5×7 character matrix, seven boards are cemented together. On the front side of the board, the conducting areas are formed in groups of five linear fingers, the ends of which after assembly will form the stylii for contacting the dielectric side of the paper. Each group corresponds to one character position. On the back side of the board the conducting areas comprise five linear strips. Preferably these strips are disposed at right angles to the fingers on the front of the board. Corresponding fingers in each group are electrically connected by appropriately positioned front to back plate-through holes (holes having electrically plated walls) or other suitable conducting means. The corresponding elements in each character position are thus electrically connected together and isolated from other elements in the same character position. Between each circuit board a thin layer of insulative material is interposed to prevent electrical interference between electrodes of successive circuit boards.

The completed matrix printing head assembly will contain 72 groups of writing stylii each group the size of one alphanumeric character. The matrix head assembly can be formed from a single unit, or if desired from several smaller units, say 10 characters wide, the units butted together. Electrical connection between the units would comprise sets of 35 short jumper wires across each butt joint.

In a preferred embodiment of this invention, it is contemplated that the size of the printed circuit boards be varied whereby that portion of each board which carries the back electrodes will extend or project beyond the edge of the printed circuit board stacked immediately above. By resorting to this staggered or step-like configuration, the necessity of providing the insulative material, otherwise required, is eliminated. Additionally, as the electrical conducting paths are not superposed overtop one another, there is less likelihood of electrically induced interference with the printing electrodes of an adjacent board. Such a matrix head configuration may easily be constructed by first staggering a plurality of identical boards and cementing them together. After curing of the cement, the stack can be cut square to expose the ends of the printing electrodes which form the writing stylii.

A more complete description of this invention will be given in connection with the accompanying drawings in which:

FIG. 1 is a fragmented isometric view of a printing head matrix according to this invention;

FIG. 2 is an enlarged fragmentary isometric view of the top two printed circuit boards illustrated in FIG. 1; and

FIG. 3 is a fragmentary bottom elevation of a circuit board as shown in FIGS. 1 and 2 illustrating the arrangements of the printing electrodes.

With reference now to the drawings wherein like numerals refer to like elements throughout the several views, a matrix printing head **10** is illustrated which is formed from a plurality of stacked circuit boards **12**. These circuit boards may be constructed of any suitable material, preferably the types of materials presently used with printed circuitry. Such a board may be composed of an epoxy resin impregnated glass cloth, and the metal coating may be of copper, stainless steel, or other materials suitable for forming electrode leads.

A plurality of mutually spaced printing electrodes **14** on the underside **13** of the boards **12** terminate along a leading edge **16** defining writing stylii **18**. On the opposite side **17** of printed circuit boards **12** are a plurality of mutually spaced back electrodes, or conductive paths **20** aligned essentially perpendicular to the printing electrodes **14**. The electrodes **14** are arranged in groups of five, the spacing in between each group corresponding to the spacing between the alphanumeric characters to be printed. The length of the printing electrodes **14** in a given array progressively decreases from left to right when the circuit board is viewed from the leading edge. Enlarged portions **22** are provided at the end of the printing electrodes away from the writing end. Holes **24** drilled through the printed circuit boards, the walls of which are conductively coated, are spaced at appropriate points along back electrodes **20**, and electrically communicate with the enlarged end portions **22** of the corresponding printing electrodes **14** on the opposite side of the printed circuit board **12**. At the bottom of the matrix head, insulative board **26** is provided to increase the strength of the overall structure and protect the printing electrodes on the underside of the bottommost printed circuit board.

In printing, the terminal ends of the back electrodes **20** are connected to an appropriate information source. The information input to the matrix printing head may be one of any of those commonly utilized with printers of this type, such as for example computer information input, telegraph input, light actuated input, and the like. Electrostatic paper is inserted between the matrix head and the counter electrodes (not shown). The appropriate conductive paths are energized to energize the writing stylii of the 5×7 arrays in the configuration of the character to be electrostatically established on the paper. This character is established in all of the arrays **30** of the matrix printing head **10**. To print, a single counter electrode in the desired position on the other side of the paper is connected to ground, or otherwise connected to the matrix head to complete a circuit with only a selected one of the arrays **30**. The voltage discharge forms an electrostatic image on the paper at the desired position along the matrix head. In a similar manner images of other characters are established in the other character position. Such an arrangement for selectively printing from only one of a plurality of similarly addressed arrays of electrostatic stylii using a plurality of counter electrodes is described in U.S. Pat. No. 3,434,157. When all the desired character charge images in a horizontal line have been deposited, the paper advances past a developing station where toner makes the image visible.

To prepare a staggered printing matrix head assembly according to this invention, a desired number of similarly sized printed circuit boards are overlaid one atop another and staggered to expose the back electrodes of each preceding printed circuit board. The boards are cemented together, and then cut along a line parallel to the back electrodes to expose a planar array of printing stylii.

The printed circuit boards themselves may be prepared by standard photoetching techniques. By way of illustration, printed circuit boards are usually covered with a layer of copper on both sides. Photo resist is coated on one side and a pattern corresponding to the positioning of the back electrodes is projected onto the photo resist covered side. The resist hardens where exposed to light, and unexposed resist is thereafter washed away to leave a photo resist pattern corresponding to the electrode pattern. The surface is then etched except where the photo resist has hardened. The photo resist is then removed, the copper in the pattern of the back electrodes remaining on the board. A similar process is repeated on the opposite side of the board to establish the printing electrodes in the configuration described. After the electrodes have been established on the printing boards, a small amount of metal may be deposited at the tips of the printing electrodes to form larger contact points.

Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is understood that certain changes and modifications may be practiced within the spirit of the invention as limited only by the scope of the appended claims.

I claim:

1. A multi character matrix printing head assembly for electrostatic printers comprising a plurality of stacked, superposed, printed circuit insulative boards cemented together, each of said boards having a leading edge and trailing edge, and including a plurality of groups of mutually spaced linear printing electrodes on one side of each board which terminate along the leading edge of said board a number of spaced back electrodes on an opposite side of said board which is equal to the number of printing electrodes in a group, the back electrodes extending parallel to the leading edge over substantially the full length of the leading edge, and means for electrically connecting each printing electrode of each group to a preselected back electrode, whereby corresponding printing electrodes in each of the group are electrically connected together and isolated from other elements in the same character position.

2. A method for assembling a matrix printing head comprising the steps of:

a. selecting seven identical printed circuit boards, each board including at least one grouping of spaced printing electrodes on one side thereof, the printing electrode terminating along a common edge of the board at equally spaced apart points, each grouping containing the same number of printing electrodes, a plurality, equal to the number of printing electrodes within a group, of spaced back electrodes on the opposite side of the board, and means for electrically connecting each of said printing electrodes to a back electrode whereby each printing electrode within a group is electrically isolated from other printing electrodes on the board within the same group, and con-

nected to corresponding electrodes in the other groups;

b. superposing said seven circuit boards one atop another in a staggered pattern to expose the back electrode of each preceding circuit board;

c. cementing said boards together; and

d. cutting the staggered cemented boards through a line parallel to the back electrodes to expose a planar array of printing stylii.

3. A multi-character printing head comprising a plurality of elongate insulative circuit boards stacked one on top of the other and secured to each other, the boards of each stack having a common aligned edge defining a printing surface of the head, the boards further having progressively varying widths so that a portion of a side of each board remote from the printing surface is exposed, a plurality of printing electrode sets, each set having a plurality of electrodes distributed over the length of each board, the electrodes on each board being secured to another side of the board and terminating at the printing surface, printing electrode sets on adjacent boards being mutually aligned, the printing electrodes further extending away from the printing surface to the area of the exposed sides, back electrodes running over substantially the length of the boards parallel to the printing surface secured to the exposed sides of the respective boards, the number of back electrodes equalling the number of printing electrodes in the sets, and means connecting each back electrode with the printing electrode in a given relative position within a set.

4. A matrix printing head assembly comprising a laminate of a plurality of flat insulative boards, each board having a top surface, a bottom surface, and at least one edge, the one edge of each board being aligned with the one edge of each other board to define a planar surface, the top and bottom surface of each successive insulative board extending progressively beyond the top and bottom surface of the preceding board; a plurality of printing arrays positioned on said planar surface, each array composed of a rectangular grid of electrically conductive writing stylii substantially uniformly spaced one from another, the size of each grid corresponding to the size of an alphanumeric character to be printed, a plurality of groupings of mutually spaced printing electrodes disposed on the bottom surface of each insulative board, said electrodes terminating along said one edge of said board to define said electrically conductive writing stylii; a plurality of parallely spaced back electrodes on the top surface of said insulative board, disposed at right angles to said printing electrodes and passing thereabove, the number of back electrodes corresponding to the number of printing electrodes in each grouping of printing electrodes for a given board , the back electrodes of each board being disposed on that portion of the board extending beyond the board stacked immediately adjacent thereto, the printing electrodes extending from said edge to a point directly below said back electrodes; and means electrically connecting each printing electrode to a single back electrode carried on the same board, corresponding elements in each character position being connected to the same back electrode and insulated from other elements in the same character position.

5. A matrix printing head for an electrostatic printer comprising in combination a plurality of printed circuit insulative boards superposed one atop another, each board having a leading edge and a trailing edge, the leading edges of said boards being aligned to define a planar surface; at least two groups of spaced electrodes on one side of each board, the number of electrodes within each group being the same, said groups of electrodes terminating at the leading edge of said board at spaced points to define a row of printing elements; a plurality of continuous spaced, back electrodes on the other side of each board equal in number to the number of printing electrodes within a group, and means for electrically connecting each of said back electrodes to corresponding ones of said printing electrodes in each group whereby each printing electrode within a group is electrically isolated from other printing electrodes within the same group so that a plurality of groups can be formed on one set of circuit boards and interconnected on these same circuit boards, and connected to corresponding electrodes within each other group.

6. The matrix printing head of claim 5 wherein the printing electrodes are parallel spaced, intersecting the leading edge of the board at right angles thereto, and the back electrodes are parallel spaced, disposed at right angles to said printing electrodes and extend over substantially the full length of the planar surface.

7. The matrix printing head of claim 5 wherein the insulative boards define a step-like configuration, the spaced back electrodes on each board lying on that portion of each board which extends beyond the trailing edge of the preceding insulative board.

8. The matrix printing head of claim 5 wherein the back electrodes of each board are electrically connected to the corresponding printing electrodes on the same board by plated through holes provided in said insulative board.

9. The matrix printing head of claim 5 including an insulative base board mounted beneath the bottommost board of the matrix printing head.

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