Surface Pattern Stylus Board

Abstract

A stylus board for a printing machine prints from styli formed on the face of the board. The printing styli can be shaped by etching or deposition to give accurate stylus shapes in a variety of patterns. The board may be curved or folded to elevate the stylus at the printing station.

17 Claims, 24 Drawing Figures
SURFACE PATTERN STYLUS BOARD

The present invention relates to a printing machine of the kind which utilizes a plurality of individual styli linearly aligned at a printing station for producing electrostatic, thermal or electro-sensitive printing of a printing medium which is moved in increments, or steps, or continuously over the styli at the printing station.

The present invention relates particularly to a method of forming individual styli on a face of a stylus board for such a printing machine and to a method of and apparatus for using the stylus board so that printing can be done from the face of the board.

The stylus board of the present invention has a particular use in a printer of the kind disclosed in my pending U.S. Application Ser. No. 877,128 filed Nov. 17, 1969 and assigned to the same assignee as this application.

The single most important technical factor in the production and use of electrostatic, thermal and electro-sensitive printers is the printing head which marks the paper or other medium to be printed.

The head design affects the aesthetics of the print out. That is, the head design affects the resolution, the sharpness and the dot shape for print out. The head design also affects the cost and reliability of the printer.

In a printing machine of the kind in which this invention relates, the styli or electrodes for energizing or producing a charge on selected areas of the recording medium are arranged in a line at a printing station. The recording medium is transported in strip form past the printing station. The image is progressively built up by successive application of voltage to the styli or electrodes as the strip is moved past the printing station.

Individual styli or electrodes used in printing machines of this kind are quite small. The individual styli may have an area in contact with the proper which is 0.010 inch by 0.010 inch, more or less.

By suitable control of the energization or firing of such styli or electrodes, almost any pattern of surface image can be produced. Numbers, letters, graphs, charts and drawings can be produced.

For electrostatic printing, the assignee of this application has in the past used a printed circuit board (in a machine of the kind disclosed in the above noted pending U.S. Application Ser. No. 877,128) with conductor traces electro-formed up to 5 mils by 5 mils at the end of the traces (at the edge of the board) where the traces or styli touch the paper. Other manufacturers have used wires. Still other manufacturers have used both printed circuit boards and wires. In the prior art the present commercial machines all use the end of the styli to print, and the shape of the dots and the overall pattern is limited by the processes used. All of these prior art boards have been relatively expensive.

It is a primary object of the present invention to fabricate a stylus board for electrostatic, thermal, and electro-sensitive printing wherein the face of the board, rather than the edge of the board contacts the paper.

It is a related object to shape the printing styli by etching or deposition to give more accurate shapes in a greater variety of patterns than is possible with the prior art method of fabricating styli boards.

It is another object of the present invention to arrange the styli in two rows with the individual styli in one row offset or staggered, with respect to the individual styli in the other row. The individual styli can be made oversized with respect to the lateral spacing between styli in the opposite row and with respect to the spacing between the two rows so that the styli can print a solid line in both horizontal and vertical directions on the recording medium. It is a related and specific object of the present invention to construct such a dual row of staggered styli that will print dot matrix alpha numerics in a way that the alpha numerics do not show a dot pattern.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show preferred embodiments of the present invention and the principles thereof and what are now considered to be the best modes contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side elevation view, partially broken away to show the details of construction, of a printing machine constructed in accordance with one embodiment of the present invention;

FIG. 2 is a block diagram showing in diagramatic form the way in which the elements of the printing machine shown in FIG. 1 are operatively associated;

FIG. 3 is a front elevation view showing the way in which styli electrodes and segment electrodes may be positioned on opposite sides of the recording medium (for electrodes and segments positioned on the same side of the recording medium see FIGS. 21 and 22);

FIG. 4 is a diagrammatic view illustrating the way in which the total voltage for energizing the electrodes is divided between the styli electrodes and the segment electrodes;

FIG. 5 is a top plan view, partially broken away, of a stylus board constructed in accordance with one embodiment of the present invention;

FIG. 6 is a fragmentary enlarged view of the portion of the stylus board shown encircled by the arrows 6—6 in FIG. 5 and shows details of how the styli electrodes are accessed from different sides of the stylus board;

FIG. 7 is a fragmentary enlarged plan view of a portion of FIG. 6 illustrating details of the way in which the traces are connected to the conductors on the opposite sides of the board;

FIG. 8 is a fragmentary cross-sectional view taken along the lines and in the direction indicated by the arrows 8—8 in FIG. 7;

FIG. 9 is a fragmentary enlarged and elevation view, in cross-section, showing a stylus board folded in accordance with an embodiment of the present invention;

FIG. 10 is a fragmentary perspective view of another embodiment of a folded stylus board constructed in accordance with the present invention;

FIG. 11 is a fragmentary enlarged end elevation view in cross-section illustrating a way in which the folded stylus board of FIG. 10 is associated with the recording medium;

FIG. 12 is a fragmentary plan view showing how the stylus electrodes may be formed in two rows and offset, or staggered, in a stylus board constructed in accor-
dance with another embodiment of the present invention;

FIG. 12A is a plan view of a horizontal line printed with the stylus board construction shown in FIG.12 and illustrates how a solid line may be printed with the electrode arrangement shown in FIG.12.

FIG. 13 is a fragmentary top plan view of a part of the stylus board shown in FIG.12;

FIG. 14 is an end elevation view cross-section view taken along the line and in the direction indicated by the arrows 14—14 in FIG. 13;

FIG. 15 is a fragmentary top plan view of a part of a stylus board shown in FIG. 12;

FIGS. 16, 17 and 18 are end elevation views in cross-section, taken generally along the line and in the direction indicated by the arrows 18—18 in FIG. 15, showing how the stylus board may be progressively built up by deposition;

FIG. 19 is a plan view of the alpha numeric character S as printed by the stylus board shown in FIG. 12; and

FIG. 20 is a view like FIG. 19, showing, for comparison, the same character as printed by a stylus board having a single row of stylus electrodes.

FIG. 21 is a fragmentary elevation view (like FIG. 9) showing an embodiment in which the segments are on the same side of the recording medium;

FIG. 22 is a fragmentary top plan view taken along the line and in the direction of the arrows 22—22 in FIG. 21; and

FIG. 23 is a fragmentary perspective view showing an embodiment in which the paper is curved at the printing station to define the area over which charge transfer takes place.

A printing machine constructed in accordance with one embodiment of the present invention is indicated generally by the reference numeral 31 in FIG. 1.

The printing machine 31 includes a base frame 33 (which may be a casting) and a cover 35.

The printing machine includes a printing station 37.

The printing machine illustrated in FIG. 1 is an electrostatic printing machine and thus includes a toner station 39.

It should be pointed out, however, that the present invention is not limited to electrostatic printing machines. The present invention is equally applicable for other printing machines, such as thermal and electro-sensitive printing machines.

The printing machine includes a drive means 41.

As best shown in FIG. 2 the printing machine 31 also includes a control means indicated generally by the reference numeral 45.

The power supply for the printing machine 31 is indicated generally by the reference numeral 47 in FIG. 2.

The top cover 39 includes a lid 49 mounted for pivoting movement about a pivot 51. The lid 49, when opened, provides access to the storage compartment 43.

The printing medium in the form of sheet material 52 is transported through the printing machine in strip form, and the material may be supplied by a roll 55 as illustrated in the solid outline in FIG. 2, or from a fan folded supply 59 of sheet material located below the storage compartment as shown by the dashed outline in FIG. 1.

When the sheet 52 is paper, the sheet may have a thin layer of dielectric material which receives an electrostatic charge at the printing station 37.

The electrostatic charge is produced on the sheet at the printing station by coaction between two rows of electrodes.

As most easily seen in the diagrammatic view of FIG. 4, the printing station 37 has a lower row of stylus electrodes 61 and an upper row of segment electrodes 63. It may also have stylus and segments on the same side of the paper.

The individual stylus electrodes are indicated by the reference characters E1 – E96 in FIG. 3. These stylus electrodes are shown as lines for ease of illustration in FIG. 3 but actually have small rectangular or circular shapes at their surfaces presented to the underside of sheet 52.

As will be described in greater detail below, one form of the present invention permits the use of electrodes of circular shape having diameters larger than the distance between printed dots, e.g. 0.015 inches on 0.010 centers.

In a specific form of the printing machine of the present invention, there are 10.24 of the stylus electrodes in the row 61 to cover 1024 inches of a standard 11 inch wide recording sheet.

In accordance with the present invention, the stylus electrodes are divided into groups, with the same number of electrodes in each group. Correspondingly numbered and located electrodes in each group are connected together by a common supply line.

Thus, referring to FIG. 3, the first electrode E1 in each group is connected in parallel with the first electrode E1 in each other group by a common supply line or highway H1, and the fifth electrode E5 in each group is connected by a common supply line or highway H5. Highway H1 thus connects electrodes E1, E33, E65 and so on. (counting the electrodes consecutively from the left side as shown in FIG. 3) and highway H5 connects electrodes E5, E37, E69 and so on.

The row of stylus electrodes 61 also has each group further divided into an odd block and even block as illustrated in FIG. 3. Each block has the same number of electrodes.

As will be described in greater detail below in the description of the operation of the printing machine, the control means 45 include a register which loads one block at a time. The control means then fire that block after loading and while the data register for the next block is loading.

This manner of firing a block of stylus electrodes and also the manner in which the row 63 of segment, or back-up, electrodes is associated with the block of stylus electrodes is effective to cause only the stylus electrodes to fire that are required for charging a selected area on the sheet, even though the common highway supplies voltage to a corresponding electrode in every group.

As also best shown in FIG. 3, the row of segment or back-up electrodes 63 include individual segment electrodes B0, B1, B3, etc., aligned in an even, odd, even, odd, etc., manner as illustrated in FIG. 3.

Each segment electrode has a length equal to the length of a block of stylus electrodes.

The row 63 of segment electrodes may be offset as illustrated in FIG. 3 so that each block has two segment electrodes associated with that block. Thus, the first odd block of the first group of stylus electrodes has even segment electrode B0 and odd segment electrode B1 associated with that block. The even block of stylus
electrodes of the first group has the first odd segment electrode B1 and the second even electrode B2 associated with that second block. The third odd block of stylus electrodes in the second group has the second even segment electrode B2 and the third odd segment electrode B3 associated with that third block.

A certain threshold voltage is required to produce a printable charge on the sheet. One type of coated paper can require a minimum charge of about 350 volts for the pigmented particles of the toner to be attached to the charged area of the paper. Any charge less than this would not be sufficient to pick up a particle from the toner. Any charge greater than this would be sufficient to pick up a particle from the toner.

In accordance with the present invention, the required total charging voltage is divided between the rows of electrodes, so that the voltage supplied to any individual stylus electrode is not by itself sufficient to produce a charge above the threshold level, but is sufficient to produce a charge on the paper when combined with the charge of an energized and opposed segment electrode. If the stylus electrodes were individually connected to the control means (rather than in parallel by the highways H as described above), it would be possible to energize a single backup electrode continuously at a set level (rather than segmented electrodes) and then to fire the individual stylus electrodes by selective energization of the stylus electrodes at greater than threshold voltage, e.g. (350-400 v). However, with the parallel connections through the highways H, the firing of the stylus electrodes is controlled by selective energization of certain ones of the segment electrodes.

As shown in FIGS. 2 and 3, the stylus electrodes go from ground to about minus 300 volts when energized and the segment electrodes go from ground to about plus 300 volts when energized.

As also shown in FIG. 2, the data bus is divided by the data register 71 which contains the positive voltage power supply and allows negative high voltage power supply.

In the operation of the printing station 37 as so far described, and with reference to FIGS. 2 and 3, the input data for the stylus electrodes is fed into a data register 71 of the control means 45 in either bit serial form, or 16 bit parallel form. The data register 71 receives the data for the first odd block of stylus electrodes until the register for that block is filled. At that time the information is fed in parallel by the data register to the stylus drivers 73, and the stylus drivers fire the first group in response to a signal from the position register 75. This energizes the selected individual electrodes of the first odd block in the first group. Firing the stylus electrodes in parallel increases the speed by the order of magnitude of the stylus electrodes in parallel, e.g. 100 styli in parallel would give a 100 fold increase in speed over firing each electrode individually.

At this time the position select register 75 has also signaled the segment select and drivers 77 to fire the first even segment B0 and the first odd segment B1, so that the individual stylus electrodes energized in the first odd block of the first group are effective to produce the desired charge on the selected area of the sheet above the first odd block. At this time, no other segment electrodes are energized by the segment select 77. Even though individual electrodes in the other odd blocks of the other groups of stylus electrodes corresponding to the selected electrodes in the first odd block are also energized, none of these other stylus electrodes will be effective to produce a charge on the paper since none of the other opposed segments are energized.

While the first odd block is firing, the data register for the second even block is being filled up. After the first odd block has fired, and after the data register for the second even block has been filled, the position select register 75 signals the stylus drivers 73 to fire the second even block of stylus electrodes as selected by the information supplied from the data register 71, and the position select register 75 simultaneously signals the segment selection logic and drivers 77 to fire the first odd segment electrode B1 and the second even segment electrode B2 associated with the second block of stylus electrodes. As described above with reference to the first odd block of stylus electrodes, only the selected electrodes in the selected block are effective to produce an electrostatic charge on the sheet. While the second even block of stylus electrodes are firing, the data register for the third odd block of stylus electrodes in the second group is filling. After firing of the second even block is completed, the firing of the third block begins; and the filling of the data for the fourth even block also begins. On the firing of the third block of stylus electrodes, the second even segment electrode B2 and the third odd segment electrode B3 are energized by the segment select and driver 77. This process is repeated down the length of the two rows of electrodes until all of the stylus electrodes selected for producing a charge on the sheet have been fired.

After the firing of the rows of stylus electrodes has been completed, the position select register 75 signals the motor control 79 to step the sheet 52 one step in preparation for the next firing of the row of electrodes.

The data fed into the data register is supplied from a logic circuit which is energized at a relatively low voltage, e.g. plus five volts as illustrated in FIG. 2.

The logic circuit and the greater part of the control means 45 are contained on printed circuit cards not shown, carried in a card cage 83 located behind the storage compartment 43 for the supply of sheet material.

The drive means 41 for transporting the sheet 52 through the printing machine include a drive roller 121 and a squeegee roller 123.

The squeegee roller 123 is directly connected for drive by tactor 125 (FIG. 2). Alternatively, the squeegee roller may be driven by friction from the paper. The drive roller 121 and the toner roller 105 are driven from the squeegee roller by gears. The force with which the squeegee roller and drive roller 121 are engaged causes the drive roller to pull the sheet 52 through the printing machine by a winching action.

The toner roller 105 picks up toner from the trough and applies that toner to the underside of the sheet 52. The toner roller 105 is partly immersed in toner liquid 105 containing the pigment and particles, e.g. carbon particles in a colloid suspension. The toner roller has a surface which distributes the particles evenly across the surface of the sheet 52 so that the particles can be attracted to the areas of the sheet having the electrostatic charges.

Thus, as the sheet 52 passes through the toner station 39, a predetermined image is reproduced as repre-
sented by the figures S in FIGS. 19 and 20. The width of each individual dot represents the width of an individual stylus electrode, and the distance between the centers of two immediately adjacent vertical dots represents the amount that the sheet has advanced on each advancement through the printing station.

In the machine shown in FIG. 1 the row 63 of segment electrodes may be attached to the underside of the lid 49. Alternatively, they might be formed on the stylus board, as shown for example in FIG. 21.

In accordance with the present invention the stylus electrodes are formed on the surface of the stylus board 91 rather than on the edge of the board.

Different embodiments of the stylus board having stylus electrodes formed on the surface of the board are shown in FIGS. 5 – 18 of the drawings.

The stylus electrodes may be presented in a single line, as illustrated in FIGS. 5 – 11.

The stylus electrodes may also be presented in two or more rows in which the stylus electrodes in one row are offset with respect to the stylus electrodes in the other row. This form of the present invention is illustrated in FIGS. 12, 12A, 13, 14 and 15–18.

In either embodiment the stylus electrodes may be formed by a photo etching process or by a combined photo etching and deposition process (as illustrated in FIGS. 15–18) or by other suitable fabrication processes, such as, for example, thin/thick film techniques; burying conductors in ceramic and adding styli and traces after potting the ceramic; metal coating channels in ceramic blanks or squeezing metal in such channels and lapping true before adding traces and styli; and curing green blanks having molded in holes and channels and then adding metal.

In any event, the principle of the present invention (forming the stylus electrodes or pads on the face or surface of the stylus board) provides structural, operational and cost benefits which have not previously been attainable in printing machines of the kind to which this invention relates.

Regardless of the specific process used, the shapes of the stylus electrodes can be very accurately made on the surface of the board. The spacing and arrangement of the stylus electrodes can also be very accurately controlled.

In the embodiment of the invention having two rows of offset or staggered stylus electrodes, forming the stylus electrodes on the face or surface of the stylus board produces a perfect staggered pattern with no cumulative error in the stagger. That is, each stylus electrode in one row is perfectly registered between two stylus electrodes in the opposite row, whether at the beginning of the row, the middle of the row or at the end of the row. This is possible because both rows of stylus electrodes are exposed from one transparency, in the photo etching process, and this gives perfect registration. Obtaining satisfactory registration for two rows of stylus electrodes has been a problem in the prior art. In the prior art it has been necessary to laminate two separate stylus boards (having edge formed stylus electrodes) together. Because of the small size of the electrodes, the small spacing between adjacent electrodes and the limitations of the manufacturing processes available for forming edge mounted electrodes, attempts to laminate two boards together often resulted in unacceptable registration at various points along the rows of electrodes. That is, placing the stylus electrodes in registration at one end of the board might result in a complete lack of registration at the other end of the board.

An embodiment of the present invention in which the stylus electrodes are aligned in a single row as illustrated in FIGS. 5, 6, 7 and 8.

FIG. 5 is a plan view of a stylus board 91, and FIG. 6 is a fragmentary enlarged plan view of the portion of the stylus board 91 shown encircled by the arrows 6–6 in FIG. 5. FIGS. 7 and 8 are additional fragmentary enlarged views showing structural features in larger detail than FIGS. 5 and 6.

The individual stylus electrodes may be formed with a rectangular shape as shown in FIGS. 5 and 6, or with circular dot shapes, as shown in FIGS. 7 and 8 or with some other pad configuration if desired.

As best illustrated in FIGS. 6 and 7, each stylus electrode E1 through E65 in FIG. 6 is connected by its own conductor trace (T1 – T65 in FIG. 6) to a terminal point on the stylus board located at varying distances from the row of stylus electrodes.

Thus, stylus electrode E1 is connected through a conductor trace T1 to a pad 95 having a plated through hole 97. The plated through hole 97 connects with a highway H1 on the opposite side of the board. The plated through hole 97 thus serves as a terminal point for the trace T1 and a connection to the electrical conductor (the highway H1) on the opposite side of the board.

Each stylus electrode is similarly connected to a related highway conductor on the opposite side of the board by a pad 95 and a plated through hole 97.

The highway H1 through H32 are in turn connected to plug-in connectors on a side edge of the stylus board 91 and the plug-in connectors connect the stylus board to the stylus drivers 73 (FIG. 2).

As best illustrated in FIG. 8 each stylus electrode or pad is raised slightly (e.g. ½ to 5 mils) above the surface of the conductor trace. The difference in height between the stylus pad or electrode and the trace surface gives preferential charge transfer from the stylus pad to the paper over the transfer from the trace to the paper. An insulating layer over the trace may be added to increase the preferential differential.

Another feature of the present invention, as well illustrated in FIG. 6, is the fact that the stylus electrode or pad can be accessed by traces on alternate sides of the board. This doubles the space available for each trace. This makes the traces much easier to manufacture. Thus, as illustrated in FIG. 6, the stylus electrodes E1, E3, E5, etc., are accessed from one side of the board by the corresponding traces, T1, T2, T3, etc., and the stylus electrodes, E2, E4, E6 etc., are accessed by traces T2, T4, T6, etc.

The traces are etched (or deposited) on a relatively thin substrate (e.g. 0.002 inch to 0.10 inch) and the plated through holes 95 can be larger and therefore easier to drill and to plate than in the prior art stylus board constructions.

The stylus heads may be plated to build up the height as illustrated in FIG. 8. The stylus electrodes or pads may also be made by using thick metal and etching down the conductor traces to give the height (thickness) differential.

The stylus boards may be fabricated from blanks with metal on both sides. The larger holes and thinner substrates permit drilling many more boards simulta-
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neously than has been possible in the prior art. The larger tolerances on the hole locations also reduces cost.

The stylus boards 91 are etched and plated in the flat, as illustrated in FIG. 5.

As illustrated in FIGS. 9, 10 and 11 the stylus boards may then be formed around a core to a final shape as shown in FIGS. 9, 10, and 11. In this form of the invention, the stylus electrodes are placed on the periphery of the curve (which typically may be 1/2 inch radius).

FIG. 12 shows an embodiment of the invention in which the stylus electrodes are arranged in two rows with the electrodes in one row offset with respect to the electrodes in the other row.

FIG. 12A illustrates a possible print out from a dual row of stylus electrodes having the relative dimensions and spacings illustrated in FIG. 12. By using circular shaped electrodes or pads having diameters larger than the lateral spacings between the adjacent electrodes it is possible to print a horizontal line with full overlap for a very dark trace as illustrated in FIG. 12A. In FIG. 12A the printed dots 201 are numbered 1, 2, 3, 4, 5, 6 . . . to correspond to the electrodes E1 through E6 which print these dots.

The row printing sequence for accomplishing the print out shown in FIG. 12A would be as follows:
1. first row odd
2. second row odd
3. third row odd first row even
4. fourth row odd second row even

This staggered pattern requires delaying printing of even stylus for two full paperer steps. A two line buffer memory is used for this. Two steps after printing the first line, its dot images are aligned between the even stylus pads and at that time the first line of even dots is printed.

The arrangement of stylus electrodes shown in FIG. 12 also permits printing solid black in a vertical direction, as illustrated by the print out of the letter S in FIG. 19. In this regard, it should be noted that the incremental advancement of the paper sheet is less than the diameter of the circular shaped stylus electrodes. In a typical construction, the diameter of each stylus electrode would be 0.015 inch, and distance between the lines of centers of adjacent electrodes in one row would be 0.010 inch and the distance between the center lines of the two rows would be 0.010 inch. The paper would be advanced 0.005 inches on each incremental advancement.

FIGS. 13 and 14 are fragmentary enlarged views showing how the dual row, staggered stylus electrode arrangement can be fabricated. In this case, the board 91 can be a Kapton or epoxy composition. The conductor traces T1, T2 etc. can be copper photo-etched. The stylus electrodes or pads E1, E2 etc. can be plated up nickel 0.001 inch to 0.005 inch thick. The holes 97 are plated through. And the highways such as H2 can be photo-etched copper.

An alternative would be to photo etch a pattern to a certain thickness, such as 4 mils, then to put a resist on the areas of the stylus electrodes or pads E1, E2 etc., and to photo etch the remainder back to 1 - 1/4 mils, leaving the pads 4 mils thick.

Another alternative would be to make a ceramic substrate with the highways and plated through holes metalized and then to metalize the stylus electrode pads and photo etch a pattern or to deposit the pads and the conductor trace pattern.

FIGS. 15-18 show a thick film fabrication technique which may be used. The first step of the process is to photo etch a copper highway pattern on the substrate of the board 91. The next step is to deposit a dielectric 203 with holes at 205. The next step is to deposit the conductor trace (T1, T2, etc.) pattern contacting the highways through the holes 205 in the dielectric 203.

As a last step the pads E1, E2 etc., are built up by plating or vacuum deposition.

FIGS. 21 and 22 show an embodiment of the invention in which the segment electrodes and stylus electrodes are both disposed on the same side of the recording medium.

The combination of the charges impressed on the dielectric layer 221 by the segment electrodes 23 and those stylus electrodes 61 which are energized causes an image to be formed in the same manner as described in the other embodiments of this invention.

The embodiment shown in FIGS. 21 and 22 also incorporates longerons 223 which extend along the back face of the board 91 parallel to the highways, such as the H1 shown in FIG. 21. The longerons are used primarily as stiffeners to cause the board 91 to bent at certain positions and certain angles with respect to the styl 61. Thus, the board 91 bends on the fold lines 225 (See FIG. 22) between longerons 223 and the first highway H1 to present the stylus and segments to the recording medium in a relatively flat plane.

It should also be noted that the longeron 223 can also be used on capacitive couplings to be pulsed and to correct capacitive couplings developed between relatively long traces of adjacent stylus. In this case, a pulse on a longeron 223 is capacitively coupled to all the stylus, and this pulse is selectively accepted by the stylus.

That is, the unselected stylus couple to the pulse and the selected or energized stylus are less affected because the selected stylus are shortened to ground.

FIG. 23 shows an embodiment of the invention in which the board 91 is held completely flat and the paper of the recording medium 52 is curved at the printing station.

In this construction the segment board 77B and segments 63 may also be curved as illustrated in FIG. 23. This construction has several advantages.

Curving the paper as illustrated minimizes the possibility of a charge transfer from a trace, such as T1, to the paper because the paper is kept well spaced from the traces by reason of its curvature.

The stylus board 91 can be supported by a resilient backing 229 at the printing station. This resilient backing minimizes uneven levels of the line of stylus electrodes along the length of the line, and thus insures that all stylus electrodes are maintained in good contact with the recording medium.

Curving the paper in this manner can also be an advantage in that the paper may be permitted to follow its normal curvature as it is lead off a roll with the dielectric layer inside.

The segment board 77B and segments 63 are held in position by a core 227 as illustrated.

While I have illustrated and described the preferred embodiments of my invention, it is to be understood that these are capable of variation and modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such
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11 changes and alterations as fall within the purview of the following claims.

I claim:

1. An electrode board for a printing machine of the kind in which data is printed on sheet material at a printing station by electrodes which are arranged in a line at the printing station and which are selectively energized to produce electrostatic charges on certain areas of the sheet material transported in a strip form through the printing station, said electrode board comprising: a board member of dielectric materials having first and second faces disposed on opposite sides of the board; a plurality of stylus electrodes disposed on said first face and along one part of said board member, and arranged to provide closely spaced electrodes for producing electrostatic charges on the sheet material passing over said one part of the board member, said electrodes being divided into groups along the length of said one part of the board member with the same number of electrodes in each group; a plurality of terminal points on said first face; a lead connected to each electrode and extending from said one part of the board member and terminating at one of said terminal points, each lead for each electrode in any one group having a different length than any lead of any other electrode in that group whereby the leads terminate at different distances from one said part of the board member, each lead for each corresponding electrode in each group having a length for readily connecting the corresponding electrodes in each group by a common supply line; a plurality of supply lines corresponding in number to the number of electrodes in each group mounted on said second face of the board member with each supply line aligned with the terminal point of one set of leads extending from said one part of the board member; and connection means extending through the board member for providing an electrical connection between such supply lines and the ends of the leads to connect each electrode in each group with the corresponding electrode in each other group by a common supply line on said second face of the board member.

2. The electrode board of claim 1 wherein less than all of the stylus electrodes are connected to leads extending towards one edge of said one side of said board member, and the remaining electrodes are connected to leads extending towards the opposite edge of said one side of said board member, and wherein less than all of said supply lines are disposed to be connected to said leads connected to said less than all of said electrodes, and the remainder of said supply lines are disposed to be connected to the leads connected to said remaining electrodes.

3. The electrode board as defined in claim 1 wherein said board member includes a plurality of holes through it, and wherein the connection means connecting the leads through the board member with the supply line of the other side of the board member includes electrically conductive coatings lining said holes.

4. The electrode board as defined in claim 1 wherein the supply lines terminate at one edge of the board member and wherein plug-in connectors are attached to the ends of the entire electrode board to be quickly plugged into a control circuit for controlling energization of electrodes in each of the groups.

5. A printing machine of the kind in which images are printed on sheet material at a printing station by electrostatically charging selected areas of the sheet at the printing station to attach pigmented particles to the electrostatically charged areas, comprising, a first row of electrodes and a second row of electrodes at the printing station linearly aligned on one side of the sheet, a second row of electrodes at the printing station linearly aligned on an opposite side of the sheet, control means supplying voltages to selected ones of the electrodes in the first and second rows for producing an electrostatic charge on the sheet including divider means for dividing the voltages between the two rows of electrodes in a manner such that a voltage supplied to any individual electrode in either the first or the second row is less than that required to produce the charge but is sufficient to produce the charge when added to the voltage on an opposed electrode in the opposite row, wherein the electrodes in the first row are stylus electrodes disposed on the face of a folded stylus board and are divided into groups having the same number of electrodes in each group and having correspondingly located and numbered electrodes in each group connected by a common supply line on the stylus board, each of the stylus electrode groups being further divided into two blocks with the first half of the electrodes in the group being located in an odd numbered block and the second half of the electrodes in the group being located in an even numbered block, and wherein the electrodes in the second row are segment electrodes with the length of each segment electrode being equal to the length along the stylus row of electrodes occupied by one block of stylus electrodes, the row of segment electrodes being offset with respect to the stylus electrodes in 9 manner such that each block of stylus electrodes has one even numbered and one odd numbered segment electrode spanning the length of the block of stylus electrodes with one-half of the length of the even numbered segment electrode and one-half of the length of the odd numbered segment electrode extending beyond the ends of the block of stylus electrodes.

6. A stylus board for printing machine of the kind in which data is printed on a recording medium at a printing station by styli which are arranged in a line at the printing station and which are selectively energized to produce images on the recording medium, said stylus board comprising a board member of dielectric materials having first and second faces disposed on opposite sides of the board; a plurality of individual styli disposed on said first face and along one part of said board member and arranged to extend outwardly from said first face towards said recording medium as individual raised surfaces; a plurality of terminal points on said first face; a conductor connected to each of said styli and extending from its respective styli to one of said terminal points, a plurality of supply lines disposed on said second face of the board member with each supply line aligned with at least one of said terminal points; and connection means extending through the board member for providing an electrical connection between the supply line aligned with one terminal point and the conductor extending to the same terminal point.

7. A stylus board as defined in claim 6 wherein the styli are disposed on the face of the board spaced from and intermediate opposite edges of the board and the board is made of material such that it may be folded to locate the styli at the printing station closer than said conductors to said recording medium.
8. A stylus board as defined in claim 7 wherein the styli are located on said face adjacent to and aligned with each other and the board is folded on an imaginary line drawn through adjacent styli to place the styli on the periphery of the fold.

9. A stylus board as defined in claim 6 wherein the styli are formed on a portion of the face of the board spaced from and intermediate opposite edges of the board, and less than all of the styli are connected to conductors extending from said intermediate portion towards one of said edges, and the remaining styli are connected to conductors extending from said intermediate portion to the other of said edges.

10. A stylus board as defined in claim 6 wherein the styli are spaced apart and aligned in two adjacent, spaced apart rows and the styli in one row are staggered with respect to the styli in the other row.

11. A stylus board as defined in claim 10 wherein the styli in each row are larger than the space between the styli in the opposite row so that the styli can be energized to print a solid line.

12. A stylus board as defined in claim 11 wherein the space between the adjacent rows is less than the width of the individual styli so that the styli can be energized to print solid lines in transversely disposed directions.

13. A stylus board as defined in claim 6 wherein the styli and conductors are formed as surfaces raised on said board and the styli have a greater height above the face of said board than the conductors.

14. A stylus board as defined in claim 10 wherein the styli are formed on the board by a photo-etching process.

15. A stylus board as defined in claim 10 wherein the styli in one row are accessed by conductors extending to terminal points in one part of the board and the styli in the other row are accessed by conductors extending to terminal points in an opposite part of the board.

16. A stylus board as defined in claim 6 wherein the board is curved so that the styli are linearly aligned on the outside periphery of the curve.

17. A stylus board as defined in claim 6 including segment electrodes formed on the same face of the board as the styli, said segment electrodes being aligned adjacent to and spaced from the styli.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,771,634 ___________________ Dated November 13, 1973

Inventor(s) Reginald T. Lamb

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 37, "proper" should read -- paper --.
Column 4, line 21, "10.21" should read -- 1021 --.
Column 4, line 22, "1024" should read -- 10.24 --.
Column 3, line 30, "connected" should read -- connected --.
Column 10, line 25, "bent" should read -- bend --.
Column 12, line 6, "supply" should read -- supplying --.
Column 12, line 27, "now" should read -- row --.
Column 12, line 30, "thestylus" should read -- the stylus --.
Column 12, line 32, "9" should read -- a --.

Signed and sealed this 21st day of May 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR. C. MARSHALL DAHN
Attesting Officer Commissioner of Patents
UNIVERS STATES PATENT OFFICE
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