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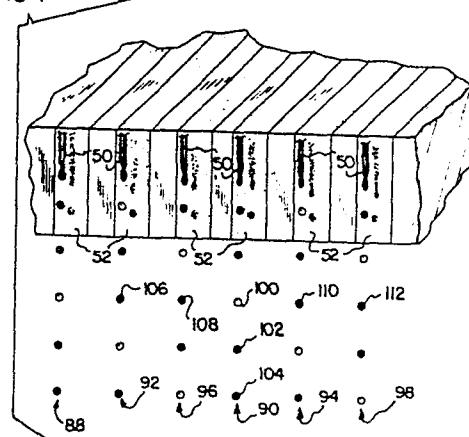
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(54) Ink jet printer and method of printer operation.

(57) An ink jet printer includes a print head for generating a plurality of groups (88,90, etc, 92,94, etc, and 96,98 etc.) of jet drop streams (50) arranged in a first row in which the jet drop streams in each of the groups are uniformly spaced along the row and interspersed with jet drop streams in each of the other groups. A plurality of charge electrodes (52) are provided with each electrode positioned adjacent one of the jet drop streams. A deflection electrode provides a deflection field through which the jet drop streams pass, whereby drops charged to a catch charge level or a guard charge level are deflected to a catcher. Control means repetitively applies print control signals in sequence to the charge electrodes associated with each group of jet drop streams, while simultaneously applying a guard signal to the remaining charge electrodes. This arrangement results in predictable drop-to-drop and interjet crosstalk which may be compensated by a shift in charge voltage levels.

FIG-7



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INK JET PRINTER AND METHOD OF PRINTER OPERATION

The present invention relates to ink jet printers and, more particularly, to a multiple jet ink jet printer and printing method in which crosstalk between adjacent
5 charging electrodes and cross talk from previously formed drops in each jet drop stream are compensated.

Ink jet printers are known in which a plurality of jets of ink drops are projected toward a moving print receiving medium, such as a sheet or a web of paper or
10 other material. Drops in each of the jet drop streams are selectively electrically charged and an electric field in the path of the jets deflects the trajectories of the charged drops. The uncharged drops, on the other hand, are unaffected by the field. A catcher receives drops
15 deflected into a catch trajectory and prevents the received drops from striking the print receiving medium. The remainder of the drops, however, strike the medium and collectively form a print image on the medium.

Some ink jet printers are "binary" in operation
20 in that the drops from each jet drop stream can be directed to the catcher or, alternatively, into a single print trajectory for deposit on the print receiving medium. Such a system is shown in U.S. patent No. 3,701,998, issued October 31, 1972, to Mathis. In another
25 type of printer, the drops in each jet drop stream may be selectively charged to any of a number of charge levels and deflected to a catcher or into any of a number of print trajectories. Thus the drops from a single jet drop stream can be deposited at any one of a number of print
30 positions on the print receiving medium. It will be appreciated that this type of printer has the advantage of



servicing a larger number of print positions for a given size print head and, as a consequence, of providing a print image of higher quality than a binary printer having the same number of jets. Such a printer is shown in U.S. patent No. 4,085,409, issued April 18, 1978, to Paranjpe, and assigned to the assignee of the present invention.

In any of the above described types of printers, it will be appreciated that slight fluctuations in the charges carried by the drops which are to be deposited upon the print receiving medium result in corresponding fluctuations in the trajectories of these drops and, ultimately, in the points of impact of the drops on the medium. As a consequence, such charge fluctuations necessarily result in deterioration of the collective image produced by the drops since the drops are not accurately deposited at the desired print positions.

One source of inaccurate charging of drops in a jet drop stream is the charged drops which have been previously formed in the stream. If a drop in a stream carries a charge, the next drop formed will carry a charge which is dependent in part upon the charge which is carried by the previously formed drop. Such drop-to-drop crosstalk has been recognized as a significant problem and has been treated in a number of ways. In U.S. patent No. 3,827,057, issued July 30, 1974, to Bischoff et al; U.S. patent No. 3,838,354, issued August 6, 1974, to Hilton; U.S. patent No. 3,946,399, issued March 23, 1976, to Zaretsky; U.S. patent No. 4,032,924, issued June 28, 1977, to Takano et al; U.S. patent No. 4,157,551, issued June 5, 1979, to Takano et al; U.S. patent No. 4,080,606, issued March 21, 1978, to Yamada; U.S. patent



No. 3,631,511, issued December 28, 1971, to Keur et al;
and U.S. patent No. 3,789,422, issued January 29, 1974, to
Haskell et al, circuit arrangements are disclosed to
adjust the charge potentials supplied to a charge
5 electrode in dependence upon the charge induced on one or
more of the previously formed drops in the fluid stream.

An alternative approach to the problem of
drop-to-drop crosstalk is to provide "guard drops" between
each of the successive print drops in a jet drop stream.
10 A guard drop is a drop which is not used for printing but
which serves the sole function of permitting the print
drops to be spaced further apart in a stream, thereby
reducing the crosstalk between print drops. The guard
drops may be drops carrying no charge, such as shown in
15 U.S. patent No. 3,562,757, issued February 9, 1971, to
Bischoff, and U.S. patent No. 4,086,601, issued April 25,
1978, to Fillmore et al. Alternatively, the guard drops
may be charged, as shown in U.S. patent No. 3,596,275,
issued July 27, 1971, to Sweet. In either case, as a
20 print drop is formed the charge carried by the preceding
drop in a jet drop stream, i.e., a guard drop, is known.
As a consequence, the charge potential applied to the
charge electrode in order to charge a drop appropriately
for printing is also known. Where the guard drops are
25 charged, the charge potential applied to a charge
electrode as a print drop is formed may be offset by a
d.c. voltage level which compensates for the effect of the
charge carried by the previously formed guard drop.

Another difficulty encountered in accurately
30 charging drops in a multi-jet ink jet printing system is
that of jet-to-jet crosstalk. When a high resolution

printer uses a charge electrode arrangement in which the electrodes do not completely surround their associated jet drop streams, the charge induced on a drop in a stream is a function of both the potential applied to the charge electrode associated with the stream and also the potentials applied to charge electrodes associated with the adjacent streams. This problem of interjet crosstalk increases as the spacing between adjacent jet drop streams is decreased.

Several approaches have been used to reduce interjet crosstalk or to compensate for it. U.S. patent No. 4,074,278, issued February 14, 1978, to Robertson, discloses an arrangement in which a charge potential applied to a charge electrode is adjusted in response to the charge potentials applied to charge electrodes associated with adjacent jets in order to compensate for interjet crosstalk. U.S. patent No. 3,656,171, issued April 11, 1972, to Robertson, recognizes the crosstalk problem but the device disclosed in the patent is such that the effect of crosstalk is minimized and no compensation is needed.

In U.S. patent No. 3,604,980, issued September 14, 1971, to Robertson, crosstalk is minimized by shielding between the adjacent charging electrodes. In fact, where the charge electrode takes form of a cylindrical tunnel with the drops being formed within the tunnel, the charge electrode itself shields the drops as they are formed from the effects of adjacent charge electrodes. In a high resolution printer, in which a flat electrode is positioned next to a jet drop stream at the point of break off in order to reduce spacing between

adjacent electrodes, the electrodes do not provide shielding and interjet crosstalk becomes a significant problem.

5 Accordingly, it is seen that there is a need for an ink jet printer in which the effects of both drop-to-drop crosstalk and interjet crosstalk are reduced.

According to one aspect of the present invention, an ink jet printer includes print head means for generating a first plurality of groups of jet drop streams arranged in a first row. The jet drop streams in each of the groups are uniformly spaced along the first row and interspersed with jet drop streams in each of the other groups. A first plurality of charge electrodes are provided with each of the electrodes positioned adjacent an associated one of the jet drop streams. A plurality of print control signals are provided for application to associated ones of the charge electrodes. Each of the print control signals is selectively variable between at least one print potential level and a catch potential level, whereby drops having a print charge level or a catch charge level, respectively, may be produced. A guard signal at a guard potential level is provided for application to the charge electrodes, whereby drops having a guard charge level may be produced. A deflection electrode means provides an electrical deflection field through which the jet drop streams pass. A catcher means catches drops charged to the catch charge level and drops charged to the guard charge level. A control means repetitively applies print control signals in sequence to charge electrodes associated with each group of the jet drop streams, while simultaneously applying the guard signal to the remaining charge electrodes.

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The control means may comprise means for applying print control signals to charge electrodes associated with each group of the jet drop streams for a time period substantially equal to the time required for production of a predetermined number of drops in the jet drop streams.

The jet printer may have a print head which includes means for generating a second plurality of groups of jet drop streams arranged in a second row parallel to and adjacent the first row. The jet drop streams in each of the groups of the second plurality are uniformly spaced along the second row and interspersed with jet drop streams in each of the other groups in the second plurality. The printer may further comprise a second plurality of charge electrodes with each of the charge electrodes being positioned adjacent an associated one of the jet drop streams in the second row, a catcher means for catching drops in the second row charged to the catch charge level and to the guard charge level, and a control means for repetitively applying print control signals in sequence to charge electrodes associated with each group of the jet drop streams in the second row. The control means simultaneously applies the guard signals to the remaining charge electrodes associated with jet drop streams in the second row.

The ink jet printer may have a control means which applies the guard signal to charge electrodes associated with jet drop streams in the second row when print control signals are applied to charge electrodes associated with jet drop streams adjacent thereto in the first row.



The method of the present invention of operating the ink jet printer includes the steps of:

(a) applying print control signals to charge electrodes associated with a group of the jet drop streams which are interspersed along the first row with other jet drop streams, while simultaneously applying the guard signal to the remaining charge electrode, and

(b) thereafter applying the guard signal to the charge electrodes associated with the group of jet drop streams while simultaneously applying print control signals to at least some of the remaining charge electrodes.

The step of applying print control signals may comprise the step of cyclically applying in sequence print control signals to charge electrodes associated with each group of the jet drop streams, while simultaneously applying the guard signal to the remaining charge electrodes.

The step of cyclically applying print control signals may include the step of sequentially applying print control signals to charge electrodes associated with each group of the jet drop streams for a time period substantially equal to the time required for production of a predetermined number of drops in the jet drop streams. The time period may be approximately equal to the time required for production of one drop or, alternatively, to the time required for production of a plurality of drops.

In the case where the print head generates a second plurality of groups of jet drop streams arranged in a second row, the method may further include the step of



cyclically applying in sequence print control signals to charge electrodes associated with each group of the jet drop streams in the second row while simultaneously applying the guard signal to the remaining charge electrodes associated with jet drop streams in the second row. The guard signal may be applied to charge electrodes associated with jet drop streams in each of the rows when the print control signals are applied to charge electrodes associated with the jet drop streams opposite thereto in the other of the rows.

Accordingly, it is an object of the present invention to provide an ink jet printer and a method of printer operation in which the effects of drop-to-drop crosstalk and interjet crosstalk are effectively compensated and the fluctuations in charge level carried by the drops which would otherwise occur as a result of such a crosstalk are eliminated; to provide such a printer and method in which guard drops are produced in each of the jet drop streams between successive print drops; to provide such a printer and method in which the timing of the application of print control signals to the electrodes associated with each of the jets in a row of jets is such that when a print control signal is applied to a charge electrode, the adjacent charge electrodes receive a guard signal; and to provide such a printer producing a pair of parallel rows of jet drop streams in which the timing of print control signals to the electrodes is such that guard signals are applied to the charge electrodes in one row of jets which are opposite the electrodes in the other row of jets receiving print control signals.



1 In order that the invention may be more readily
understood, reference will now be made to the accompanying
drawings, in which:

5 Fig. 1 is an exploded perspective view of an ink
jet printer of the type to which the present invention
relates;

Fig. 2 is a sectional view of the printer of Fig.
1, taken generally along line 2-2 in Fig. 1;

Fig. 3 is an enlarged sectional view, similar to
Fig. 2;

10 Fig. 4 is a simplified diagrammatic view, taken
generally along line 4-4 in Fig. 3, illustrating the print
positions serviced by the various jet drop streams of the
printer;

15 Fig. 5 is an electrical schematic diagram
illustrating circuitry for controlling the application of
print control signals and the guard signals to the charge
electrodes;

Fig. 6 is a waveform diagram useful in explaining
the present invention;

20 Figs. 7-9 are enlarged representations of a
number of jet drop streams in a row and the associated
charge electrodes, illustrating the charging sequence
according to the method of the present invention; and

25 Fig. 10 is a view illustrating a pair of rows of
jet drop streams as seen from below the print head,
illustrating the charging sequence.

The present invention relates to ink jet printers and a method of printer operation. Figs. 1-3 illustrate a jet drop printer according to the present invention which includes a print head means 10 for generating a first
5 plurality of jet drop streams 12 arranged in a first row and a second plurality of jet drop streams 14 arranged in a second row.

The print head means 10 includes a plurality of transducer assemblies 16, a piston member 18, a resilient
10 O-ring 20, a transducer holder 22, and a manifold block 24 with an intervening sealing O-ring 26. An orifice plate 28 defines a first row of orifices 30 and a second row of orifices 32, and is adhesively attached to the bottom of manifold block 24. Block 24 defines a fluid reservoir 34
15 to which ink is supplied under pressure via inlet connection 36. The ink flows through the orifices 30 and 32 and emerges from each orifice as a fluid filament. The fluid filaments then break up into the streams of drops 12 and 14.

Each transducer assembly 16 is composed of an
20 upper backing plate 38, a pair of piezoelectric transducers 40 which are preferably thickness mode ceramic transducers, a transducer attachment plate 42 which also functions as an electrode for transducers 40. Plate 42 is
25 supported by holder 16 and attached thereto by bolts 44. The piston member 18 is attached to the transducer assemblies 16 by means of bolts 46 which extend into threaded openings in the piston member 18. When a driving
30 potential is applied to the piezoelectric transducers 40 by electrical conductors 48, pressure waves are produced in the fluid within reservoir 34 which pass downward and



which are coupled to the fluid filaments 50 so as to produce pressure varicosities in the filaments which cause them to break up into ink drops of generally uniform size and spacing. The print head 10 is disclosed more
5 completely in U.S. patent No. 4,138,687, issued February 6, 1979, to Cha et al, and assigned to the assignee of the present invention.

A plurality of charge electrodes are provided and positioned adjacent the jet drop streams. A first
10 plurality of charge electrodes 52 is positioned adjacent the first row of streams 12. Electrodes 52 preferably comprise plated layers of metal spaced along the edge of non-conductive electrode plate 54. Similarly, a second
15 plurality of charge electrodes 56 comprise layers of metal spaced along the edge of non-conductive charge electrode plate 58. Each of the electrodes is connected to a separate printed circuit conductor on the top surface of the plates 54 and 58. The printed circuit conductors are electrically connected through connectors 60 to
20 appropriate control circuitry for supplying the desired electrical potentials to the electrodes so that the drops carry appropriate electrical charges.

After charging, the drops are subjected to a static electrical deflection field as they travel downward
25 toward print receiving medium 62. Toward this end, a deflection electrode means, including deflection electrode 64, is provided which is supported within electrically nonconductive holders 66. Holder 66 also supports catchers 68. Typically, a high electrical potential is
30 applied to electrode 64 via line 70 while catchers 68 are grounded by conductors 72. A substantial electrical field



therefore extends between electrode 64 and each of the grounded catchers 68. Catchers 68 are laterally adjustable relative to electrode 64 by means of elastic bands 74 which urge the catchers inward in slots 76 defined by holders 66. Adjusting blocks 78 are inserted upwardly through openings 80 in holders 66 and bear against the faces of the catchers. The blocks 78 are adjusted by means of screws 82 so as to position and align the catchers as desired.

As shown in Fig. 3, ink flows downward through orifices 30 and 32 forming rows 12 and 14 of streams which break up into curtains of drops. The point of break up of the fluid filaments 50 into drops is adjacent associated charge electrodes 52 and 56. The drops then are directed to one of the catchers 68 or onto the moving print receiving medium 62 at one of two print positions. Switching of drops between the "catch" trajectory and the two "print" trajectories is accomplished by electrostatic charging and deflection. Drops which are uncharged pass through the fields between the catchers 68 and the electrode 64 in undeflected trajectories as shown by streams 84. Those drops carrying a slight charge are deflected outward from the deflection electrode 64 as shown by streams 86. Finally, those drops carrying a greater charge are deflected sufficiently to strike catchers 68 with the result that the drops do not print on the medium 62.

Reference is now made to Fig. 4, a diagrammatic representation of the print positions at which drops may be deposited on the medium 62 by the printer, taken generally along line 4-4 in Fig. 3. Electrode 64 is



maintained at a deflection voltage of the same polarity as the charge levels selectively applied to the drops.

Uncharged drops strike the print receiving medium at print positions illustrated by the solid circles. Slightly

5 charged drops are deflected outward to the print positions shown by the dashed circles. If a greater charge level is placed on a drop, the drop is deflected even further outward from the electrode 64 so as to be caught by a catcher 68. The print positions have been numbered
10 1-480. It is assumed for purposes of illustration that 240 orifices are used with each of the two parallel rows having 120 such orifices.

As described previously, the print control signals are supplied to the charge electrodes in a digital
15 fashion. Each electrode is supplied with a print control signal which is selectively variable between at least one print potential level which causes a drop being formed to carry a print charge level and a catch potential level which causes the drop being formed to carry a catch charge
20 level. In the illustrated embodiment, two print potential levels are available with one of the two levels causing deposit of drops at the print positions indicated by solid circles and the other of the two print potential levels causing deposit of drops at the print positions
25 illustrated by the dashed circles. Additionally, as described more fully below, a guard potential level is available for application to electrodes when guard drops are to be charged to a guard charge level. This guard potential level may be equal to the catch potential level.

30 Reference is now made to Figs. 5, 6, and 7 which illustrate control circuitry for controlling operation of



the printer and a method of printer operation according to the present invention. Fig. 7 is a diagrammatic representation of a portion of the first row 12 of jet drop streams, depicting the fluid filaments 50 which break up into jet drop streams adjacent associated electrodes 52. The drops have been colored in Fig. 7 to differentiate between guard drops, colored black, and print drops, which are white. It should be kept in mind that a print drop is not necessarily a drop which is going to be deposited on the print receiving medium 62. Rather, a print drop is a drop which can be selectively charged for deposit on the print receiving medium or, alternatively, for deflection to a catcher. Guard drops, on the other hand, always carry a guard charge level and, therefore, are always deflected to a catcher.

In accordance with the present invention the jet drop streams in the row 12 may be grouped into a plurality of groups with the jet drop streams in each of the groups being uniformly spaced along the first row and interspersed with the jet drop streams in each of the other groups. Specifically, in this embodiment, the jet drop streams may be grouped into with three groups, with streams 88, 90, and every third stream along the row in the first group, streams 92, 94, and every third stream along the row in the second group, and streams 96, 98, and every third stream along the row in the third group. Print control signals are applied repetitively in sequence to charge electrodes associated with each group of said jet drop streams, while simultaneously applying the guard signal to the remaining charge electrodes.

The charging pattern illustrated is such that when a print drop, such as drop 100 is produced, the drop-to-drop crosstalk effect from the preceding guard drops 102 and 104 is known and, as a consequence, the potential applied to the associated charge electrode may be adjusted to compensate for this crosstalk. In point of fact, since two guard drops will always have been formed prior to formation of a print drop, this potential adjustment simply takes the form of a d.c. shift in the print control charge levels applied to the electrodes 52. It should be also noted that at the time that print drop 100 was being formed, drops 106, 108, 110, and 112 on either side of drop 100 were also being formed and that these drops are all guard drops. As a consequence, the inter-jet crosstalk from adjacent charging electrodes 52 will also be known. Thus, the crosstalk between jets can simply be compensated by another d.c. level shift in the print voltages applied to the charge electrodes.

It will be noted that the jet-to-jet crosstalk from adjacent electrodes which are charging guard drops, assuming such drops are positively charged, will also tend to induce a positive charge on the print drop. The previously formed guard drops in the jet, carrying a positive charge, however, tend to induce a negative charge on the print drop. Thus, the drop-to-drop crosstalk effect and the interjet crosstalk effect tend, to some degree, to cancel each other out. Which type of crosstalk effect predominates is dependent upon the charging potentials and the spacing of the jets and the various components of the printer.

As seen in Fig. 5, print control data is supplied to switches 114 via lines 116 from an appropriate source of such data. The signals on lines 116 are either binary 1's or 0's, indicating a print or no print decision for the appropriate print position then being serviced by the jet. Switches 114 are illustrated for purposes of explanation as mechanical switching devices but preferably, such switches will be semiconductor switching devices. Switch 114, when receiving a binary 1 on line 116 indicating that a drop is to be deposited at the print position then being serviced by the jet, will switch into its upper switching position so as to connect its output 118 to supply a print potential level signal from line 120 to switch 122. It will be appreciated that a switch 122 and a switch 114 are provided for each of the charge electrodes.

Assuming that the drop-to-drop crosstalk effect predominates, the charge voltage levels used by the circuit of Fig. 5 to implement this charging method would generally be as shown in Fig. 6. The print potential level ϕ , fluctuates between a voltage of $-\phi_1$ and a voltage of $-\phi_2$. The voltage $-\phi_1$ is selected so as to compensate for the net crosstalk effect from adjacent charge electrodes and previously formed guard drops with the result that the drop formed while $-\phi_1$ volts is applied to the charge electrode carries no charge. Such a drop will therefore pass downward through the deflection field unaffected. The voltage $-\phi_2$ is selected so as to compensate for drop-to-drop and interjet crosstalk and result in a charge being induced in a drop formed as this potential is applied to the associated electrode such that

it is deflected to one of the print positions indicated generally as 86. If, on the other hand, a drop is not to be deposited at the print position then being serviced by the jet, the output of switch 114 receives -D volts which is supplied via switch 122 to the charge electrode. This voltage is a catch potential level which results in the drop then being formed carrying a catch charge level. The drop then formed will have a sufficiently large positive electrical charge such that it will be deflected outward and will be caught by one of the catchers 68.

As seen in Fig. 5, a control circuit including shift register 124 provides control signals to switches 122. Register 124 is loaded with the sequence "100100100 ..." and is clocked in this embodiment at the drop generation frequency of the print head. The 1's and 0's are shifted downward with the output from the bottom shift register stage being returned to the top shift register stage via line 126. Each switch 112 is repetitively switched into its lower switching positions so as to provide a guard signal at a potential -D to the associated charge electrode during formation of two successive guard drops before switching into its upper switching position in which a print control signal from switch 114 is provided to the charge electrode. If desired, register 124 can be cycled at a lower rate, thus resulting in more than one print drop being formed at one time.

Figs. 8 and 9 illustrate similar drop charging patterns. Fig. 8 shows the pattern of charge and guard drops where only one guard drop is provided between successive print drops. Fig. 9, on the other hand, is a view illustrating the use of three guard drops between

successive print drops. In Fig. 8, the streams are grouped into two groups with every other stream in the row belonging to the same group. In Fig. 9, the streams are grouped into four groups, with every fourth stream belonging to the same group.

Fig. 10 depicts the rows 12 and 14 of jet drop streams subsequent to charging but prior to deflection as generally seen from above the medium 62. As is apparent, the charging of drops in row 12 is accomplished so that when a print drop is being formed in a stream in one row, the corresponding opposite stream in the other row has a guard drop being formed. By this technique, jet-to-jet interference between adjacent jets in the two rows of jet drop streams is made predictable and thus may be compensated by a further d.c. adjustment of the print control signals applied to the charge electrodes.

CLAIMS

1. A method of operating an ink jet printer of the type which includes a print head (10) for generating a plurality of jet drop streams (12) arranged in a first row and directed toward a print receiving medium (62), a
5 plurality of charge electrodes (52), each of said charge electrodes positioned adjacent an associated one of said jet drop streams (12); means (114, 118) providing a plurality of print control signals for application to associated ones of said charge electrodes, each of said
10 print control signals selectively variable between at least one print potential level and a catch potential level, whereby drops having a print charge level or a catch charge level, respectively, may be produced; means (122) providing a guard signal at a guard potential level
15 for application to said charge electrodes, whereby drops having a guard charge level may be produced; deflection electrode means (64) for providing an electrical deflection field through which said jet drop streams pass; and catcher means (68) for catching drops charged to said
20 catch charge level and for catching drops charged to said guard charge level, characterized by the steps of:

applying print control signals to charge electrodes associated with a group (88, 90) of said jet
25 drop streams which are interspersed along said first row with other jet drop streams, while simultaneously applying said guard signal to the remaining charge electrodes, and
thereafter applying said guard signal to said charge electrodes associated with said group (88, 90) of
30 jet drop streams while simultaneously applying print control signals to at least some (92, 94, 96, 98) of the remaining charge electrodes.

2. A method according to claim 1,
characterized in that said print head (10) generates a
first plurality of groups of jet drop streams and in which
the jet drop streams in each of said groups are uniformly
5 spaced along said row and interspersed with jet drop
streams in each of the other groups, in which the step of
applying print control signals comprises the step of
cyclically applying in sequence print control signals to
charge electrodes associated with each group of said jet
10 drop streams, while simultaneously applying said guard
signal to the remaining charge electrodes.

3. A method according to claim 2,
characterized in that said step of cyclically applying
print control signals includes the step of sequentially
applying print control signals to charge electrodes
5 associated with each group of said jet drop streams for a
time period substantially equal to the time required for
production of a predetermined number of drops in said jet
drop streams.

4. A method according to claim 3,
characterized in that said time period is approximately
equal to the time required for production of one drop.

5. A method according to claim 3,
characterized in that said time period is approximately
equal to the time required for production of a plurality
of drops.

6. A method according to claim 1,
characterized in that said print head generates a
plurality of jet drop streams (14) arranged in a second
row extending parallel to and adjacent said first row (12)
5 and directed toward said print receiving medium (62), and
additionally characterized in that said printer includes
an additional plurality of charge electrodes (56), each of
said additional plurality of charge electrodes positioned
adjacent an associated one of said jet drop streams in
10 said second row, and catcher means (68) for catching drops
in said second row charged to said catch charge level and
to said guard charge level, and further characterised by
the steps of:-

15 applying print control signals to charge
electrodes (56) associated with a group of said jet drop
streams in said second row which are interspersed along
said second row with other jet drop streams, while
simultaneously applying said guard signal to the remaining
20 charge electrodes (56) associated with the jet drop
streams in said second row, and

thereafter applying said guard signal to said
charge electrodes associated with said group of jet drop
streams in said second row while simultaneously applying
25 print control signals to at least some of the remaining
charge electrodes associated with the jet drop streams in
said second row.

7. A method according to claim 6,
characterized in that said guard signal is applied to
charge electrodes associated with jet drop streams in each
of said rows (12, 14) when said print control signals are
5 applied to charge electrodes associated with the jet drop
streams opposite thereto in the other of said rows.

8. An ink jet printer, comprising print head means (10) for generating a first plurality of groups of jet drop streams (12) arranged in a first row, said jet drop streams in each of said groups being uniformly spaced
5 along said first row and interspersed with jet drop streams in each of the other groups, a first plurality of charge electrodes (52), each of said electrodes positioned adjacent an associated one of said jet drop streams, means (114) providing a plurality of print control signals for
10 application to associated ones of said charge electrodes (52), each of said print control signals being selectively variable between at least one print potential level and a catch potential level, whereby drops having a print charge level or a catch charge level, respectively, may be
15 produced, means (122) providing a guard signal at a guard potential level for application to said charge electrodes, whereby drops having a guard charge level may be produced, deflection electrode means (64) for providing an
20 electrical deflection field through which said jet drop streams pass, and catcher means (68) for catching drops charged to said catch charge level and drops charged to said guard charge level, characterized by

control means (124) for repetitively applying
25 print control signals in sequence to charge electrodes associated with each group of said jet drop streams, while simultaneously applying said guard signal to the remaining charge electrodes.

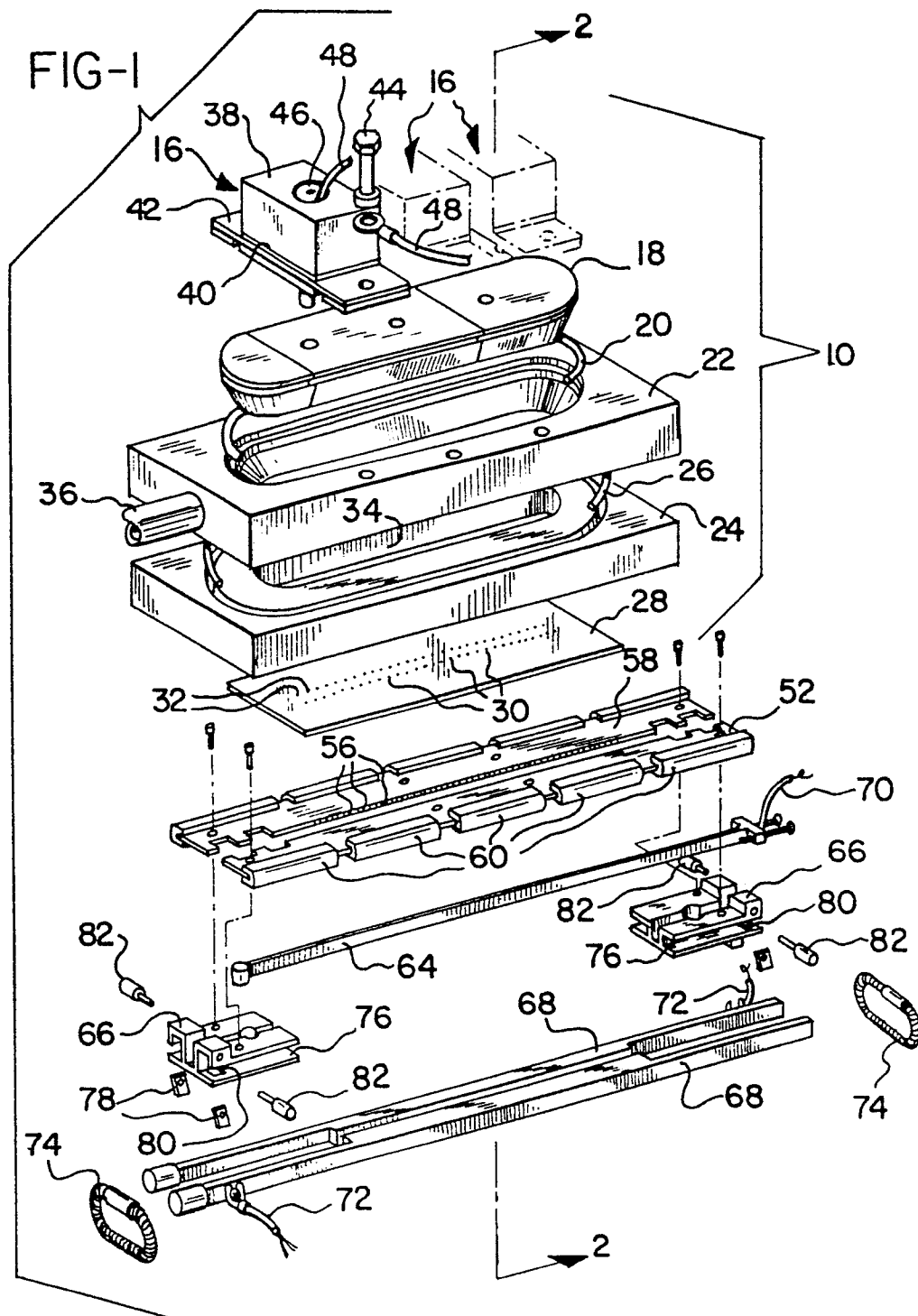
9. An ink jet printer according to claim 8, characterized in that said control means comprises means (124) for applying print control signals to charge electrodes associated with each of said groups of said jet drop streams for a time period substantially equal to the time required for production of a predetermined number of drops in said jet drop streams.

10. An ink jet printer according to claim 8, characterized in that said print head means includes means for generating a second plurality of groups of jet drop streams (14) arranged in a second row parallel to and adjacent said first row, said jet drop streams in each of said groups being uniformly spaced along said second row and interspersed with jet drop streams in each of the other groups in said second plurality, and further characterized in that said printer includes

a second plurality of charge electrodes, (56) each of said charge electrodes positioned adjacent an associated one of said jet drop streams in said second row, catcher means (68) for catching drops in said second row charged to said catch charge level and to said guard charge level, and

control means (124) for repetitively applying print control signals in sequence to charge electrodes associated with each group of said jet drop streams in said second row, while simultaneously applying said guard signal to the remaining charge electrodes associated with jet drop streams in said second row.

11. An ink jet printer according to claim 10, characterized in that said control means for repetitively applying print control signals in sequence to charge electrodes associated with each group of said jet drop streams in said second row applies said guard signal to charge electrodes associated with jet drop streams in said second row when print control signals are applied to charge electrodes associated with jet drop streams adjaceant thereto in said first row.



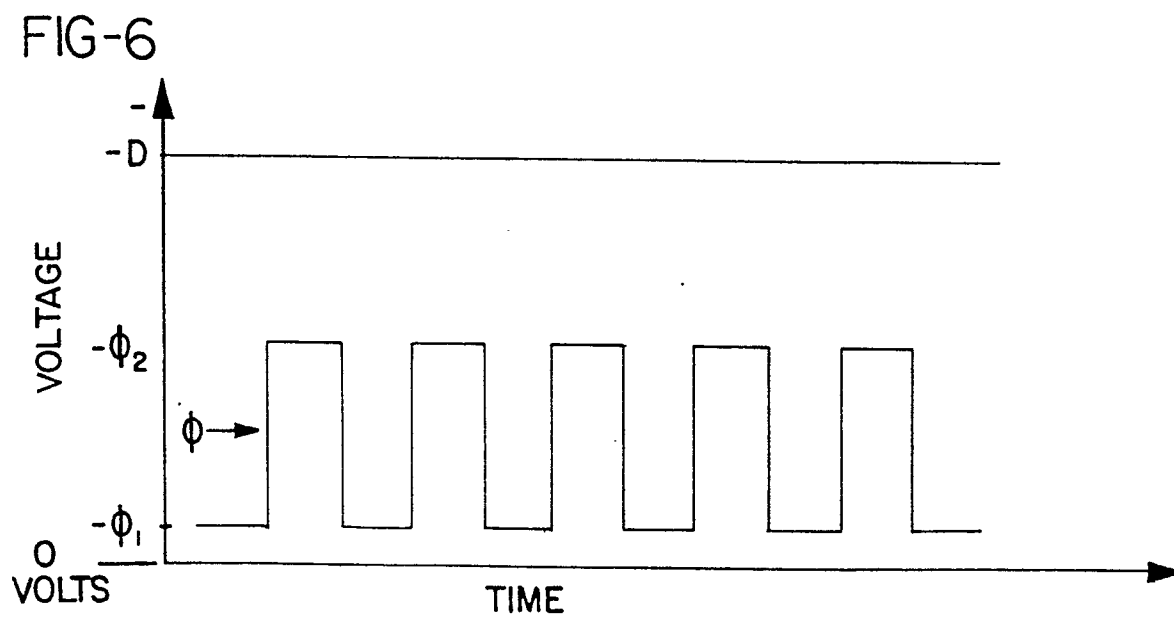
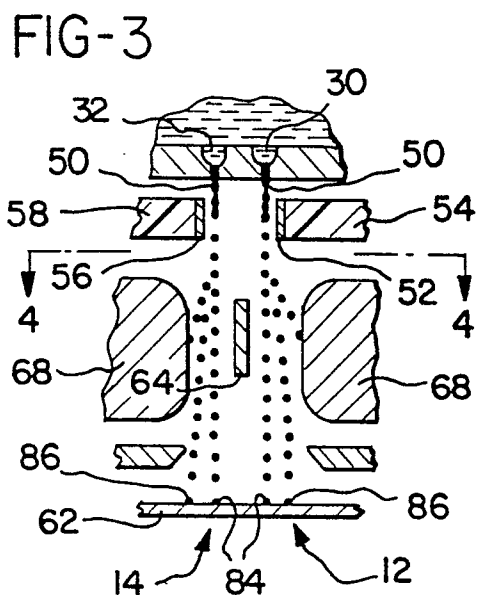
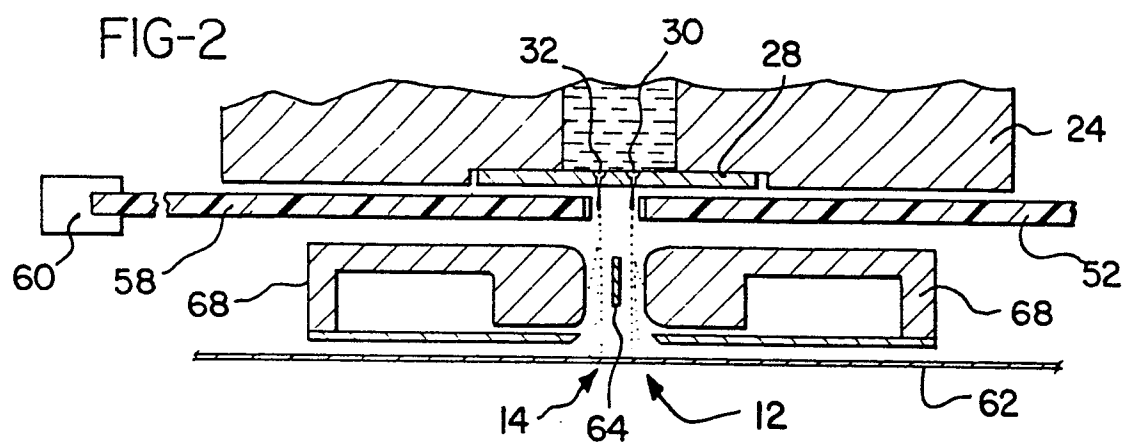


FIG-4

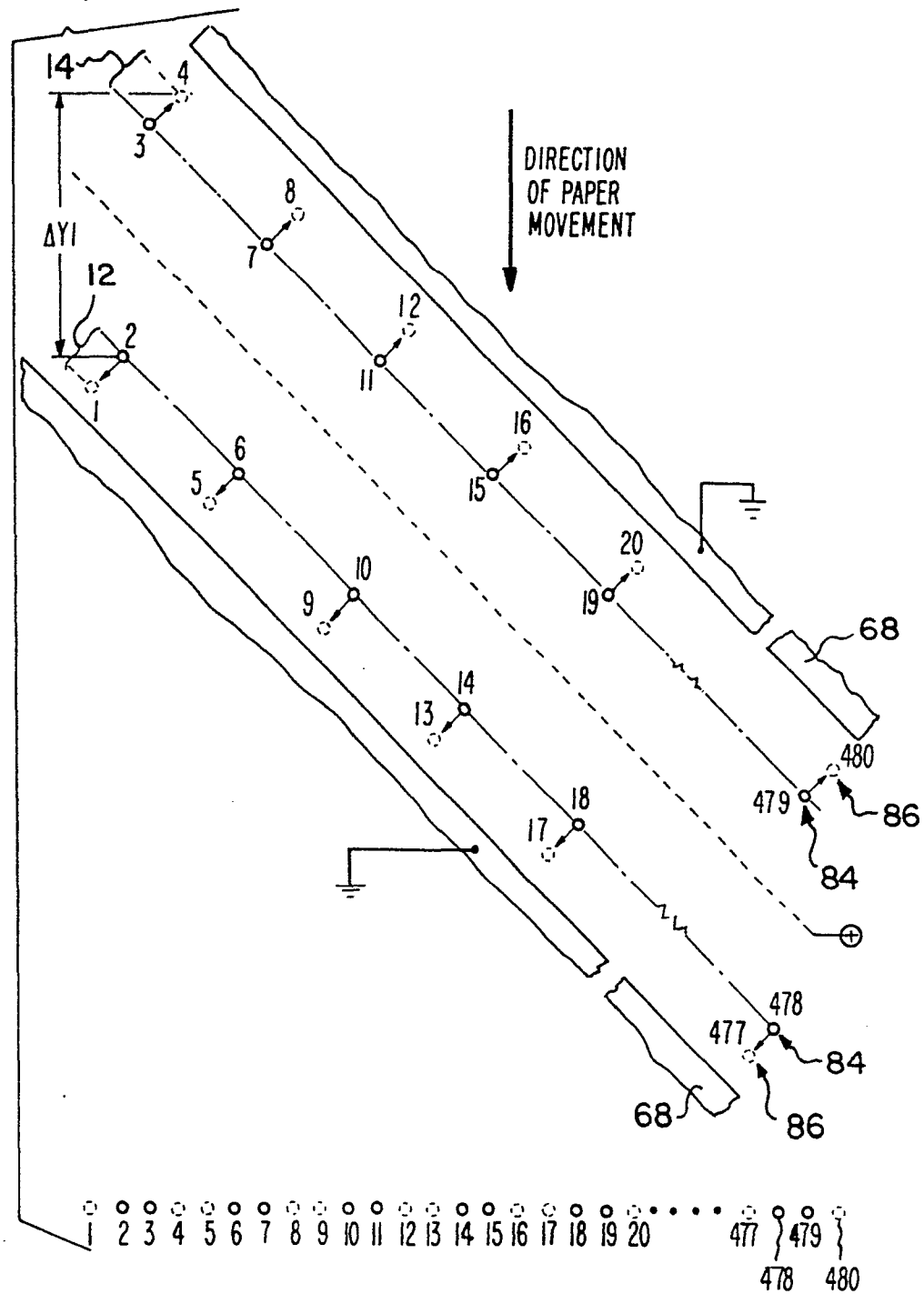


FIG-5

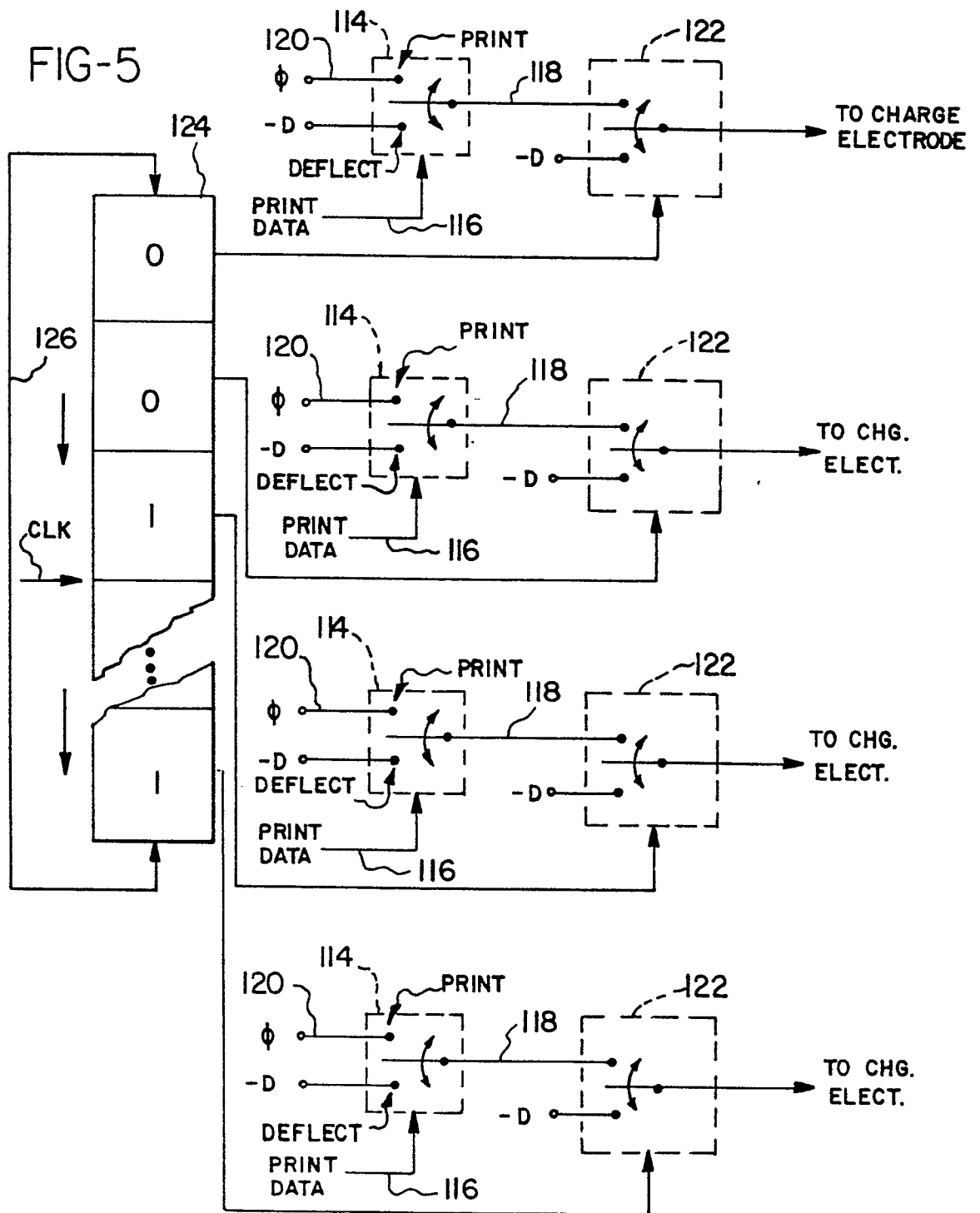


FIG-7

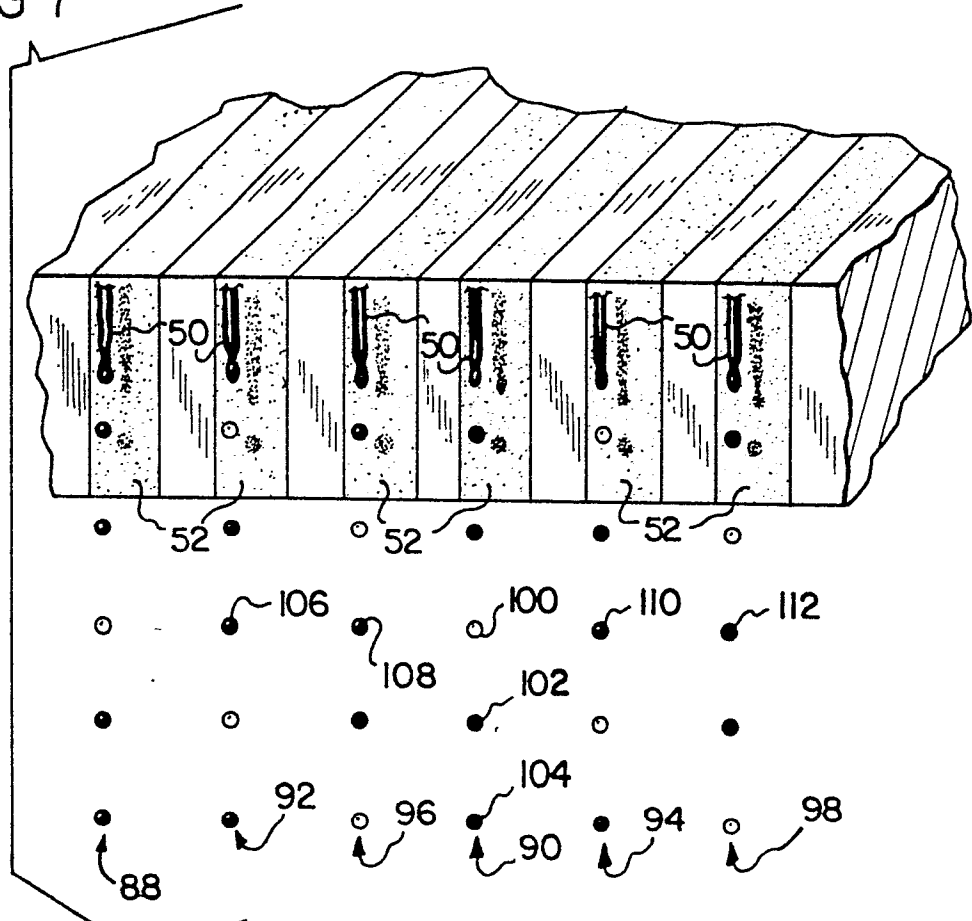


FIG-8

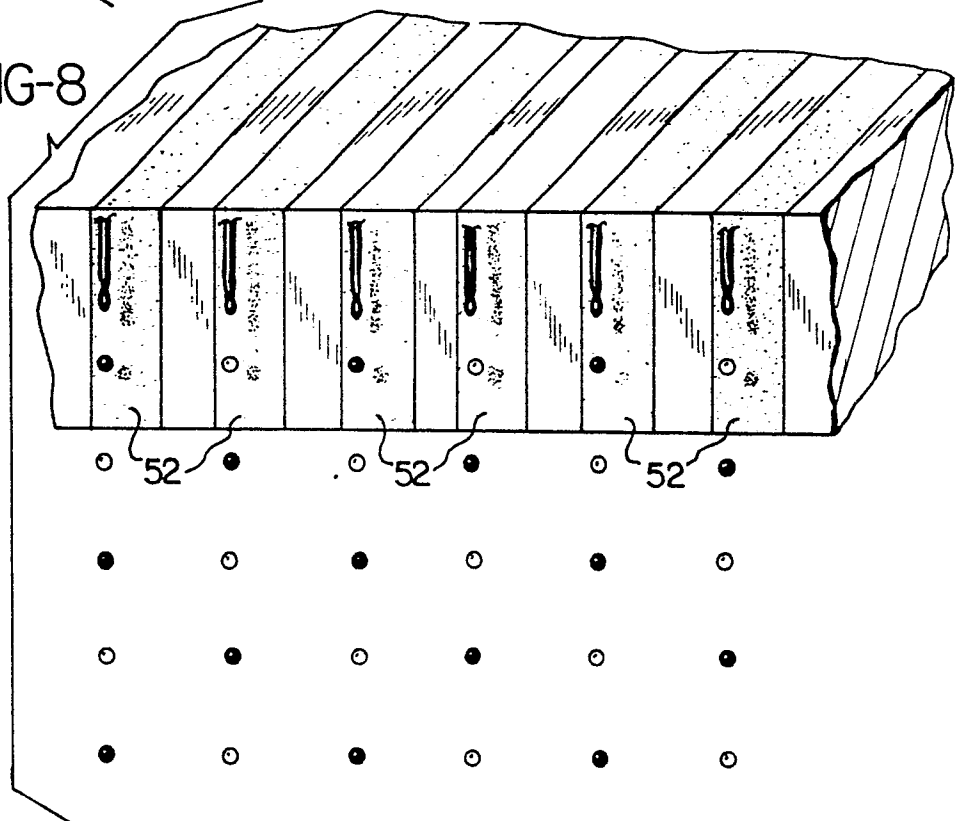


FIG-9

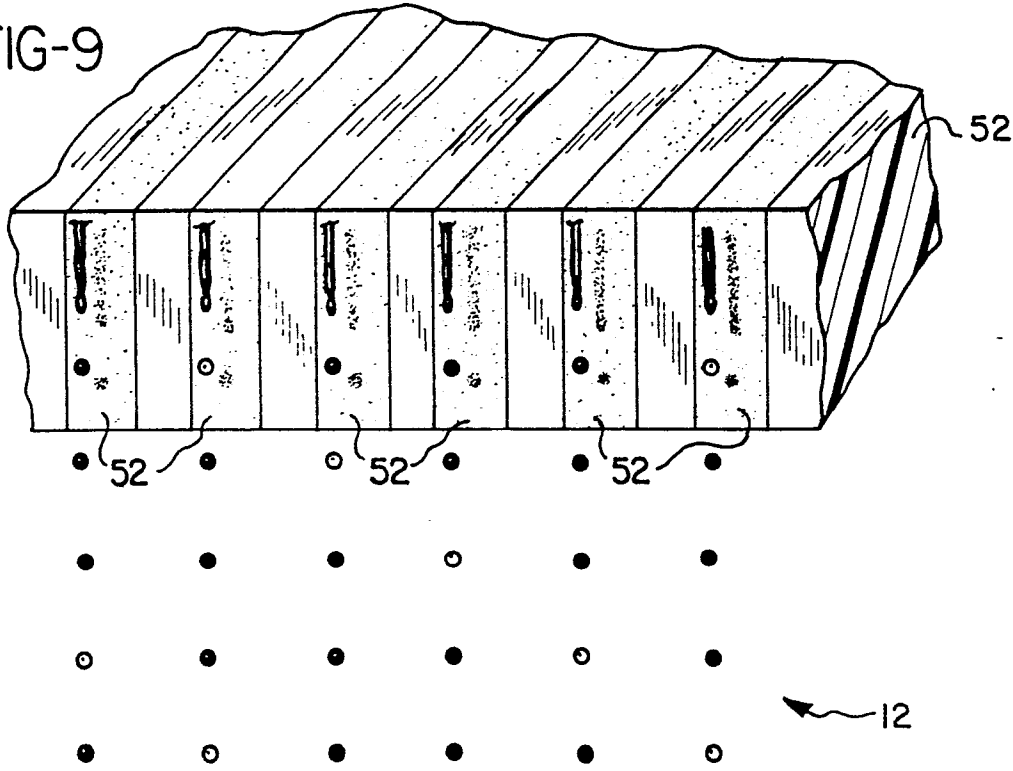


FIG-10

