

March 24, 1970

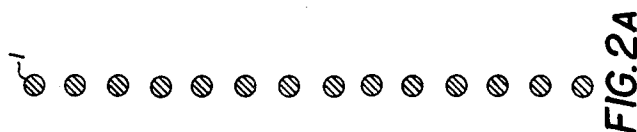
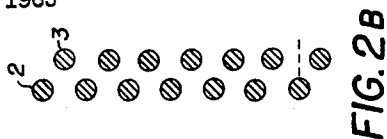
A. T. STARR

3,503,063

ELECTRIC DISCHARGE TUBES

Filed May 6, 1965

7 Sheets-Sheet 1



012
11%
- HEC

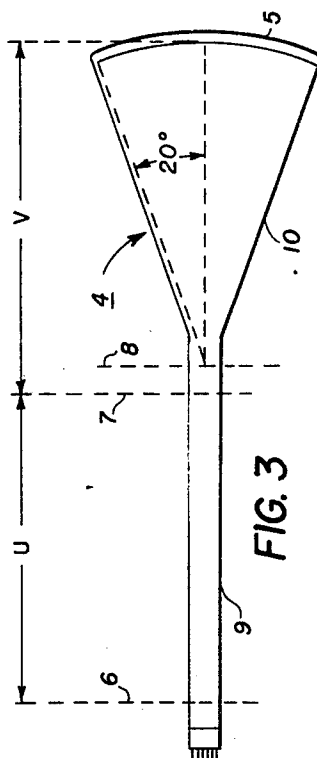
FIG. 1C

012
11%
- ABC

FIG. 1B

012
11%
- ABC

FIG. 1A



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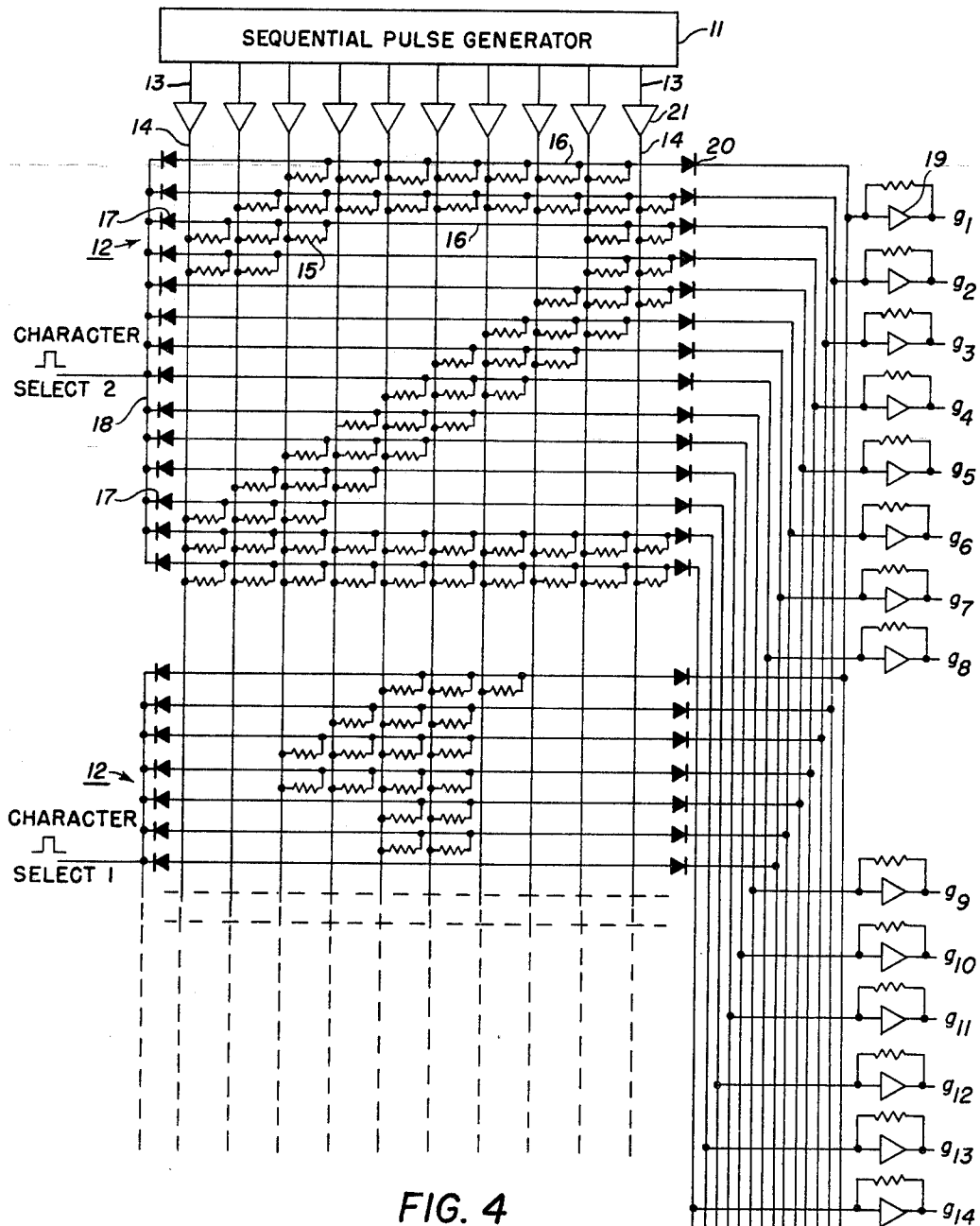
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ELECTRIC DISCHARGE TUBES

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7 Sheets-Sheet 2



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ELECTRIC DISCHARGE TUBES

Filed May 6, 1965

7 Sheets-Sheet 3

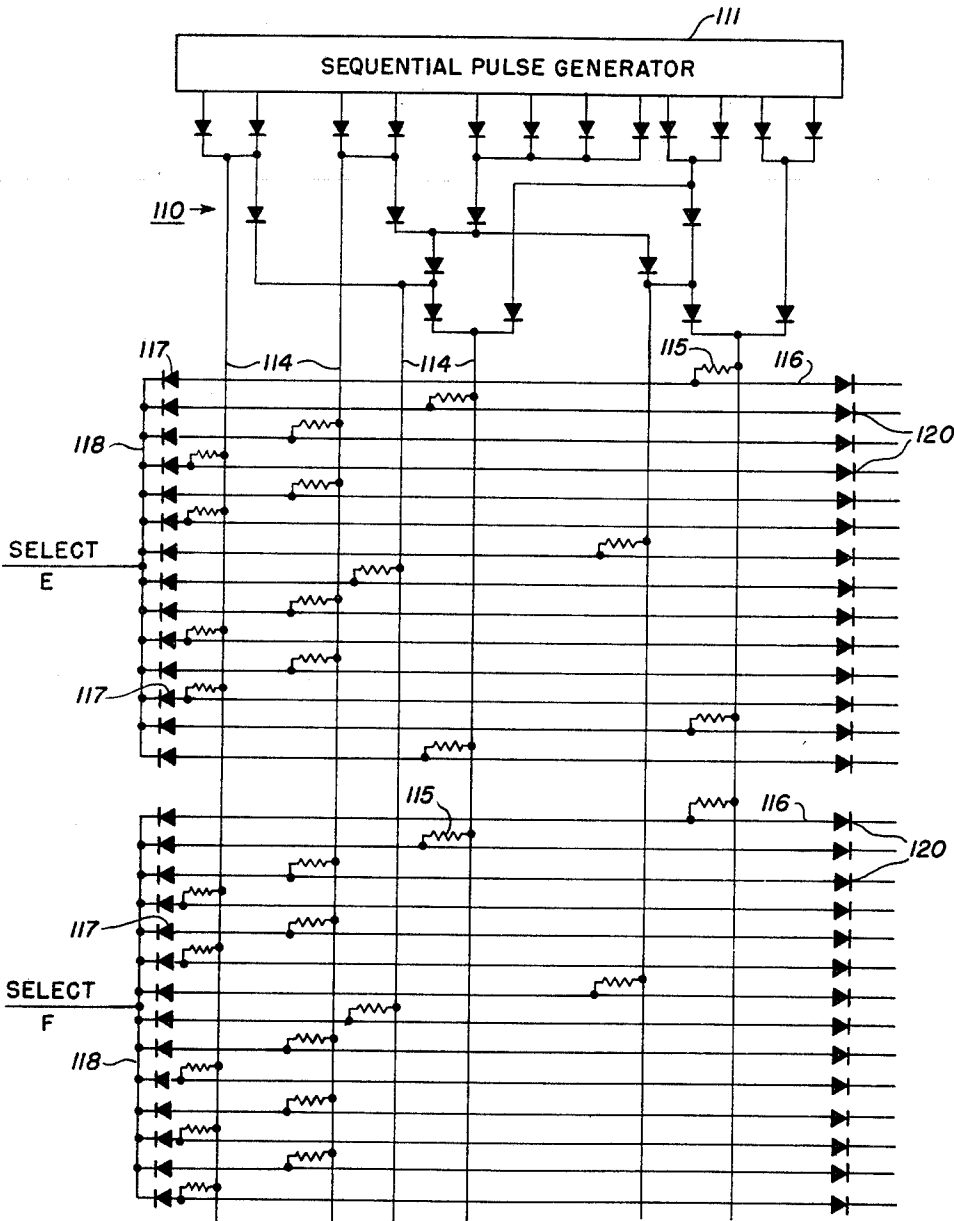


FIG. 5

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ELECTRIC DISCHARGE TUBES

Filed May 6, 1965

7 Sheets-Sheet 4

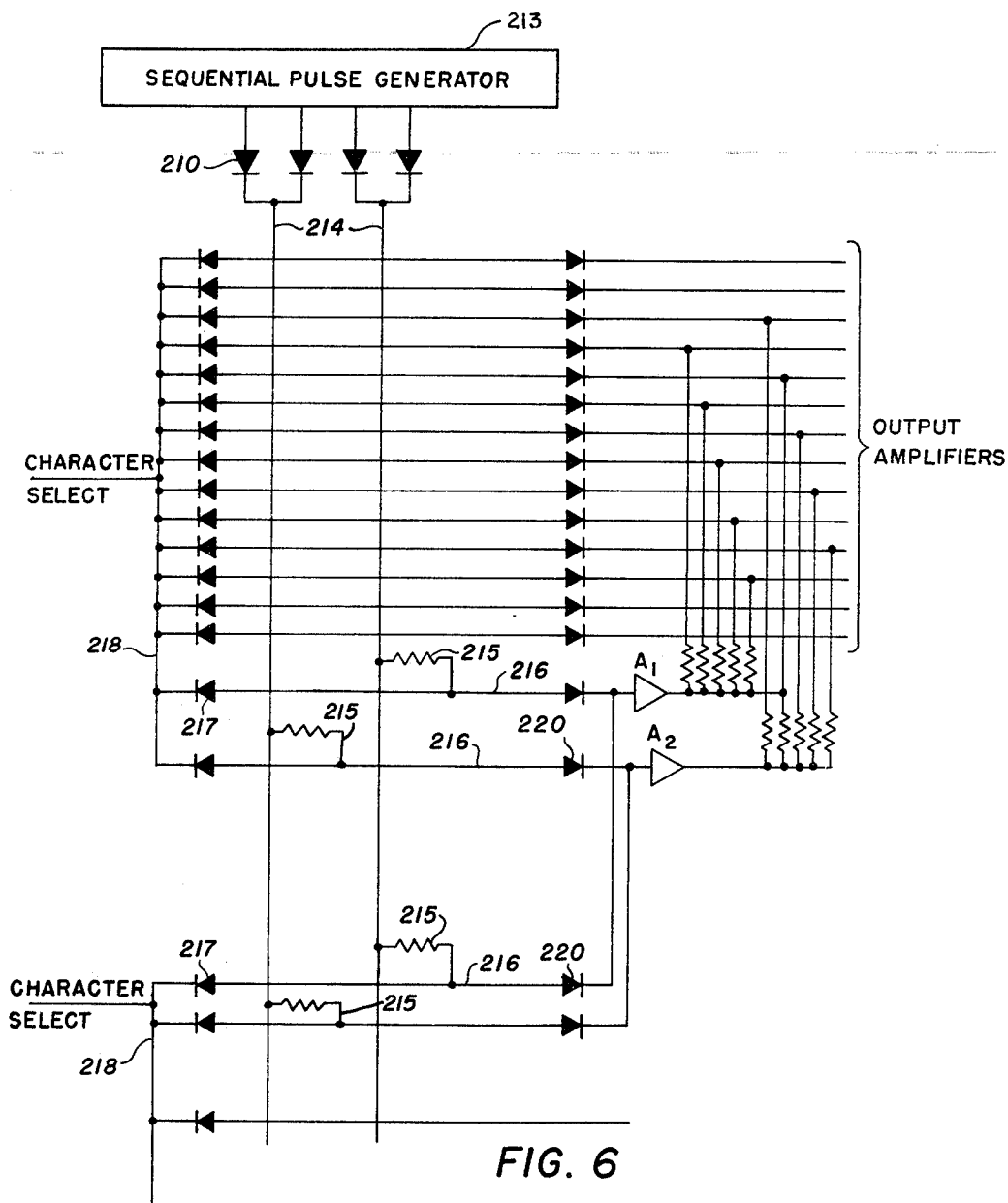


FIG. 6

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ELECTRIC DISCHARGE TUBES

Filed May 6, 1965

7 Sheets-Sheet 5

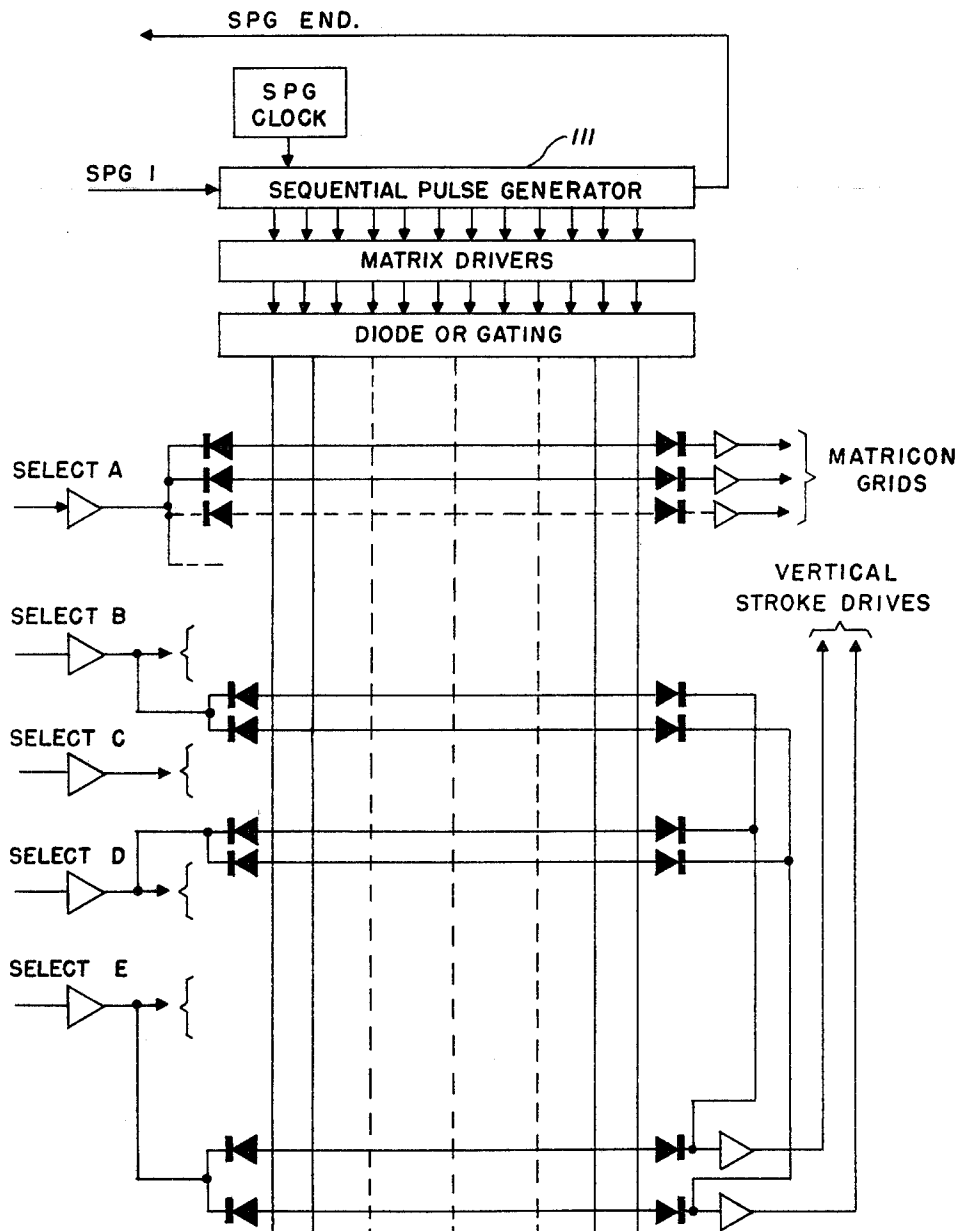


FIG. 7

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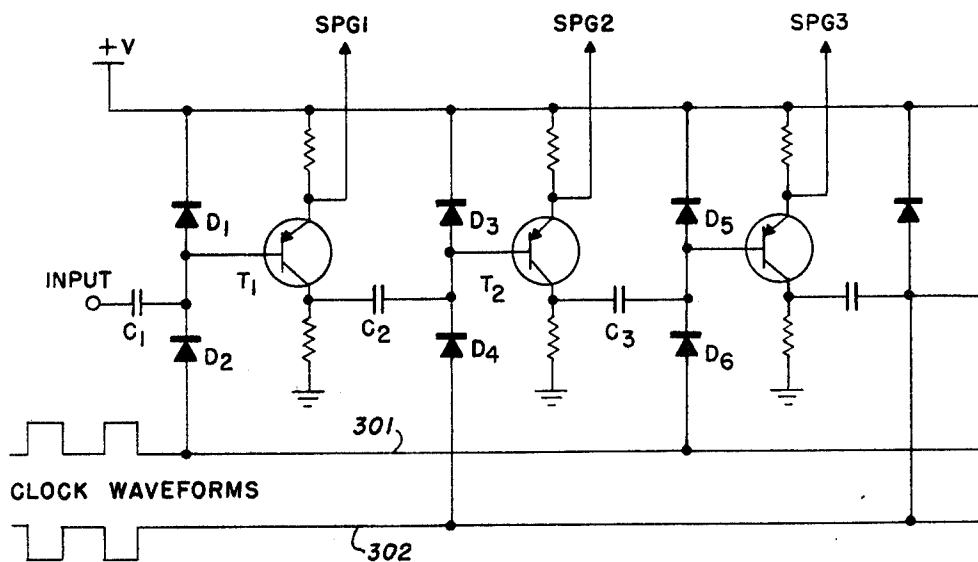
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ELECTRIC DISCHARGE TUBES

Filed May 6, 1965

7 Sheets-Sheet 6



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ELECTRIC DISCHARGE TUBES

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7 Sheets-Sheet 7

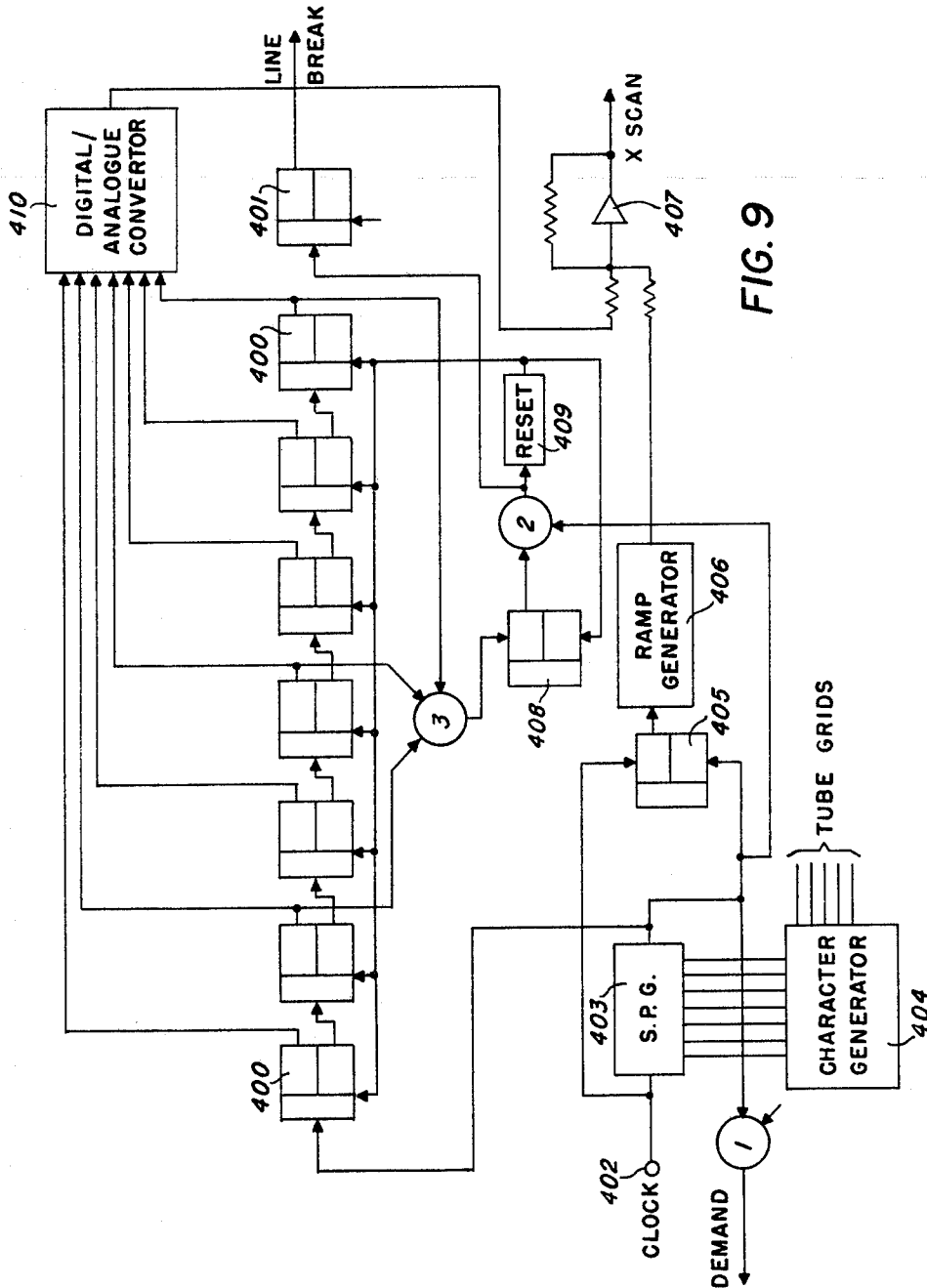


FIG. 9

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3,503,063

ELECTRIC DISCHARGE TUBES

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Claims priority, application Great Britain, May 7, 1964, 19,111/64

Int. Cl. H01j 29/50, 31/00

U.S. Cl. 340—324

6 Claims

ABSTRACT OF THE DISCLOSURE

An electric discharge tube for forming character symbols on the fluorescent material on the face thereof. A first aspect of the invention includes selection means for selecting a predetermined pattern corresponding to a symbol representing data, timing means for governing the timing of said predetermined intervals of time, and circuit means each having a set of interconnections determining said pattern. In a second embodiment there is included a first plurality of elemental electron beams arrays in a column, and additional electron beam production means for providing a second plurality of electron beams, also disposed in a column, and spaced apart from said first plurality of elemental beams so as to fill the spaces between the bright spots made by said first plurality of elemental electron beams on the face of the tube.

This invention relates to electric discharge tubes, and is concerned especially but not exclusively, with an electric discharge tube and associated circuit arrangement for the generation and display of alphanumeric characters and symbols on the face of an electric discharge tube.

In our copending applications Ser. Nos. 360,047 and 428,166, there is described an electric discharge tube comprising electron beam production means for providing a plurality of elemental electron beams arranged in a column, means being provided for accelerating the elemental electron beams, receiving means, for example, a fluorescent screen, being provided for impingement of the elemental electron beams thereon, the elemental electron beams being positionable substantially transversely of the column by beam deflecting means, for example, deflection electrodes within the tube.

The electron beam production means, in one embodiment, comprise a plurality of annular beam-modulating electrodes disposed in an upright column in an otherwise electron-impervious member, and a cathode for generating an electron beam of adequate cross sectional dimensions to flood the column of beam modulating electrodes. Application of a suitable potential to each annular electrode enables an elemental beam to be switched on or off, that is to say, to be allowed to pass through the annular electrode or not, as desired.

The elemental beams are jointly deflected in a direction such that the column of dots on the face of the tube is deflected substantially at right angles to itself and selected ones of the electrodes are supplied with appropriate potentials, suppressing some beams and allowing others to pass, so that a character or some other element of data representation is built up in an array of bright spots, column by column, on the fluorescent screen of the tube as the column of elemental beams moves across the face of the tube.

The definition of a character produced by this means tends to be inadequate for high quality printing or display purposes. The definition of a character appearing on the face of the tube depends on the number of bright spots which can be fitted into the outline of the character,

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which in turn depends on the number of possible positions in which the bright spots can be placed on the face of the tube, and it is an object of the present invention to overcome this drawback by providing a "fuller" character.

According to one aspect of the present invention there is provided a circuit arrangement for modulating the pattern of voltages appearing on a set of electrodes in an electric discharge tube at predetermined intervals of time, comprising selection means for selecting a predetermined pattern corresponding to a symbol representing data, timing means for governing the timing of said predetermined intervals of time, and circuit means each having a set of interconnections determining said pattern.

Preferably, means are provided for coordinating the pattern of voltages appearing on the set of electrodes with deflection voltages present on beam deflection means within the electric discharge tube, or in the deflection field forces of the electromagnetic deflection means arranged outside the tube.

According to another aspect of the present invention, there is provided an electric discharge tube comprising electron beam production means for providing a first plurality of elemental electron beams arranged in a column, and comprising additional electron beam production means for providing a second plurality of elemental electron beams, also disposed in a column, and spaced apart from said first plurality of elemental beams so as to fill the spaces between the bright spots made by said first plurality of elemental electron beams on the face of the tube.

In order to make the invention clearly understood, reference will now be made to the accompanying diagrammatic drawings which are given by way of example and in which:

FIGS. 1a, 1b, and 1c are illustrations of characters of various qualities and definitions;

FIGS. 2a and 2b are illustrations of two alternative arrangements of electron beam producing means;

FIG. 3 illustrates an electric discharge tube in outline, showing the relative proportions of the various component parts;

FIG. 4 is a diagrammatic representation of a circuit arrangement for a character generator for driving an electric discharge tube having electron beam producing means, as shown in FIG. 2a;

FIG. 5 is a diagrammatic representation of a circuit arrangement for a character generator for driving an electric discharge tube having electron beam producing means, as shown in FIG. 2b;

FIG. 6 is a diagrammatic representation of a circuit arrangement which is a modification of the circuit arrangement as shown in FIG. 5;

FIG. 7 is a diagrammatic representation of a further circuit arrangement for a character generator for driving an electric discharge tube according to the present invention;

FIG. 8 is a diagrammatic representation of a sequential pulse generator for use in the circuit arrangement according to the present invention; and

FIG. 9 is a diagrammatic representation of a circuit arrangement for controlling the horizontal deflection of the electron beams of an electric discharge tube according to the present invention.

Referring to FIG. 1 of the drawings, the quality of a character depends on how "full" it can be made, or how dense a matrix, that is to say a grid of squares or dots, it can be constructed from. FIG. 1a shows characters which can be constructed from a 14 x 10 matrix. FIGURE 1b shows an upper case constructed from a 12 x 9 matrix but requiring a 14 x 10 matrix to provide the lower case as well. This is because the tails of the

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lower case extend well below the character center line. FIGURE 1c shows a 7 x 5 matrix font. All the fonts are stylized, to an extent, since they have been made by filling in squares and reducing the result photographically. It will be appreciated on inspection of FIG. 1 that it would not prove possible to produce characters of the quality shown with a tube having a 7 x 5 matrix without resort to spot-wobble, because of the normally finite distance between the actual spots.

If a higher quality of characters is required, the final matrix on which the character is to be built should be at least 13 x 9 and preferably 14 x 10, as shown in FIG. 1a. This means that a line of fourteen beams, say, would be required from the electron beam producing means, as described in our aforementioned copending patent applications. A column of 14 beam sources, as indicated by reference numeral 1 in FIG. 2a, could in practice mean a source of 0.54" in length. In order to image this source down to typewriter capital size, say 0.125", a reduction of nearly four to one would be required and this would inevitably lead to an excessively long tube.

In order to reduce the length of tube to reasonable dimensions, the source must be made small and the required minification reduced as far as possible. A reduction of 2:1 in the source size can be obtained directly by using two columns of beam sources 2 and 3, as shown in FIG. 2b, instead of one column. This has the advantage that the size of the spacing of the apparatus can be made sufficiently small to ensure that a filled character results when the tube is scanned. Moreover, if the spacing between the columns 2 and 3 in FIG. 2b is chosen to be an integral number of periods of the character generator sequential pulse generator, no real complication occurs in the circuitry.

It is worthwhile considering the best arrangement for a tube in relation to FIG. 3, which shows the outline of a tube 4. A desired requirement is for a tube having a face 5, no larger than 7" in diameter, and preferably 5", which must be capable of displaying 150 character positions, if necessary, in two lines of 75 character positions each. There are two good reasons for using a scheme of two lines of characters with split optics. First, more of the tube face is used and, consequently, the resolution demanded in the tube is eased and, secondly; with a double line system, the screen quality is not so important. Most cathode ray tube screens have minor blemishes which are allowed for in the tube specification and, if the highest quality is required, the tube cost can rise alarmingly due to the screening yield becoming poor.

If it is assumed that 85% of the tube screen diameter can be used to display characters, which is a reasonable figure and allows for movement of the traces when the phosphor becomes discoloured through use, then the available time length for 75 characters is 4.25" for a 5" tube face, 5.1" for a 6" tube, and about 6" for a 7" tube. Now the character on a 14 x 10 matrix has ten horizontal dot positions, and assuming that the character spacing is to be equal to the character height, the total number of resolved dots across the tube face will be $14 \times 75 = 1050$. Thus, to get the full definition of the proposed tube, the spot diameter of the dot at the phosphor must be approximately one-thousandths of the line length on the tube. Moreover, the character height and spacing will need to be $\frac{3}{75}$ times the line length on the tube, being 0.080" for a 7" tube, 0.068" for a 6" tube, and 0.057" for a 5" tube.

The design of the tube is dependent on the minimum size of the matrix which can be provided for a source, and the electron optics must be designed to provide the correct character size at the phosphor screen from that source. It is thought at present practicable to make a matrix source of the type shown in FIG. 2b with a vertical overall dimension of approximately 0.11 inch. This would use apertures 0.010" in diameter, spaced vertically at 0.015" and separated horizontally by 0.015".

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Now considering FIG. 3, which shows a tube envelope, an approximate position 6 for the source, the center of focus 7 and the object and image distances, if a 7" tube is to be used, then the magnification v/u must equal

$$\frac{0.080}{0.110}$$

Assuming that a scan angle of approximately 40° is possible, the distance between the screen 5 and the center of scan 8 is 8.25", and, since the tube neck 9 is approximately 1.4" in diameter, the scanning yoke can project forward along the neck by approximately 1.9" before reaching the cone 10. Allow then, 4" for the scanning yoke and, after a gap of $\frac{1}{2}$ inch, assume a focus coil of 2" in length. This results in the distance V being

$$9.1 + 2 + 0.5 + 1.0 = 11.75"$$

Consequently, since $v/u = 0.71$, u must be approximately 16.4", and since a further two inches is necessary for the gun, the total length of the tube would be $11.75 + 18.4$, or approximately 30". In the experimental tubes made to date it has been usual to place an accelerating spiral in the neck of the tube. This has the result of reducing the neck length necessary for a given magnification by a factor of approximately 1.2. If used in the tube shown in FIG. 3, the distance u could be reduced from 16.4 to 13.6 inches, and the tube length would reduce to approximately 26½ inches.

The same series of calculations for a 5" tube with a 40° scanning angle, 4" scanning coils, and using the same size of source, result in a length for the tube of approximately 27". This is, of course, because although the smaller diameter of the screen allows the distance between the center of scan and the screen to shorten, this gain is offset by the greater magnification required.

There is no advantage to be gained in tube length by reducing the screen diameter at a given scanning angle and with a fixed length of scanning yoke and size of source. The tube length can only be reduced further by reducing the source size, which is difficult, or the scanning yoke length, which would require greater scanning power, or increasing the scanning angle. The latter is undesirable since for a flat faced printing tube it would almost certainly require considerable dynamic focus.

One factor which has not been taken into consideration is the effect of magnification on screen current. Obviously, if aberrations are momentarily disregarded, with a given source area and given current density in the source, the smaller the final dot on the screen, the higher is the current density at the screen and, consequently, the more completely is the phosphor saturated. Once the phosphor is fully saturated, no further light output can be obtained by increasing beam current or density at the phosphor. Evidence, obtained experimentally, has shown that the phosphor can be fully saturated in four microseconds even at unity magnification. This means that a 7" line tube will be able to saturate the phosphor fully at a character period of 56 μsec. or approximately 18 kc./s.

The above considerations have resulted in the choice of a 7" tube for the basis of the first tube to be made, with a source approximately 0.110" in length, and a tube length of approximately 29", since this is the length which will result from using the optimum available glass bulb.

It is expected that μa. can be sent through the apertures of 10 thousandths of an inch diameter. A system which has been investigated has F/4.5 optics and 100 μa. over a spot .012" in diameter, and requires an exposure time of 4 μs. The spot size here is

$$\frac{0.080}{0.110} \times 10 = 7.3 \text{ thousandths of an inch}$$

so that the current density corresponds to a current of

$$10 \times \left(\frac{12}{7.3} \right) = 27 / \mu a.$$

over a spot diameter 12 thousandths of an inch. It is known that, because of saturation, the required exposure time is $4 \times (10/6) = 7 \mu\text{s.}$, and a speed greater than 100,000 characters would be possible were it not for the time is $4 \times (10/6) = 7 \mu\text{s.}$, and a speed greater than a speed of 20,000 characters per second should be achievable.

FIG. 4 shows in diagrammatic form the circuit required for the character generator. The circuit, intended for the tube hereinabove described, uses a sequential pulse generator 11 which applies a voltage sequentially to sets of resistor matrices 12. The sequential pulses are applied to all the resistor matrices 12 in parallel through their respective amplifiers 21, and the character waveform required is selected by gating into the deflection amplifiers 19, only the currents set up in that set of resistors defining the character. A delay line, terminated by an impedance, forms part of the shift register, or sequential pulse generator 11. The line 13 applies pulses sequentially to vertical matrix wires 14 and, if a given vertical matrix wire 14 is connected by a resistance 15 to a horizontal matrix wire 16, then current flows in the respective resistance 15 and passes through a diode 17 at the end of the respective horizontal matrix wire 16. Normally the character select wires 18 are negative with respect to the inputs of the grid amplifiers 19 so that current flowing in the matrix resistances 15 normally flows into the character select wires 18; when, however, a character is selected, the respective select wire 18 is taken positive and then currents from the matrix resistances 15 flow into the grid amplifiers 19 through diodes 20, setting up the pattern held by the resistances on the grids g1 to g14 of the electric discharge tube.

FIG. 4 shows the straightforward form of a character generator for a 14 x 10 matrix. The requirements are a common sequential pulse generator or shift register 11, a common set of amplifiers 19, and a set of 28 diodes 17, 20 and approximately 70 resistors 15 per character. The actual form of the character generated will be slightly different from that described above, because of limitations in the tube itself.

The preceding description with reference to FIG. 4 explains briefly the necessary circuit for an electric discharge tube using beam sources arranged as shown in FIG. 2a. The circuit of FIG. 4 requires the modification, shown in FIG. 5, to enable the source shown in FIG. 2b to be used. Once again a shift register or sequential pulse generator 111 is necessary, but, since now one line of sources is displaced by two positions from the other, the generator must supply an extra two outputs, or a total of twelve outputs. The sequential pulse generator 111 supplies twelve outputs which are connected to vertical matrix wires 114 by an arrangement of diodes 110. The vertical matrix wires 114 are connected by resistors 115 at some of the crossing points to horizontal matrix wires 116, which, at one end, are connected through diodes 117 to character select wires 118 and, at the other end, are connected through diodes 120 to the matrix grids of the electric discharge tube.

It will be seen from FIG. 5 that the sequential pulse generator has been complicated slightly in order to reduce the amount of construction necessary in the character matrices. The extra degree of complexity depends upon an assessment of the full character font. For example, in FIG. 4 it can be seen that the bottom two matrix rows of the character 2 require a continual signal so that a set of ten diodes, associated with the sequential pulse generator, and two resistances can replace the twenty resistances used in these two rows in FIG. 4. Obviously, this would not be economical unless the pattern at the foot of the "2" were repeated elsewhere, and it happens that it is so repeated in the 3, 5, 7, E, F, L, T and Z. This means that in this font 220 resistors can be replaced by ten diodes and twenty-two resistors. Similarly, it is worth noting that in the 14 x 10 character

shapes, it is quite unusual for a single dot to occur horizontally; consequently, adjacent dots can be "or" gated with diodes to save resistances. There are in fact two good reasons for this, one being that the number of joints in the circuit will be reduced and the other being that the total current required from the sequential pulse generator source is reduced.

FIG. 5 shows the character matrix forms for the letters E and F. These characters are very similar in shape but nevertheless serve for illustrating the economy which can be made by judicious gating. Over a whole font it would almost certainly prove economical to provide certain other diode combinations in the sequential pulse generator drive circuits. In the example given, the number of resistances required for the two characters E and F is 28, as opposed to 120 which would be required if no gating were used, and the load on the sequential pulse generator is reduced by a factor of two. The reason that the load has not been reduced further is that the method described enables solid horizontal strokes to be made economically, but does not help significantly with the vertical strokes because here all the output amplifiers must be capable of being driven simultaneously. This is, in fact, a serious drawback to the proposed character generator for, if the number of characters which use almost the full left-hand set is assessed, it is found that in the alphanumeric font there are B, C, D, E, F, G, H, K, L, M, N, P, R, U, W, and 6 or a total of 16 characters. This means that if 10 of the 14 amplifiers are used at the same time in these characters, up to 160 registers, each taking sufficient current to switch a matrix control amplifier, may be loaded onto the sequential pulse generator output. It therefore may prove advantageous to introduce another pair of amplifiers which are arranged so as to enable vertical strokes to be produced economically. One method of achieving this is shown in FIG. 6. In this arrangement, four outputs of the sequential pulse generator 213 are connected by diodes 210 to vertical matrix wires 214. These wires 214 are connected to horizontal wires 216 at some crossing points by resistors 215. Wires 216 are connected at one end through diodes 217 to character select wires 218 and at the other end through diodes 220 to two amplifiers A_1 and A_2 connected so that their outputs drive the output amplifiers. Whenever a character is selected which is connected to the inputs of these amplifiers A_1 and A_2 , the column dots 3-12, inclusive, will be energized in the first two rows of the ten row character.

FIG. 7 shows a diagrammatic representation of the complete character generator incorporating diode "or" gating of the sequential pulse generator and the extra amplifiers necessary for producing vertical strokes.

With a character generator for the tube according to the present invention, the shape of the characters on the tube face must depend upon there being a proper time relationship between the rate of X-scan and the rate of the sequential pulse generator. Supposing for instance that the sequential pulses were made by a series of monostable circuits, each of a fixed duration, then there would only be one rate for the scan which would produce a character with the proper aspect rate. Such a rate could, for example, be produced by allowing each sequential pulse generator pulse to drive a counter, then allowing this counter to drive a digital-to-analogue converter. This produces the scan waveform although, in this event, extra inputs would have to be generated to provide the character spaces.

The particular arrangement for the sequential pulse generator used depends upon whether a fixed scanning speed is required or not. If this speed is fixed, a delay line method can be used, or even a set of monostables. If, on the other hand, some flexibility is required, then the oscillator method is more suitable. The circuit of three stages of a device using this latter method is shown in FIG. 8. It operates as follows:

When the transistor T1 starts to conduct, the upper

clock line 301 is negative and the lower clock line 302 is positive. Capacitor C2 is charged via diode D3 until the clock lines 301 and 302 reverse polarity. Diodes D2 and D1 then conduct and the transistor T1 is virtually cut off. Diode D4 is non-conducting and the base of transistor T2 is driven negative and T2 conducts, its base current being provided by capacitor C2. Before the charge in C2 is fully depleted, the clock lines reverse polarity, diodes D3 and D4 conduct, transistor T2 is virtually cut off, and T3 begins to conduct due to the charge in C3 to begin a fresh cycle. In this manner, the output pulse can be propagated down many stages, and the outputs from the emitters of the transistors can be used to drive sequential pulse generating output stages SPG1, SPG2, and so on. The advantage that this arrangement has over a delay line or monostable system is that the rate of propagation is controlled by the clock frequency and, with a proper choice of circuit components, can be varied over a considerable frequency range. The clock may be operated intermittently, being started when a character is being written, and being stopped for the periods between characters. The clock is always started in phase when a character is to be written, and must not be allowed to stop for long periods because the interstage condensers can acquire charge when the clock is stopped; and then when it is restored, the unwanted charge influences the pulse rate.

The best arrangement of the sequential pulse generator and circuit for a tube according to the present invention when used in a printer depends upon the facilities which the printer is to offer. If the printer is intended to print out data from magnetic tape, then it should preferably contain horizontal tabulation logic. This will then allow good tape utilization. If, on the other, hand, it is to print from a computer line store, in which an edited line of data is stored, the tube horizontal scan can be an A.C. coupled circuit and may run continuously. The latter arrangement would be considerably cheaper than the former but requires that the computer keep pace with the printing on a line-to-line basis. It would seem that the extra complications of D.C. scan and a horizontal tabulation logic are justified by the flexibility it provides. FIG. 9 shows a diagrammatic representation of a possible arrangement for the horizontal or X deflection of a tube according to the present invention. Here a set of seven bistable stages 400 and one bistable stage 401 form a horizontal register which define the character position. The seven stages 400 form a counter defining the character position along the line while the eighth stage 401 performs the line-break function. Briefly, the operation is as follows:

The logical circuit emits a demand, and in response, receives the required code, which is assumed to signify a character. The clock input 402 connected with the code triggers a sequential pulse generator 403 which controls the character generator 404 where the character outputs have been chosen by the input code. During the period of the sequential pulse generator, a bistable stage 405 is switched, and by means of a ramp generator 406 a ramp function is generated from this waveform, which is added to the X-scan waveform in an amplifier 407 and provides the "character" scan. The bistable stages 400 are connected to a digital/analog converter 410 which is connected to the amplifiers 407. The end of sequential pulse generator signal counts the horizontal register formed by the stages 401 on the one-character position. When the horizontal register reaches the 74th character position, a bistable stage 408 is set, and the next end of sequential pulse generation triggers a reseter 409 which resets the seven stages 400 to zero, and, at the same time, counts on the line-break bistable stage 401. This is used to provide the vertical split of the two half lines.

A requirement for 75 characters per half line adds considerably to the difficulty of horizontal tabulation compared with a choice of 64 characters per half line. In the

latter case, horizontal tabulation may be performed basically by a two-code order. The first code defines the function and is used to clear the horizontal register, while the second code defines in binary form the required tabulation position. Because the number of characters per half line is 64, and the basic input code is six-bit, it is possible by simply forcing the horizontal register to the pattern of the second input code, to tabulate to alternate character positions along either the upper or lower half-line. With 75 characters per half line the logic is less simple because it is not possible to use a 1:1 correspondence between the input code and the horizontal position on the tube. Various expedients can be resorted to, for instance, the tabulation position can be defined by two six-bit codes, each of which sets parts of the register. The best that can be done is to use one to define whether the tabulation is to be to the first or second line of 75 characters, and the other to define the tabulation position in the half line. This offers the ability to tabulate every fourth line position but is clumsy because it will inevitably result in programs requiring a tabulation followed by more than one space command with consequent poor tape utilization. Moreover, there are tabulation codes which are meaningless because they run off the end of the register.

It will be appreciated that a tube according to the present invention has the advantage of producing good quality characters and of providing sufficient output to discharge a selenium surface at more than 20,000 characters per second. The character generator circuits are of the same order of complexity as ones already proposed, but cheaper resistances may be used because these give only digital and not positioned information. A cheaper construction can also be employed if it is arranged that only a few of the characters may be varied by replacing printed circuit boards.

It will be appreciated that one of the advantages of an electric discharge tube according to the present invention is that the deflection of the elemental beams is steady rather than step-by-step, and yet the amount of light emitted from a character appearing on the face of the tube, for example, for xerographic printing, is the same in either case. This means that the electron beams do not have to be accelerated and then retarded, as in the case of step-by-step deflection, but move at a substantially uniform speed.

Another advantage is that a simplified tube and a small beam are all that is required for obtaining a character quality suitable for exacting standards of printing.

What is claimed is:

1. Apparatus for forming a character symbol on the face of an electron discharge tube comprising in combination a cathode ray tube envelope having a fluorescent material coated on the face thereof,

a plurality of electron emitters oppositely positioned in said envelope in a row and in a plurality of rows, one above the other relative to said face for generating a flow of electrons,

a modulator for forming a plurality of elemental electron beams for each one of said electron emitters, an electrical matrix comprising first circuit paths for each one of said emitters,

a common path for said first electrical matrix wherein each of said electrical paths in said first circuit matrix includes a uni-directional device, each one of said common paths for said first electrical matrix comprising a resistance and uni-directional device connecting said resistance to one of said respective electron emitters, and wherein corresponding circuit paths of the respective resistances in said first electrical matrix are connected to common amplifiers for providing modulating voltages for the respective electron emitters,

a second electrical matrix comprising second circuit paths and cross-connections to said first circuit paths, selection means connected to said first matrix for

selecting a predetermined pattern corresponding to a symbol representing data, said selection means comprising means for polarizing said circuit paths of the respective resistances in said first electrical matrix whereby a selected resistance matrix is effective for supplying signals to the said amplifiers, said polarizing means comprising for each resistance matrix a respective common conductor connected to the individual circuit paths of the resistance matrix through said diodes, whereby when a potential of a suitable polarity is applied to the common path allocated to a given resistance matrix, the first electrical circuit path of that resistance matrix becomes effective on the said amplifiers for supplying signals representative of the data symbol characterized by the said resistance matrix,

a pulse generator and means for connecting each one of said circuit paths from said second electrical matrix thereto,

means for feeding the output pulses of said pulse generator sequentially to each of said paths in said second electrical matrix, and further including a series of diodes, wherein said circuit paths in said first matrix are connected to said amplifiers through said diodes.

2. Apparatus for forming a character symbol on the face of an electron discharge tube comprising in combination a cathode ray tube envelope having a fluorescent material coated on the face thereof, a plurality of electron emitters oppositely positioned in said envelope in a row and in a plurality of rows, one above the other relative to said face for generating a flow of electrons,

a modulator for forming a plurality of elemental electron beams for each one of said electron emitters,

an electrical matrix comprising first circuit paths for each one of said emitters,

a common path for said first electrical matrix wherein each of said electrical paths in said first circuit matrix includes a uni-directional device, each one of said common paths for said first electrical matrix comprising a resistance and a uni-directional device connecting said resistance to one of said respective electron emitters, and wherein corresponding circuit paths of the respective resistances in said first electrical matrix are connected to common amplifiers for providing modulating voltages for the respective electron emitters,

a second electrical matrix comprising second circuit paths and cross-connections to said first circuit paths, selection means connected to said first matrix for selecting a predetermined pattern corresponding to a symbol representing data,

a pulse generator and means for connecting each one of said circuit paths from said second electrical matrix thereto,

means for feeding the output pulses of said pulse generator sequentially to each of said paths in said second electrical matrix,

a series of diodes, wherein said circuit paths in said first matrix are connected to said amplifiers through said diodes, and further including

gating means in association with said sequential pulse generator, whereby signals corresponding to one or more regions which in one or more of the data symbols to be displayed are represented by horizontally adjacent dots are supplied to the relevant circuit path of said first matrix.

3. In an electric discharge tube for forming a character symbol on the face thereof, said tube comprising a cathode ray tube envelope having a fluorescent material on the face thereof, the combination comprising

a plurality of electron emitters in a plane substantially equidistant from each other, means for forming a plurality of elemental electron beams for each one of said electron emitters,

a first plurality of circuit paths for each one of said emitters,

a second plurality of circuit paths for forming a matrix array with said first plurality of circuit paths,

means for selectively coupling said first circuit paths to said second circuit paths in a predetermined pattern corresponding to a symbol representing data,

pulse generating means coupled to said second plurality of circuit paths for sequentially pulsing said circuit paths,

selection means coupled to said first plurality of circuit paths for selecting said predetermined pattern,

a first and second plurality of diode means coupled to each end of said first plurality of circuit paths for allowing the selective enabling thereof,

amplifier means coupled to the output of each of said first plurality of circuit paths for amplifying the currents established by said means for selectively coupling said first and second circuit paths, whereby said elemental electron beams in said predetermined pattern form said character symbol on the face of said electric discharge tube,

a second plurality of electron emitters in a plane substantially parallel to said first plane, said second plane having emitter spacing such that the center lines of the second plane of emitters are intermediate the center lines of the emitters in said first plane,

said first plurality of circuit paths comprising a third plurality of circuit paths alternately arranged therewith for each one of said second plane of emitters,

said second plurality of circuit paths comprising a fourth plurality of circuit paths alternately arranged therewith for forming a second matrix array with said third plurality of circuit paths,

second means for coupling said second and fourth plurality of circuit paths to said pulse generating means in a manner such that said second and fourth circuit paths are alternately and sequentially pulsed thereby,

said second plurality of electron emitters forming a second beam of electrons to fill in on the face of said cathode ray tube the spaces between the beams formed by said first plurality of electron beams.

4. The combination as set forth in claim 3 wherein said second coupling means comprises gating means for selectively applying the output of said pulse generating means to said second and fourth plurality of circuit paths.

5. The combination as set forth in claim 3 wherein said gating means is a third plurality of diodes connected in a predetermined relationship.

6. The combination as set forth in claim 3 wherein each of said third and fourth plurality of circuit paths include two further circuit paths respectively, each of said circuit paths coupled by further of said first means for selectively coupling said first circuit paths, to said second circuit paths

third diode means coupled to each end of said two further circuit paths in said third plurality of circuit paths for allowing the selective enabling of said two further circuit paths in said third plurality of circuit paths,

further second means for coupling said two further circuit paths in said fourth plurality of circuit paths to said pulse generating means in a manner such that said two circuit paths are alternately pulsed thereby,

second amplifier means coupled to the outputs of said two further circuit paths in said third plurality of circuit paths for amplifying the currents established by said further second means for coupling said two further circuit paths in said third and fourth plurality of circuit paths, and

third means for coupling the outputs of said second amplifier means to selected outputs of said first and

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third plurality of circuit paths to pulse said outputs
by bypassing the other selection paths.

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