(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 072 494**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 82107042.2

(51) Int. Cl.³: B 41 J 3/20

(22) Date of filing: 04.08.82

(30) Priority: 14.08.81 JP 127546/81

(43) Date of publication of application:
23.02.83 Bulletin 83/8

(84) Designated Contracting States:
BE DE FR GB IT NL

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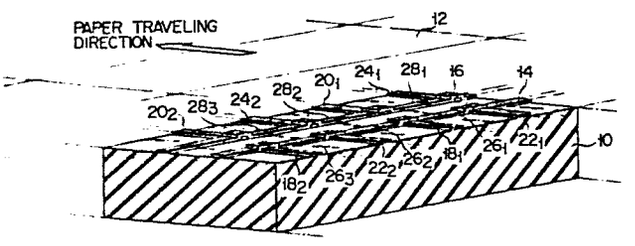
(54) A thermal head apparatus.

(57) A thermal head which comprises a plurality of heating resistor strips (14, 16) arranged in a main scanning direction on an insulator layer (10). Each heating resistor strip (14, 16) includes a plurality of resistor pieces (261, 262, ..., 281, 282, ...) aligned in a main scanning direction. The resistor piece (261, 262, ..., 281, 282, ...) of each heating resistor strip (14, 16) is displaced in a main scanning direction so as not to be superposed in the subscanning direction. The resistor pieces (261, 262, ..., 281, 282, ...) of each heating resistor strip (14, 16) are supplied with currents in response to bit data at a predetermined timing and are thus heated to obtain a line of recording dots for a main scanning line.

FIG. 1



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A thermal head apparatus

The present invention relates to a thermal head apparatus which can reproduce, print and record picture information transmitted, for example, in a facsimile or the like and, more particularly, to a thermal head apparatus which can reproduce a picture of accurate and high quality on recording paper.

A conventional thermal head of this type used to reproduce a picture has a number of heating resistors arranged at an infinitesimal interval along a line extending in a main scanning direction, and electrodes formed on the heating resistors for selectively supplying heating currents to the respective resistors. The thermal head forms a dotted record on a heat-sensitive recording sheet to reproduce a picture, by selectively supplying the heating currents to a number of these heating resistors.

More particularly, transmission information obtained mainly by scanning a picture in its widthwise direction is transmitted from a transmission site. In a thermal head at a reception site, voltages are then applied to electrodes connected to a number of heating resistors aligned in a main scanning direction on the basis of the transmission information. As a consequence, the thermal head reproduces an image corresponding to the transmission information on recording paper. The recording paper is subscanned

in a longitudinal direction with respect to the main scanning direction to thereby reproduce a picture transmitted at the transmission site on the recording paper.

When the interval between a number of heating resistors arranged at an infinitesimal interval is reduced as short as possible to increase the number of recording dots per unit length, a picture of high quality can be reproduced. When the density of the recording dots is increased, however, the interval between the heating resistors to be partitioned with electrodes is shortened. As a result, the fabrication of a thermal head becomes technically difficult, thereby causing lower productivity. At present, a thermal head which has 3 to 6 recording dots in a range of 1 mm provides the best picture quality and productivity. However, in order to reproduce a picture of higher quality, it is desired to form more than 8 recording dots in a range of 1 mm.

It is an object of the present invention to provide a thermal head apparatus which can accurately reproduce a picture of higher quality on recording paper.

It is another object of the present invention to provide a thermal head apparatus which has a structure capable of enhancing the productivity without decreasing the quality of a picture.

The above objects have been attained by a thermal head apparatus which comprises:

a plurality of heating resistor strips, provided to extend in a main scanning direction parallel to each other at an interval on an insulator layer the total sum of which intervals corresponds to a subscanning distance in one scanning period of time; a plurality of electrodes, provided in parallel with each other and in substantially perpendicular with the heating resistor strips for dividing the respective resistor strips to form a plurality of resistor pieces in such a manner

that the resistor pieces belonging to the respective resistor strips are not superposed with each other with respect to the subscanning direction; and current supplying means, connected to the plurality of electrodes for storing data bits corresponding to the recording dots and supplying currents to the resistor pieces belonging to the respective resistor strips at a timing which is so set as to supply currents to the row of the resistor pieces when such a row comes above a dotted portion recorded on recording paper with the row of the resistor pieces belonging to the previous resistor strip; whereby a line of dots for one main scanning line is recorded on recording paper after the currents are supplied to all the resistor pieces belonging to the plurality of heating resistor strips.

When the present invention is applied to a thermal head apparatus having two heating resistor strips, dots recorded by the second heating resistor strip are disposed between dots recorded by the first heating resistor strip to thereby record a line of dots for one main scanning line. In this manner, it is possible to record dots of twice the density of the resistor pieces of the first and second resistor strips. Therefore, a picture that is more accurate and of higher quality than the conventional picture can be obtained. Since the density of the recording dots can be increased without increasing the density of the resistor pieces of the first and second resistor strips, the productivity of the thermal head apparatus can be enhanced.

By way of example and to make the description clearer, reference is made to the accompanying drawings in which:

Fig. 1 is a partially enlarged schematic perspective view of a thermal head apparatus according to one preferred embodiment of the present invention;

Fig. 2 is an equivalent circuit diagram of the portion shown in Fig. 1;

Fig. 3 is a view for explaining the operation of the thermal head apparatus shown in Fig. 1;

Fig. 4 is a circuit diagram of the thermal head shown in Fig. 2 and a drive circuit therefor; and

Fig. 5 is a timing chart of the signals applied to the circuit shown in Fig. 4.

The present invention will now be described in more detail with reference to the accompanying drawings.

In Fig. 1, first and second resistor strips 14, 16 are provided at a predetermined interval in parallel with each other in a main scanning direction (or the crosswise direction of recording paper 12) on an insulating substrate 10 made of, for example, glass or the like. The first and second resistor strips 14, 16 constitute a recording heater. The recording paper 12 is moved in a direction designated by an arrow, that is, in a subscanning direction perpendicular to the main scanning direction.

The first and second resistors 14, 16 respectively have a length corresponding to the length of the main scanning line, and the interval between the first resistor 14 and the second resistor 16 is set corresponding to the distance which the recording paper 12 moves through the subscanning, during one main scanning period of time. The first and second resistor strips 14, 16 have a plurality of data electrodes 18_1, 18_2, ... and 20_1, 20_2, ... provided at a predetermined interval in a longitudinal direction to obtain a plurality of resistor pieces, respectively. Further, common electrodes 22_1, 22_2, ... and 24_1, 24_2, ... are provided between the data electrodes 18_1, 18_2, ... and 20_1, 20_2, ... and the resistor pieces between the data electrodes 18_1, 18_2, ... and 20_1, 20_2, ... are further respectively divided into two segments. The resistor piece interposed between data electrodes and common electrodes forms one recording unit. The recording units 26_1, 26_2, ... and 28_1, 28_2, ... are formed along the first

and second resistor strips 14, 16.

Fig. 2 shows an equivalent circuit of the portion shown in Fig. 1. The portions which are equivalent to those in Fig. 1 are designated by the same reference numerals as those in Fig. 1.

When a current flows through the resistor piece between adjacent data electrodes and common electrodes, the resistor piece is heated. A dot is recorded on heat-sensitive recording paper where it makes contact with the heated resistor piece.

The recording units 26_1, 26_2, ... on the first resistor strip 14 are displaced by 1/2 of the recording unit width of the recording units 28_1, 28_2, ... with respect to the main scanning direction on the second resistor strip 16.

The first and second heads 30, 32 extending in the recording-paper crosswise direction are formed of the first and second resistor strips 14, 16 thus constructed.

According to the thermal head thus constructed, dots 36_1, 36_2, ... recorded by the second head 32 are disposed, as shown in Fig. 3, between the dots 34_1, 34_2, ... recorded by the first head 30. Therefore, as described above, the interval between the first head 30 and the second head 32 is set corresponding to the distance covered by the moving recording paper during one main scanning period of time. Thus, as shown in Fig. 3, the dots 36_1, 36_2, ... recorded by the second head 32 are inserted between the dots 34_1, 34_2, ... recorded by the first head 30 to form a line of dots corresponding to one recording scannling line. Accordingly, when compared with a unit dot interval as recorded by a head formed of only one resistor strip, the unit dot interval in this embodiment is 1/2 that of the conventional device. In other words, the recording dot density of this embodiment of the present invention becomes twice that of the conventional one.

For example, the first and second heads 30, 32 are so constructed as to record six dots within a range of 1 mm of the recording bands 14, 16. Thus, in effect, 12 dots are recorded with a range of 1 mm of the resistor bands 14, 16. In this manner, a picture of high density and excellent resolution can be reproduced.

Fig. 4 shows a circuit diagram showing the thermal heads 30, 32 shown in Fig. 2 and a drive circuit for driving these thermal heads.

The common electrodes 22_1, 22_2, ... and 24_1, 24_2, ... of the first and second head 30, 32 are alternately connected through isolating diodes 40_1, 40_2, ... and 42_1, 42_2, ... to common lines C_1, C_2, and C_1', C_2', respectively. Common currents SC1, SC2 and SC1', SC2' of different timings (or different phases) shown in Figs. 5D, 5E, 5G, 5H are supplied to these common lines C_1, C_2, and C_1', C_2'. When these common currents of two types are employed, the bit data D_1 corresponding to the recording dots can be divided into two groups for use. The diodes 40_1, 40_2, ... form the first common signal supplying means 41_1, and the diodes 42_1, 42_2, ... form the second common signal supplying means 41_2.

The data electrodes 18_1, 18_2, ... and 20_1, 20_2, ... of the first and second heads 30, 32 are respectively connected to the output terminals of NAND gates 44_1, 44_2, ... and 46_1, 46_2, ... A strobe signal STR1 shown in Fig. 5F is supplied as a gate signal through a buffer amplifier 48 to one of the input terminals of each of the NAND gates 44_1, 44_2, ... On the other hand, a strobe signal STR2 shown in Fig. 5I is supplied as a gate signal through a buffer amplifier 50 to one of the input terminals of each of the NAND gates 46_1, 46_2, ...

Data stored in trigger flip-flops 52_1, 52_2, ... are supplied to the other input terminals of the NAND gates 44_1, 44_2, ... On the other hand, data stored in trigger flip-flops 54_1, 54_2, ... are supplied to the other input terminals of the NAND gates 46_1, 46_2, ...

The flip-flops 52_1, 52_2, ... form a shift register, and bit data D1 shown in Fig. 5B corresponding to the common current SC1 are sequentially supplied through a buffer amplifier 56 in a serial manner, and the second bit data D2 shown in Fig. 5B corresponding to the common circuit SC2 are similarly supplied. Similarly, the flip-flops 54_1, 54_2, ... form a shift register, and bit data D2 corresponding to the common current SC1' shown in Fig. 5C are sequentially supplied in a serial manner, and the second bit data D2 shown in Fig. 5C corresponding to the common current SC2' are similarly supplied.

Shift pulses SP1, SP2 are respectively supplied through inverters 60 and 62 to the inverting trigger input terminals of the flip-flops 52_1, 52_2, ... and 54_1, 54_2, ...

The NAND gates 44_1, 44_2, ..., flip-flops 52_1, 52_2, ... buffer amplifiers 48, 56 and inverter 60 form the first data signal supplying means 61_1. Similarly, the NAND gates 46_1, 46_2, ... flip-flops 54_1, 54_2, ... buffer amplifiers 50, 58 and inverter 62 form the second data signal supplying means 61_2.

The operation of the thermal head thus constructed will now be described. The first head 32 is driven as below. The first recording bit data D1 shown in Fig. 5B are serially supplied to the trigger flip-flops 52_1, 52_2, ... forming a shift register corresponding to the first head 32. The shift pulse SP1 shown in Fig. 5A is supplied in synchronism with the supply of the data D1. As a consequence, the first recording bit data D1 are stored in the flip-flops 52_1, 52_2, ...

A common signal SC1 is supplied to the common line C1 in this state. Simultaneously, the strobe signal STR1 is supplied to the NAND gates 44_1, 44_2, ... As a result, a current will flow through the resistor pieces, that is, the recording units between the common electrodes 22_1, 22_2, ... connected with the common line C1 and

the data electrodes 18_1, 18_2, ... corresponding to the first recording bit data D_1, and this portion is thus heated. Consequently, a dot recording is carried out. In this manner, the respective recording units are alternately controlled.

Subsequently, the second bit data D_1 shown in Fig. 5B and disposed between the first bit data D_1 are serially supplied to the flip-flops 52_1, 52_2, ... The shift pulse SP_1 is supplied in synchronism with the supply of the second data D_1. As a result, the second recording bit data D_1 is stored in the flip-flops 52_1, 52_2, ...

In this state, the common signal SC_2 is supplied to the common line C_2. Simultaneously, the strobe signal STR_1 is supplied to the NAND gates 44_1, 44_2, ... Consequently, a current flows through the resistor piece (recording unit) between the common electrodes 22_1, 22_2, ... connected to the common line C_2 and the data electrodes 18_1, 18_2, ... corresponding to the second recording bit data D_1, and this portion is heated. As a result, a dot recording is carried out. In this manner, the recording operation of the first step relative to one main scanning line by the first head 30 is completed.

The recording operation is carried out again when the recording paper 12 is subscanned and the second head 32 is moved onto the dotted portion by the first head 30 after the initial recording by the first head 30 is completed. This recording operation is similar to the recording operation of the first head 30. As a consequence, the recording dots made by the second head 32 are formed between the recording dots made by the first head 30 as shown in Fig. 3.

Such a thermal head can be effectively formed by a thick film printing technique. In other words, respective electrodes are projected and formed as shown in Fig. 1 by the thick film printing on an insulating

substrate. Subsequently, resistor strips are so formed as to connect and to cross the respective electrodes as shown in Fig. 1. Thereafter, a hard glass coating layer is formed on the resistor strips including the respective electrodes. Thus, the heater portion is so formed as to improve the contact between the heater and the heat-sensitive recording paper, thereby effectively producing the recording dots with the respective recording units.

Since the recording density of a facsimile at present is ordinarily 8 dots per 1 mm, the recording density of the first and second heads 30, 32 may be, when the embodiment of this invention is applied thereto, 4 dots per 1 mm. Therefore, the recording unit width or the resistor piece width in the first and second heads 30, 32 may be sufficiently increased. Accordingly, the fabrication of the heads can be facilitated, and the recording density of the respective recording units can be enhanced.

The present invention is not limited to the particular embodiment described above. For example, in the embodiment described above, two sets of heads 30, 32 are employed. However, three sets of heads may be used. Further, in the embodiment described above, the recording dots are alinged on the same line by the two sets of heads 30, 32. However, the recording dots may be displaced in subscanning direction. In the embodiments described above, the recording paper is moved. However, the heads 30, 32 may be moved.

Of course, other various changes and modifications may be made within the spirit and scope of the present invention.

Claims:

1. A thermal head apparatus, having a plurality of heating resistors disposed at an infinitesimal interval in a main scanning direction, for selectively supplying a current to said resistors to heat said resistors to record dots on recording paper which is transferred in a subscanning direction perpendicular to the main scanning direction, characterized in that said apparatus comprises:

a plurality of heating resistor strips (14, 16), provided on an insulator layer to extend in a main scanning direction in parallel with each other at an interval the total sum of which intervals is set corresponding to a subscanning distance during one main scanning period of time;

a plurality of electrodes (18_1, 18_2, ..., 20_1, 20_2, ..., 22_1, 22_2, ..., 24_1, 24_2, ...), provided in parallel with each other and in perpendicular to said plurality of heating resistor strips (24, 26) for dividing said respective resistor strips, to form a plurality of resistor pieces (26_1, 26_2, ..., 28_1, 28_2, ...) in such a manner that said resistor pieces (26_1, 26_2, ..., 28_1, 28_2, ...) belonging to said respective resistor strips (14, 16) are not superposed with each other with respect to said subscanning direction; and

current supplying means (41_1, 41_2, 61_1, 61_2), connected to said plurality of electrodes (18_1, 18_2, ..., 20_1, 20_2, ..., 22_1, 22_2, ..., 24_1, 24_2, ...), for storing data bits corresponding to the recording dots to supply, on the basis of said data bits, currents to said resistor pieces (26_1, 26_2, ..., 28_1, 28_2, ...) belonging to said respective resistor strips (14, 16) at a timing which is so set as to supply currents to said resistor pieces (28_1, 28_2, ...) when a row of resistor pieces (28_1, 28_2, ...) belonging to said resistor strip (16) comes above the dotted portion recorded on recording

paper by a row of said resistor pieces (26_1, 26_2, ...) belonging to said previous resistor strip (14);

whereby a line of dots for the main scanning line is recorded on recording paper after currents are supplied to all the resistor pieces (26_1, 26_2, ..., 28_1, 28_2, ...) belonging to said plurality of heating resistor strips (14, 16).

2. A thermal head apparatus according to claim 1, characterized in that said plurality of heating resistor strips (14, 16) comprise a first heating resistor strip (14) and a second heating resistor strip (16).

3. A thermal head apparatus according to claim 1 or 2, characterized in that said plurality of electrodes (18_1, 18_2, ..., 20_1, 20_2, ..., 22_1, 22_2, ..., 24_1, 24_2, ...) comprise a plurality of data electrodes (18_1, 18_2, ..., 20_1, 20_2, ...) and common electrodes (22_1, 22_2, ..., 24_1, 24_2, ...) disposed between said data electrodes.

4. A thermal head apparatus according to claim 3, characterized in that the resistor pieces (26_1, 26_2, ...) divided by said data electrodes (18_1, 18_2, ...) and said common electrodes (22_1, 22_2, ...) of said first heating resistor strip (14) are displaced by 1/2 of the length of said resistor piece in a main scanning direction from the resistor pieces (28_1, 28_2, ...) divided by said data electrodes (20_1, 20_2, ...) and said common electrodes (24_1, 24_2, ...) of said second heating resistor strip (16).

5. A thermal head apparatus according to claim 3, characterized in that said current supplying means (41_1, 41_2, 61_1, 61_2) comprises both a common current supplying means (41_1, 41_2) for supplying a common current to said common electrodes, (22_1, 22_2, ..., 24_1, 24_2, ...) and a data supplying means (61_1, 61_2) for supplying data to said data electrodes (18_1, 18_2, ..., 20_1, 20_2, ...) and also supplies currents to said resistor pieces corresponding to said data bits between said common electrodes

and said data electrodes to cause corresponding resistor pieces to generate heat.

6. A thermal head apparatus according to claim 5, characterized in that said data supplying means (611, 612) comprises a shift registor.

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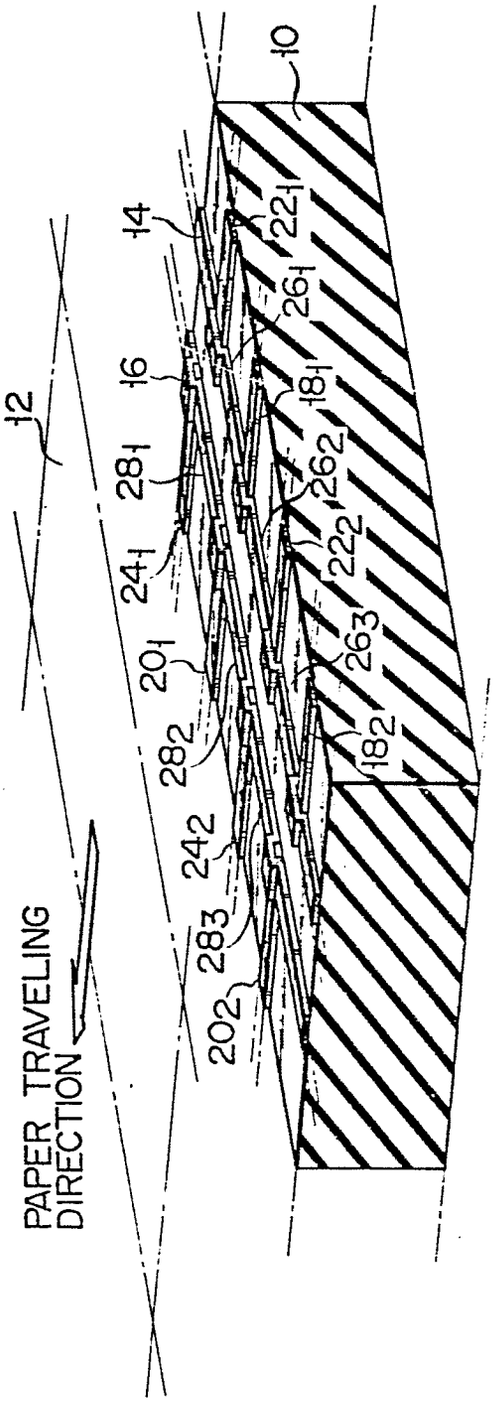
FIG. 1



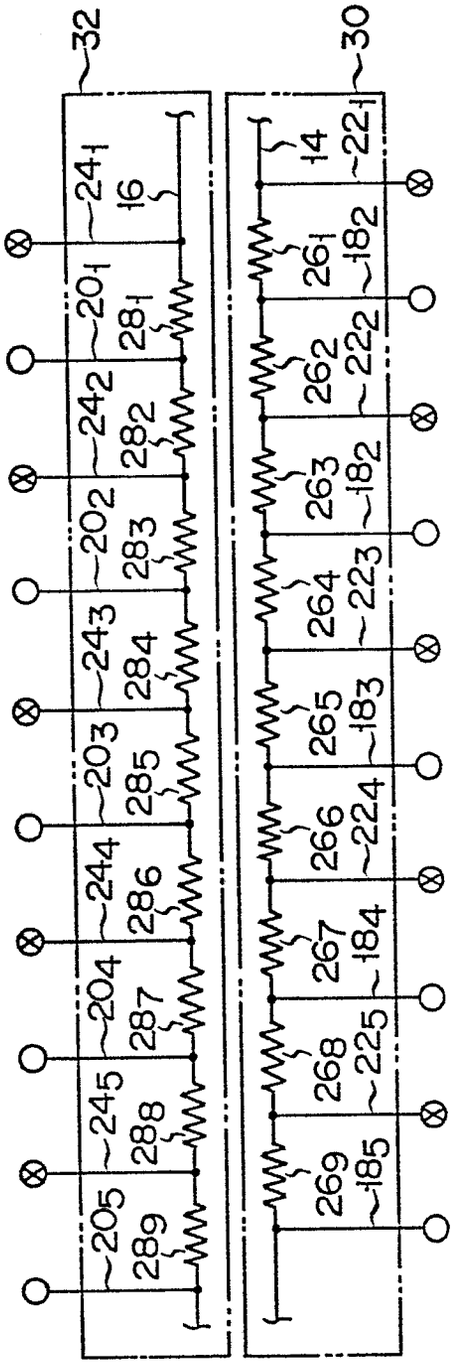

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FIG. 2

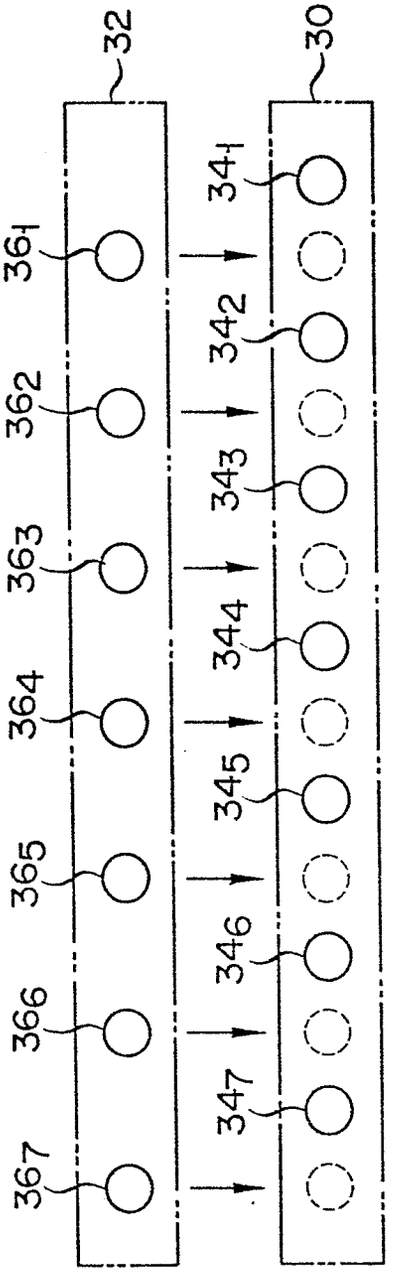
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FIG. 3

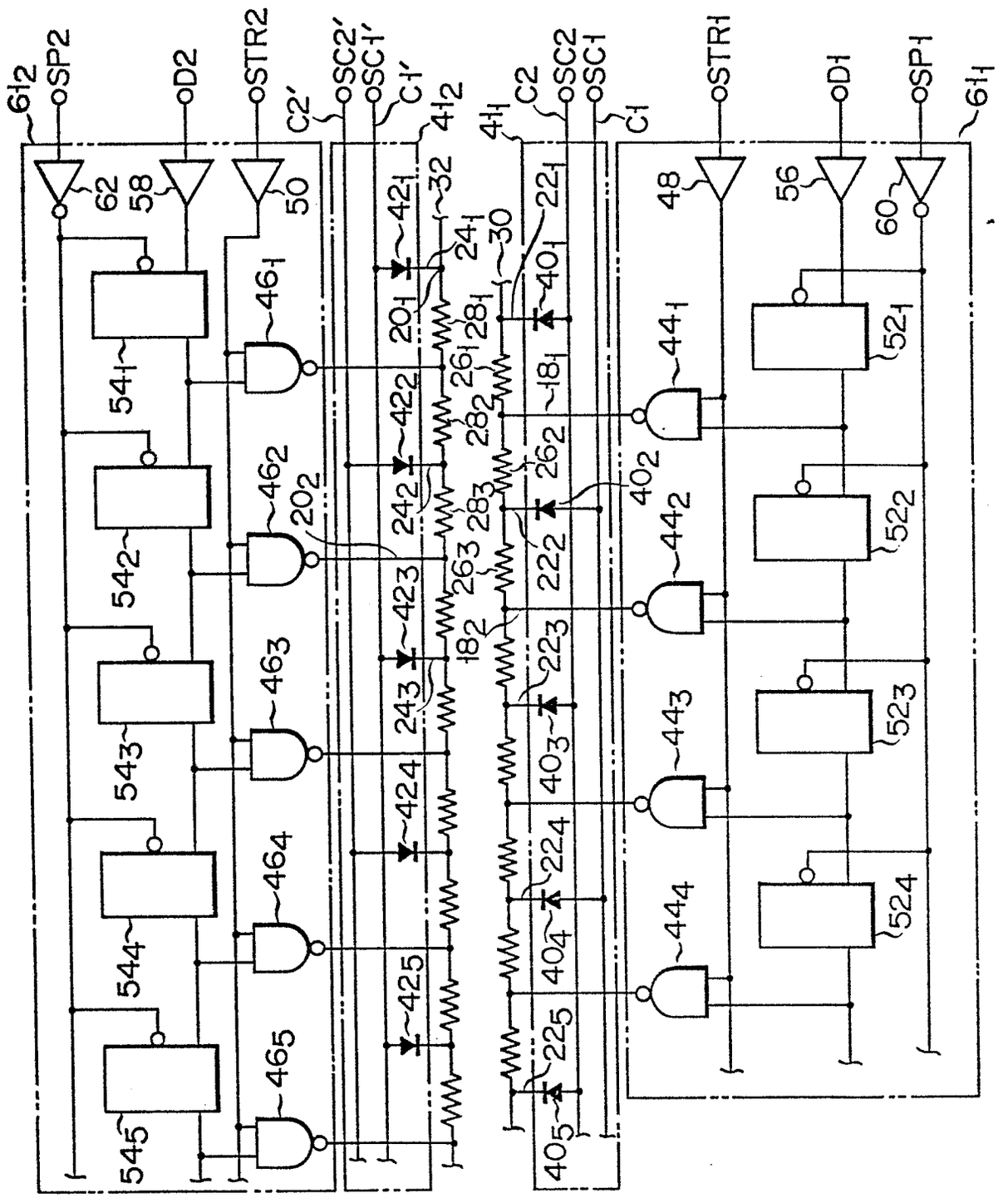
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FIG. 4

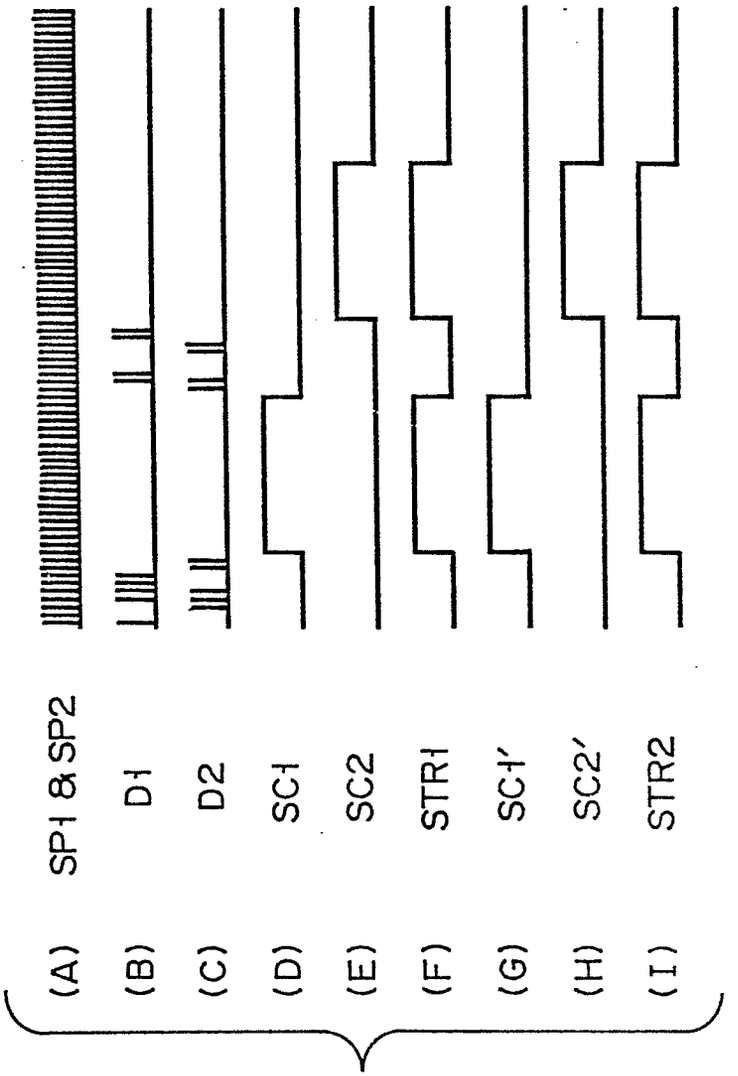

FIG. 5