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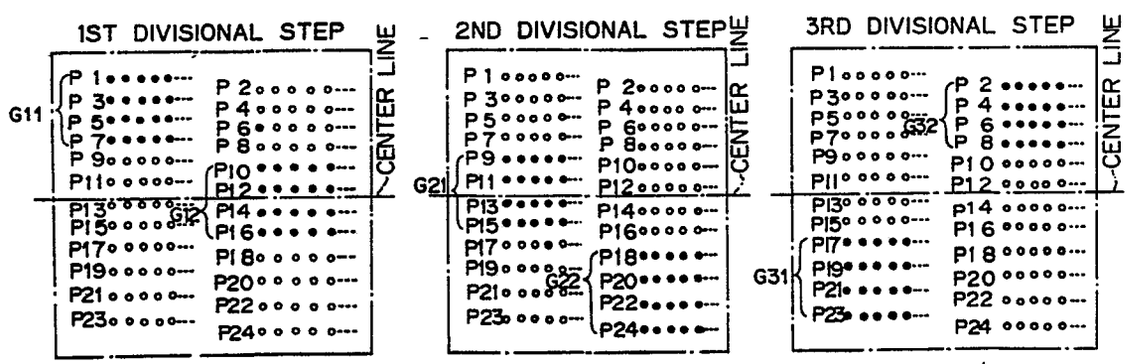
(54) Divisional step dot printer.

(57) A divisional step dot printing device has a plurality of dot pins (P1-P24) of its dot printing head (22) divided into a plurality of groups (G11,G12,G21,G22,G31,G32) each containing a sequence of adjacent dot pins. The device is driven in a sequence of divisional dot printing steps. Each of the divisional dot printing steps is carried out by a combination of groups (G11,G12,G21,G22,G31,G32) of dot pins which extend over both sides of the centre line of the printing head (22) in the direction of the axis of the platen (11).

Fig. 8



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DIVISIONAL STEP DOT PRINTER

The present invention relates to a divisional step dot printing device for a wire dot printer. The device according to the present invention can be used for a wire dot type serial printer used, for example, in an electronic computer system.

In a prior art method of divisional step dot printing with a wire dot printer, all of the dot pins are divided into a plurality of groups each consisting of a plurality of successive dot pins, and a first group of dot pins is driven in a first divisional step during a first travel of a carriage over the length of a platen, the next group of dot pins is driven in the next divisional step during the next travel of the carriage over the length of the platen, and the succeeding group of dot pins is driven in the next divisional step during the next travel of the carriage over the length of the platen.

In this method, one row of printing is constituted by a plurality of parts thereof, and the printing of this plurality of parts is carried out sequentially to print one row.

In this method, however, a problem arises in that the paper to be printed and placed on the platen is deformed in different ways during the sequence of the divisional printing steps, leading to an undesirable shifting of the paper, and accordingly, the colors printed by the sequence of divisional printing steps are overlapped or separated from each other.

In another prior art method of divisional step dot printing with a wire dot printer, all of the dot pins are divided into a plurality of groups each consisting of a plurality of dot pins, at intervals of two dot pin positions, and a first group is driven in the first divisional step during the first travel of a carriage over the length of a platen, the next group is driven in the next divisional step during the next travel of a carriage over the length of a platen, and the succeeding group is driven in the next divisional step during the next travel of the carriage over the length of the platen.

In this method, one row of printing is constituted by a plurality of row constituents, and the printing of this plurality of row constituents are carried out sequentially to accomplish the printing of one row.

In this method, however, a problem arises in that the space between adjacent and simultaneously driven dot pins is relatively large, and therefore, the impact of a dot pin on the paper on the platen is made only by a single dot pin, without considering the accumulated effect of the simultaneous impact of a plurality of adjacent dot pins, and accordingly, the density of the colors printed by the sequence of divisional printing steps is usually low.

An object of the present invention is to provide an improved divisional step dot printing device in which an undesirable shift of the paper during the divisional dot printing steps is prevented and in which, a satisfactory density of print is obtained.

According to this invention a divisional step wire dot printer comprises:

a dot printing head having a plurality of dot pins, a platen arranged opposite the dot printing head and which, in use, carries a print medium, and driving means for driving the plurality of dot pins which divides the dot pins into a plurality of groups each of which contains a sequence of adjacent dot pins and drives the groups in a sequence of divisional printing steps, a combination of groups being driven in each of the sequence of divisional printing steps so that dot pins on both sides of a centre line of the print head extending in the direction of the axis of the platen are driven in each divisional printing step.

Particular embodiments of divisional step dot printers will now be described and contrasted with the prior art with reference to the accompanying drawings, in which:-

Figure 1 is a plan view of the structure of a dot printer to which the device according to the present invention is to be applied;

Fig. 2 is a cross-sectional view taken along the line II-II of Fig. 1;

Figs. 3 and 4 illustrate a prior art method of divisional step dot printing;

Figs. 5 and 6 illustrate another prior art method of divisional step dot printing;

Fig. 7 illustrates a modification of the method illustrated in Fig. 5;

Fig. 8 illustrates the principle of the operation of a divisional step dot printing device according to an embodiment of the present invention;

Fig. 9 illustrates the operation of a divisional step dot printing device according to an embodiment of the present invention;

Fig. 10 illustrates the appearance of color printed on a print medium by the impact of dot pins;

Fig. 11 is a block diagram of a circuit of a divisional step printing device according to an embodiment of the present invention; and

Fig. 12 illustrates an operation of a divisional step dot printing device according to another embodiment of the present invention.

Before describing the preferred embodiments in detail, the structure of a dot printer to which the device according to the present invention is to be applied and a prior art method of divisional step

dot printing will be described with reference to Figs. 1 to 7.

As shown in Figs. 1 and 2, a dot printer to which the device according to the present invention is to be applied is constituted by a platen 11, a paper 12 to be printed, and a carriage 21 on which a printing head 22 is mounted. In the printing head 22, a one line sequence of wire dot pins P1, P2, ... P24 is arranged as shown in Fig. 2. Note, it is possible to arrange a two line sequence of wire dot pins.

In a printing operation, while the carriage 21 is moved over the length of the platen 11, the selected ones of the dot pins P1, P2, ... P24 are driven to strike the paper 12 on the platen 11, to carry out a printing operation on the paper 12. One row of printing on the paper 12 by the dot pins P1, P2, ... P24 is carried out during one travel of the carriage 21 over the length of the platen 11 or during a plurality of travels of the carriage 21 over the length of the platen 11. The latter type printing is called a divisional step dot printing.

A prior art method of divisional step dot printing is illustrated in Figs. 3 and 4. In this method, all of the dot pins P1, P2, ... P24 are divided into three groups, GROUP 1, GROUP 2, AND GROUP 3, each consisting of 8 successive dot pins. In Fig. 3, a driven dot is expressed by a block dot. In a printing operation, GROUP 1 consisting of P1, P2, ... P8 is driven in the first divisional step during the first travel of the carriage 21 over the length of the platen 11, GROUP 2 consisting of P9, P10, ... P16 is driven in the second divisional step during the second travel of the carriage 21 over the length of the platen 11, and GROUP 3 consisting of P17, P18, ... P24 is driven in the third divisional step during the third travel of the carriage 21 over the length of the platen 11. In this method, one row of printing is constituted by three parts, upper, middle, and lower, and the printing of these three parts is carried out sequentially to print one row.

Another prior art method of divisional step dot printing is illustrated in Figs. 5 and 6. In this method, all of the dot pins P1, P2, ... P24 are divided into three groups, GROUP 1, GROUP 2, and GROUP 3, each consisting of 8 dot pins at intervals of two dot pin positions. In the printing operation, GROUP 1 consisting of P1, P4, P7, P10, P13, P16, P19, and P22 is driven in the first divisional step during the first travel of the carriage 21 over the length of the platen 11, GROUP 2 consisting of P2, P5, P8, P11, P14, P17, P20, and P23 is driven in the second divisional step during the second travel of the carriage 21 over the length of the platen 11, and GROUP 3 consisting of P3, P6, P9, P12, P15, P18, P21, and P24 is driven in the third divisional step during the third travel of the carriage 21 over the length of the platen 11.

In this method, one row of printing is constituted by a plurality of row constituents, and the printing of this plurality of row constituents is carried out sequentially to print one row. Reference can be made to U.S. Patent No. 4743127.

Alternatively, it is possible to use the modified arrangement of dot pins shown in Fig. 7, in which the dot pins P1, P2, ... P24 are arranged in a zigzag fashion.

In the method shown in Figs. 3 and 4, however, a problem arises in that the paper 12 is deformed in a different way, as shown by a broken line, a one dot chain line, and a solid line, in correspondence with the first, second, and third divisional steps, leading to an undesirable shifting of the paper 12 over the first, second, and third divisional steps, and accordingly, the colors printed by the first, second, and third divisional steps are overlapped or separated from each other.

Also, in the method shown in Figs. 5, 6, and 7, a problem arises in that the space between simultaneously driven adjacent dot pins is relatively large, and therefore, the impact of dot pin onto the paper on the platen is made by a single dot pin, without considering the accumulated effect of the simultaneous impact of a plurality of adjacent dot pins as in the case of Figs. 3 and 4, and accordingly, the density of colors printed by the first, second, and third divisional steps is usually low.

The principle of the operation of a divisional dot printing device according to an embodiment of the present invention will be described with reference to Fig. 8. The operation of the divisional dot printing device shown in Fig. 8 is applicable to the dot printer shown in Figs. 1 and 2.

As shown in Fig. 8, all of the dot pins P1, P2, ... P24 are divided into six groups, i.e., G11, G21, G31, G32, G12, and G22, and the printing is carried out in a sequence of divisional steps, i.e., a first divisional step, a second divisional step, and a third divisional step. Each of the groups G11, G21, G31, G32, G12, and G22 is constituted by a sequence of successive dot pins, i.e., G11 by P1, P3, P5, and P7, G21 by P9, P11, P13, and P15, G31 by P17, P19, P21, and P23, G32 by P2, P4, P6, and P8, G12 by P10, P12, P14, and P16, and G22 by P18, P20, P22, and P24.

In the first divisional step, the groups G11 and G12 are driven, in the second divisional step the groups G21 and G22 are driven, and in the third divisional step the groups G31 and G32 are driven. In each of the first to third divisional steps, each of the combination of the driven groups of dot pins, i.e., G11 and G12 in the first divisional step, G21 and G22 in the second divisional step, and G31 and G32 in the third divisional step, substantially cover the center line of the platen 11. Namely, in the first divisional step, G12 directly covers the

center line, in the second divisional step, G21 directly covers the center line, and in the third divisional step, G31 and G32 hold the center line therebetween.

As shown in Fig. 8, each of the groups G11, G21, G31, G32, G12, and G22 is constituted by a sequence of successive dot pins and the interval between adjacent dot pins in any of the groups is small, and accordingly, the force of the impact of the dot pins onto the paper to be printed is increased, and thus the density of the colors printed by the divisional step printing sequence is increased.

Also, as shown in Fig. 8, the printing operations on the paper in the first, the second, and the third divisional steps are located in neighbouring positions or at similar positions, and thus the undesirable shifting of the paper as in the prior art is prevented, and accordingly, a satisfactory result is obtained by the divisional step printing sequence.

The operation of a divisional step dot printing device according to an embodiment of the present invention is illustrated in Fig. 9 in connection with Fig. 8.

Here, the dot pins P1 to P24 are arranged in a zigzag fashion in two columns, as shown in Fig. 1. The odd number pins P1 to P23 are in the left column, and the even number pins P2 to P24 are in the right column.

As shown in Fig. 9, in the first divisional printing step, the groups G11 and G12 of dot pins strike the upper and middle parts of the paper 12 on the platen 11, in the second divisional printing step, the groups G21 and G22 of dot pins strike the middle and lower parts of the paper 12 on the platen 11, and in the third divisional printing step, the groups G32 and G31 of dot pins strike the upper and lower parts of the paper 12 on the platen 11. In each of the first, the second, and the third divisional printing steps the driven dot pins substantially cover the center line, and throughout the sequence of the first, second, and third divisional printing steps, the dot pins stroke at neighbouring positions or similar positions.

In the operation of the device illustrated in Fig. 9, the interval between adjacent dot pins P1 and P3, which are driven simultaneously, is relatively small, the force of the impact of the dot pins onto the paper 12 is increased, and the density of the appearance of the color printed on the paper 12 is satisfactorily maintained, as illustrated in Fig. 10.

A block diagram of a circuit of a divisional step printing device according to an embodiment of the present invention is shown in Fig. 11. The device of Fig. 11 includes data registers 301, 302, and 303, a bus control circuit 31, AND gates 3211 to 3218, 3221 to 3228, and 3231 to 3238, an address decoder 33, latch circuits 341, 342, and 343, a current supply timer 35, AND gates 3611 to 3618, 3621 to 3628, and 3631 to 3638, a driver 37, and a printing head 22.

The first divisional step data registered in the data register 301 passes through AND gates 3211 to 3218, is latched by the latch circuit 341, passes through AND gates 3611 to 3618, and is then supplied to the driver 37 to drive the groups G11 and G12 of the dot pins.

The second divisional step data registered in the data register 302 passes through AND gates 3221 to 3228, is latched by the latch circuit 342, passes through AND gates 3621 to 3628, and is then supplied to the driver 37 to drive the groups G21 and G22 of the dot pins.

The third divisional step data registered in the data register 303 passes through AND gates 3231 to 3238, is latched by the latch circuit 343, passes through AND gates 3631 to 3638, and is then supplied to the driver 37 to drive the groups G31 and G32 of the dot pins.

In the case of a non-divisional-step printing, all of the potentials of the step 1 valid signal, step 2 valid signal, and step 3 valid signal delivered from the bus control circuit 31 are made HIGH. In the case of a divisional step printing, the potentials of the step 1 valid signal, step 2 valid signal, and step 3 valid signal delivered from the bus control circuit 31 are sequentially made HIGH. The step 1, step 2, and step 3 valid signals delivered from the bus control circuit 31 are supplied to input terminals of the AND gates 3211 to 3218, 3221 to 3228, and 3231 to 3238.

The current supply timer 35 supplies an energization pulse having a predetermined duration to input terminals of the AND gates 3611 to 3618, 3621 to 3628, and 3631 to 3638.

In the divisional step printing operation mode of the device of Fig. 11, in the first divisional step, the potential of the STEP 1 VALID SIGNAL from the bus control circuit 31 is made HIGH and the potentials of the STEP 2 and STEP 3 VALID SIGNALS are made LOW, the AND gates 3211 to 3218 are turned ON, and the groups G11 and G12 of dot pins are driven through the latch circuit 341, the AND gates 3611 to 3618, and the driver 37.

In the second divisional step, the potential of the STEP 2 VALID SIGNAL from the bus control circuit 31 is made HIGH and the potentials of the STEP 1 and STEP 3 VALID SIGNALs are made LOW, the AND gates 3221 to 3228 are turned ON, and the groups G21 and G22 of dot pins are driven through the latch circuit 342, the AND gates 3621 to 3628, and the driver 37.

In the third divisional step, the potential of the STEP 3 VALID SIGNAL from the bus control circuit 31 is made HIGH and the potentials of the STEP 1 and STEP 2 VALID SIGNALs are made LOW, the

AND gates 3231 to 3238 are turned ON, and the groups G31 and G32 of dot pins are driven through the latch circuit 343, the AND gates 3631 to 3638, and the driver 37.

In the non-divisional-step printing operation mode of the device of Fig. 11, the potentials of all of the STEP 1, STEP 2, and STEP 3 VALID SIGNALs are made HIGH, all of the AND gates 3211 to 3218, 3221 to 3228, and 3231 to 3238 are turned ON, and all of the groups G11, G12, G21, G22, G31, and G32 of dot pins are driven through the latch circuits 341, 342, and 343, the AND gates 3611 to 3618, 3621 to 3628, and 3631 to 3638, and the driver 37.

The operation of a divisional step dot printing device according to another embodiment of the present invention is illustrated in Fig. 12. In the operation illustrated in Fig. 12, the dot pins P1 to P24 are arranged in a single column, and are divided into groups of the successive dot pins: G11, G21, G31, G12, G22, and G32.

In the operation illustrated in Fig. 12, in the first divisional step the groups G11 and G12 are driven, in the second divisional step the groups G21 and G22 are driven, and in the third divisional step the groups G31 and G32 are driven.

Instead of the operation illustrated in Fig. 8, it is possible to drive the groups G11 and G22 in the first divisional step, the groups G21 and G12 in the second divisional step, and the groups G31 and G32 in the third divisional step.

Instead of the operation illustrated in Fig. 8, it is also possible to adopt a number of the dot pins other than 24, and to adopt a number of divisional steps other than three.

Claims

1. A divisional step wire dot printer comprising:
a dot printing head (22) having a plurality of dot pins (P1-P24), a platen (11) arranged opposite the dot printing head (22) and which, in use, carries a print medium (12), and driving means for driving the plurality of dot pins (P1-P24) which divides the dot pins (P1-P24) into a plurality of groups (G11, G12, G21, G22, G31, G32) each of which contains a sequence of adjacent dot pins and drives the groups in a sequence of divisional printing steps, a combination of groups being driven in each of the sequence of divisional printing steps so that dot pins on both sides of a centre line of the print head (22) extending in the direction of the axis of the platen (11) are driven in each divisional printing step.

2. A divisional step wire dot printer according to claim 1, in which all the dot pins (P1-P24) are arranged in a single line (Figure 11).

3. A divisional step wire dot printer according to claims 1, in which the dot pins (P1-P24) are arranged in two lines.

4. A divisional step dot printing device for a wire dot printer comprising:
a dot printing head having a plurality of dot pins;
a print medium on which printing by said dot pins is carried out; and
a platen arranged opposite to said dot printing head and on which said print medium for dot printing is placed;
said plurality of dot pins of said dot printing head being divided into a plurality of groups of a sequence of dot pins and being driven in a sequence of divisional dot printing steps;
each of said divisional dot printing steps being carried out by a combination of groups of dot pins which substantially cover the center line of said platen.

Fig. 1

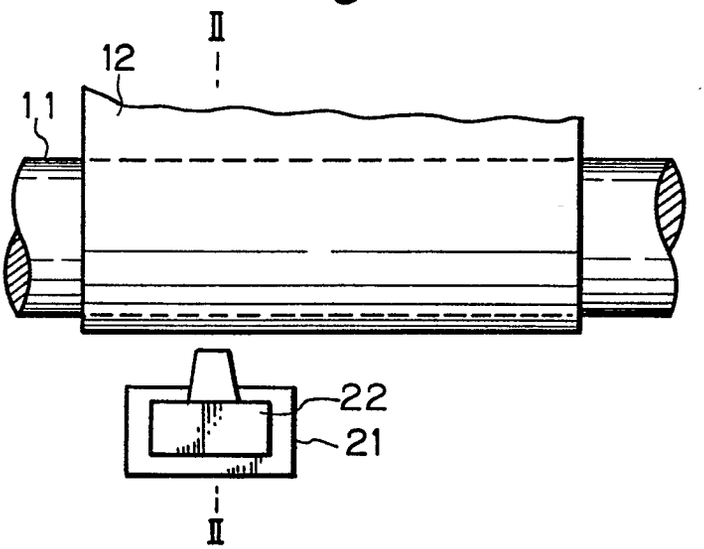


Fig. 2

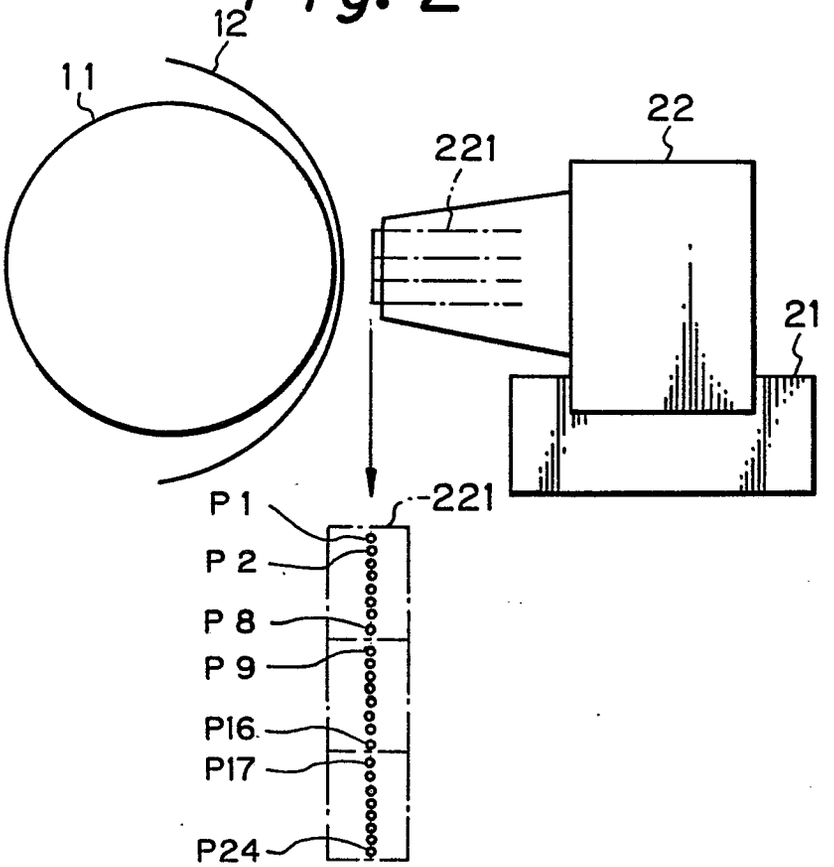


Fig. 3

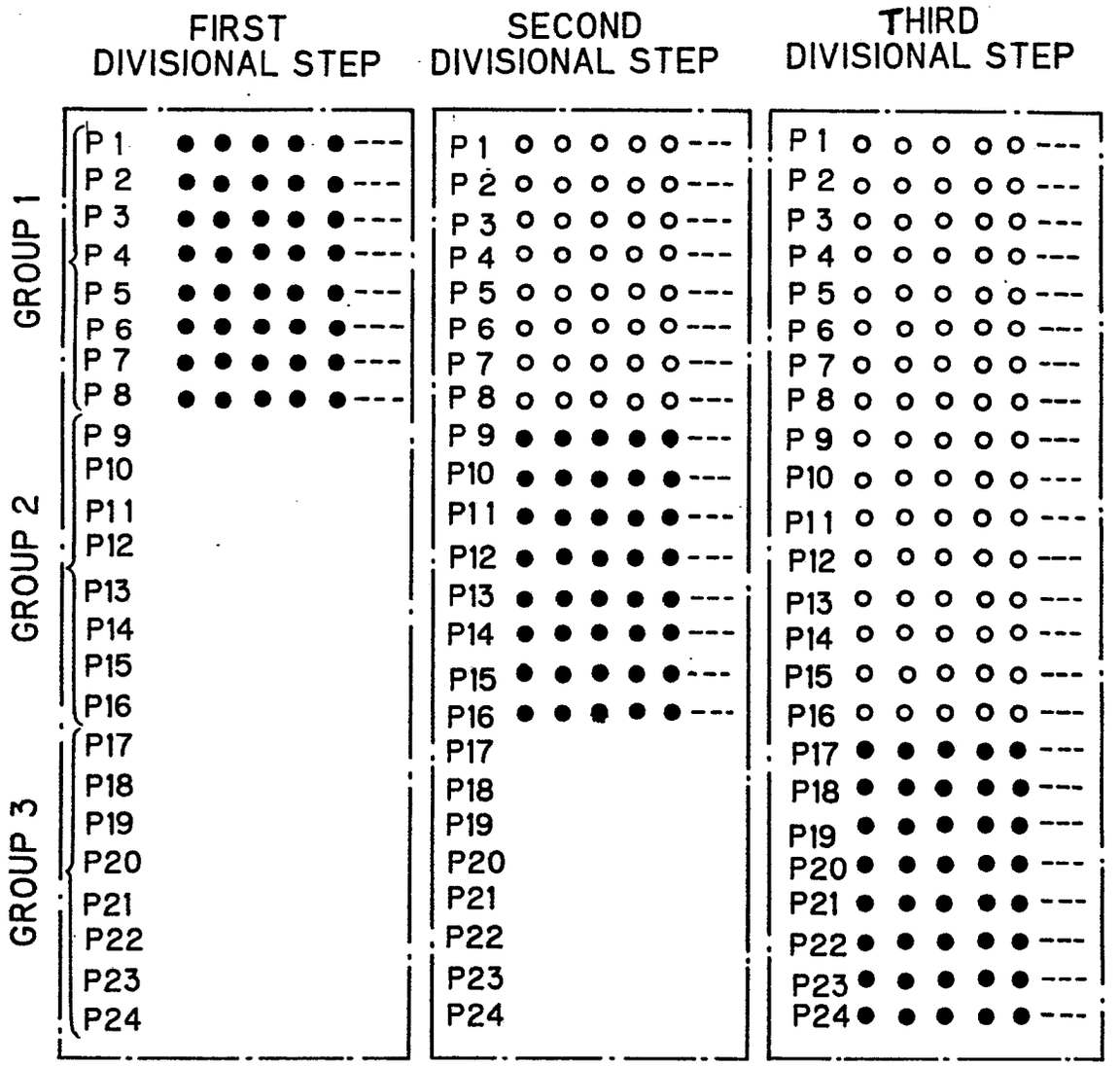

FIRST DIVISIONAL STEP
SECOND DIVISIONAL STEP
THIRD DIVISIONAL STEP
GROUP 1
GROUP 2
GROUP 3
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
P13
P14
P15
P16
P17
P18
P19
P20
P21
P22
P23
P24

Fig. 4

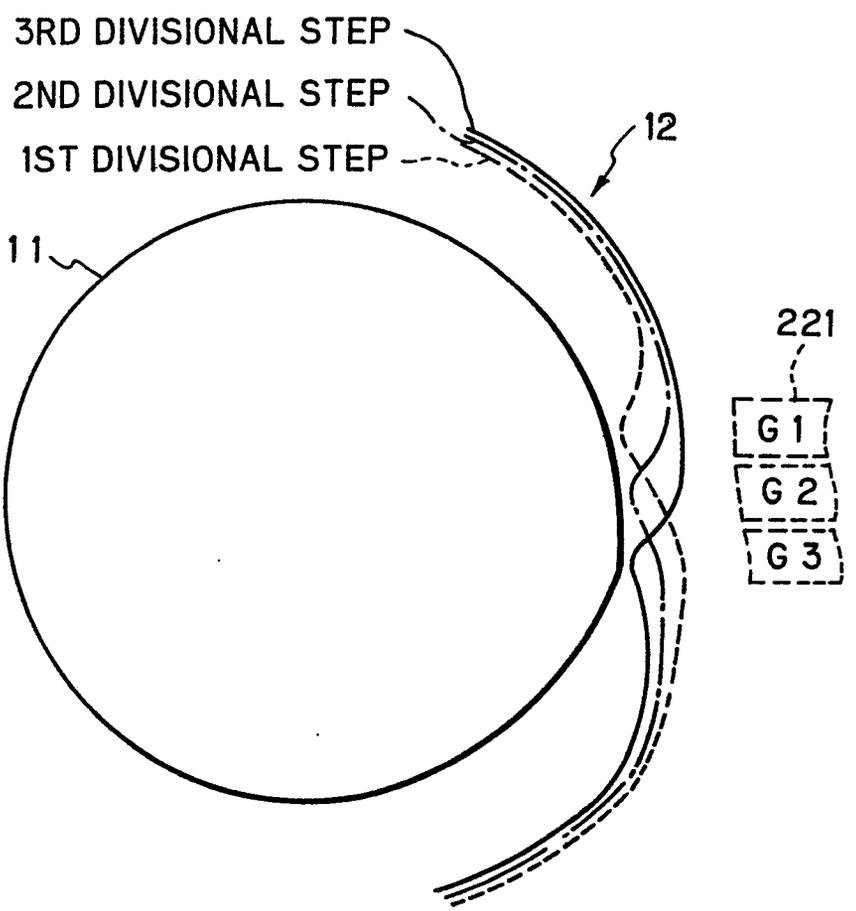

3RD DIVISIONAL STEP
2ND DIVISIONAL STEP
1ST DIVISIONAL STEP
12
11
221
G1
G2
G3

Fig. 5

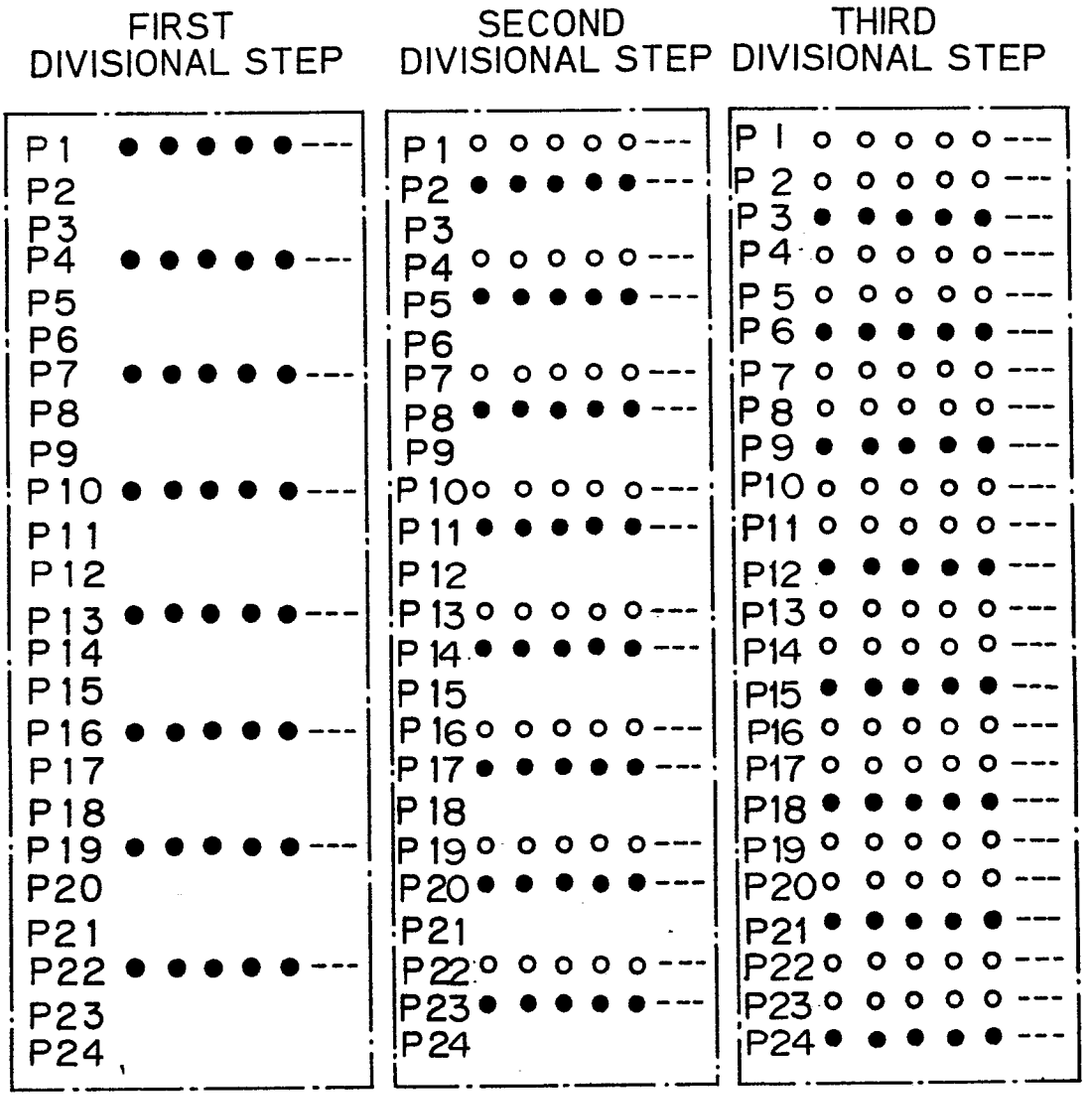

FIRST DIVISIONAL STEP
SECOND DIVISIONAL STEP
THIRD DIVISIONAL STEP
P1 ● ● ● ● ●---
P2
P3
P4 ● ● ● ● ●---
P5
P6
P7 ● ● ● ● ●---
P8
P9
P10 ● ● ● ● ●---
P11
P12
P13 ● ● ● ● ●---
P14
P15
P16 ● ● ● ● ●---
P17
P18
P19 ● ● ● ● ●---
P20
P21
P22 ● ● ● ● ●---
P23
P24
P1 o o o o o---
P2 ● ● ● ● ●---
P3
P4 o o o o o---
P5 ● ● ● ● ●---
P6
P7 o o o o o---
P8 ● ● ● ● ●---
P9
P10 o o o o o---
P11 ● ● ● ● ●---
P12
P13 o o o o o---
P14 ● ● ● ● ●---
P15
P16 o o o o o---
P17 ● ● ● ● ●---
P18
P19 o o o o o---
P20 ● ● ● ● ●---
P21
P22 o o o o o---
P23 ● ● ● ● ●---
P24
P1 o o o o o---
P2 o o o o o---
P3 ● ● ● ● ●---
P4 o o o o o---
P5 o o o o o---
P6 ● ● ● ● ●---
P7 o o o o o---
P8 o o o o o---
P9 ● ● ● ● ●---
P10 o o o o o---
P11 o o o o o---
P12 ● ● ● ● ●---
P13 o o o o o---
P14 o o o o o---
P15 ● ● ● ● ●---
P16 o o o o o---
P17 o o o o o---
P18 ● ● ● ● ●---
P19 o o o o o---
P20 o o o o o---
P21 ● ● ● ● ●---
P22 o o o o o---
P23 o o o o o---
P24 ● ● ● ● ●---

Fig. 6

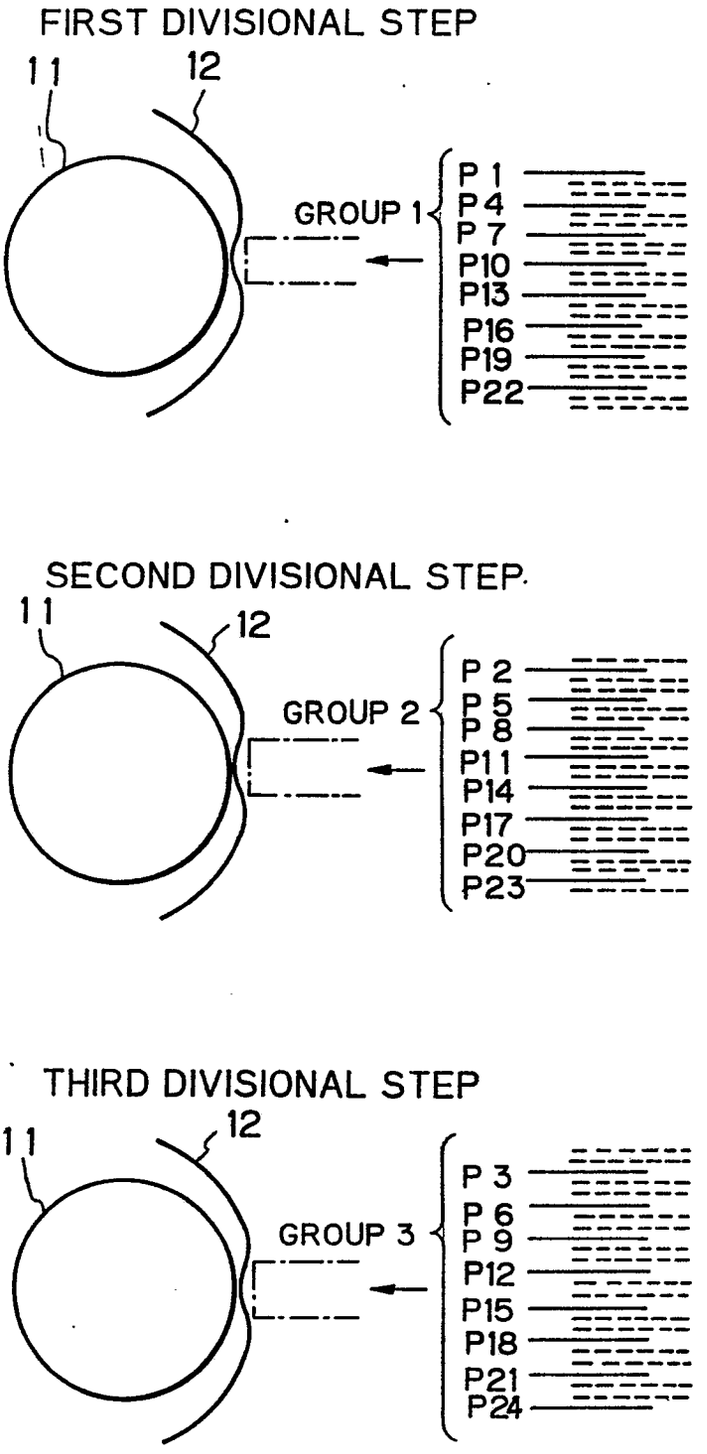

FIRST DIVISIONAL STEP
11
12
GROUP 1
P 1
P 4
P 7
P10
P13
P16
P19
P22
SECOND DIVISIONAL STEP
11
12
GROUP 2
P 2
P 5
P 8
P11
P14
P17
P20
P23
THIRD DIVISIONAL STEP
11
12
GROUP 3
P 3
P 6
P 9
P12
P15
P18
P21
P24

Fig. 7

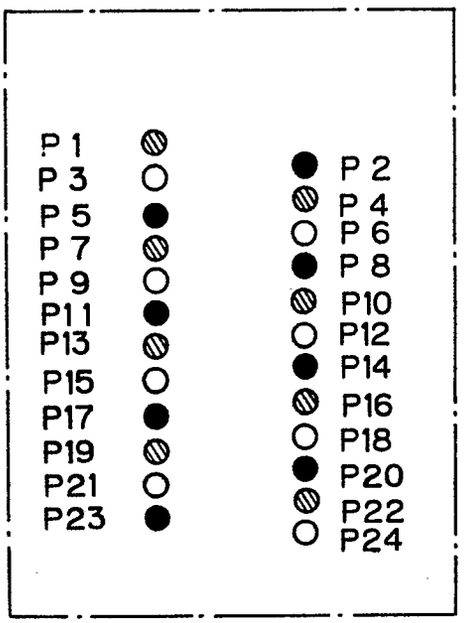

P 1
P 3
P 5
P 7
P 9
P11
P13
P15
P17
P19
P21
P23
P 2
P 4
P 6
P 8
P10
P12
P14
P16
P18
P20
P22
P24

Fig. 10

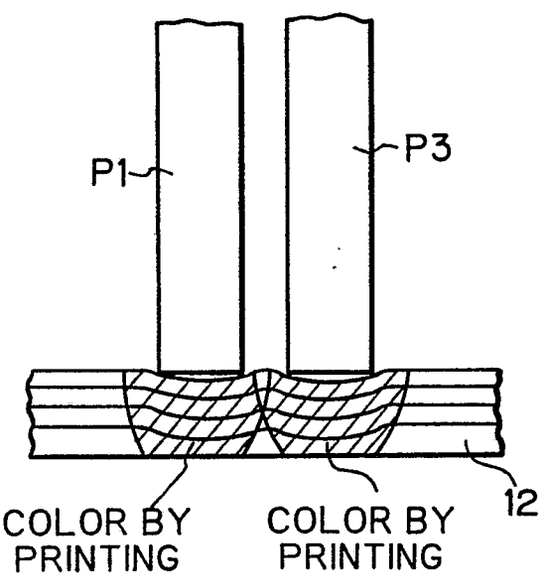

P1
P3
12
COLOR BY PRINTING
COLOR BY PRINTING

Fig. 8

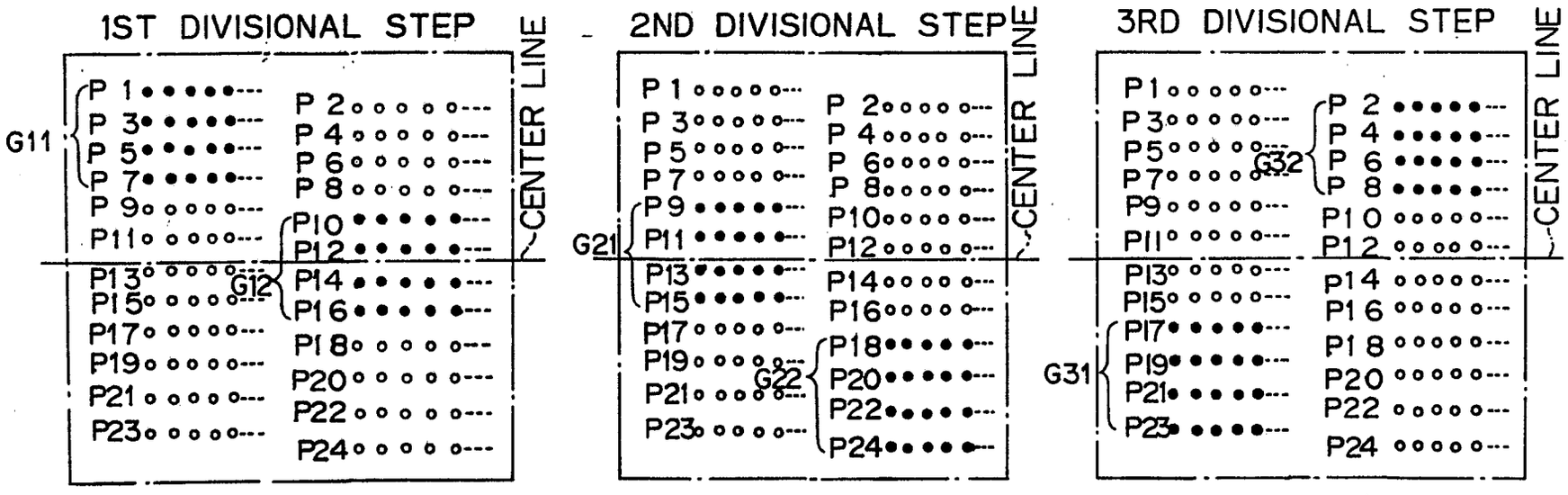

1ST DIVISIONAL STEP
2ND DIVISIONAL STEP
3RD DIVISIONAL STEP
CENTER LINE
G11
G12
G21
G22
G31
G32
P 1
P 2
P 3
P 4
P 5
P 6
P 7
P 8
P 9
P10
P11
P12
P13
P14
P15
P16
P17
P18
P19
P20
P21
P22
P23
P24

Fig. 9

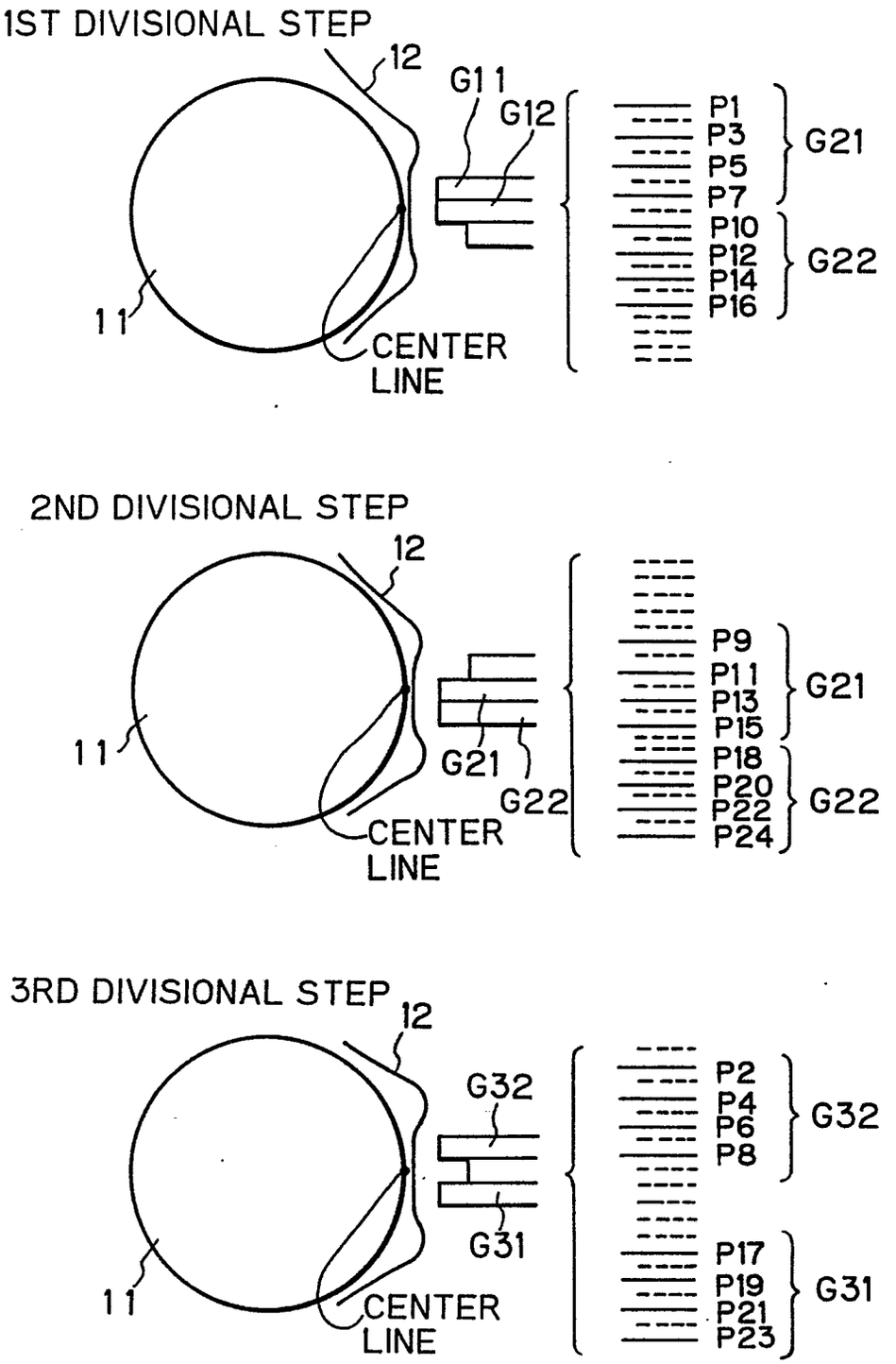

1ST DIVISIONAL STEP
12
G11
G12
P1
P3
P5
P7
G21
P10
P12
P14
P16
G22
11
CENTER LINE
2ND DIVISIONAL STEP
12
P9
P11
P13
P15
G21
G21
P18
P20
P22
P24
G22
G22
11
CENTER LINE
3RD DIVISIONAL STEP
12
G32
P2
P4
P6
P8
G32
G31
P17
P19
P21
P23
G31
11
CENTER LINE

Fig. 11A

Fig.11

Fig.11A	Fig.11B

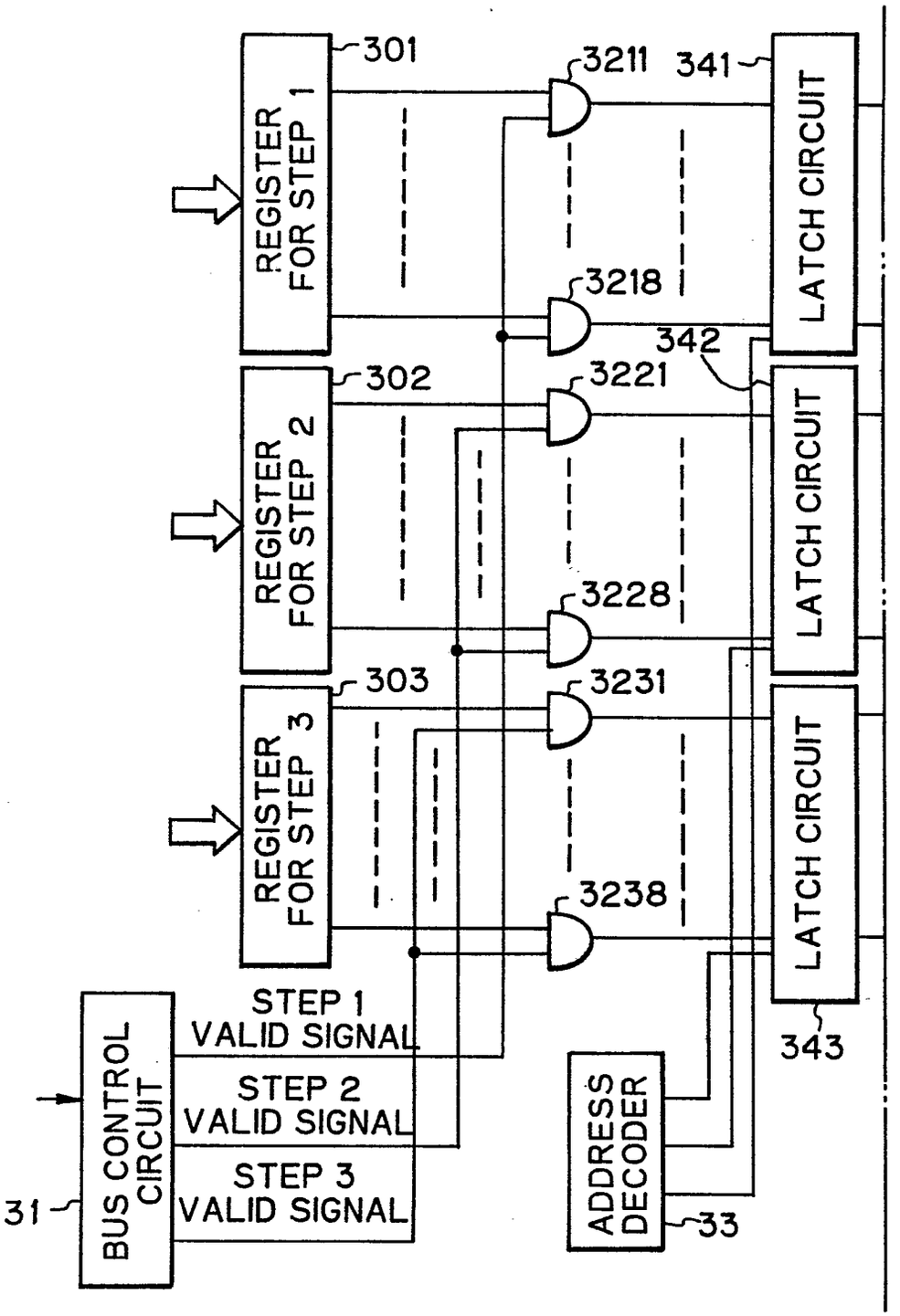


Fig. 11B

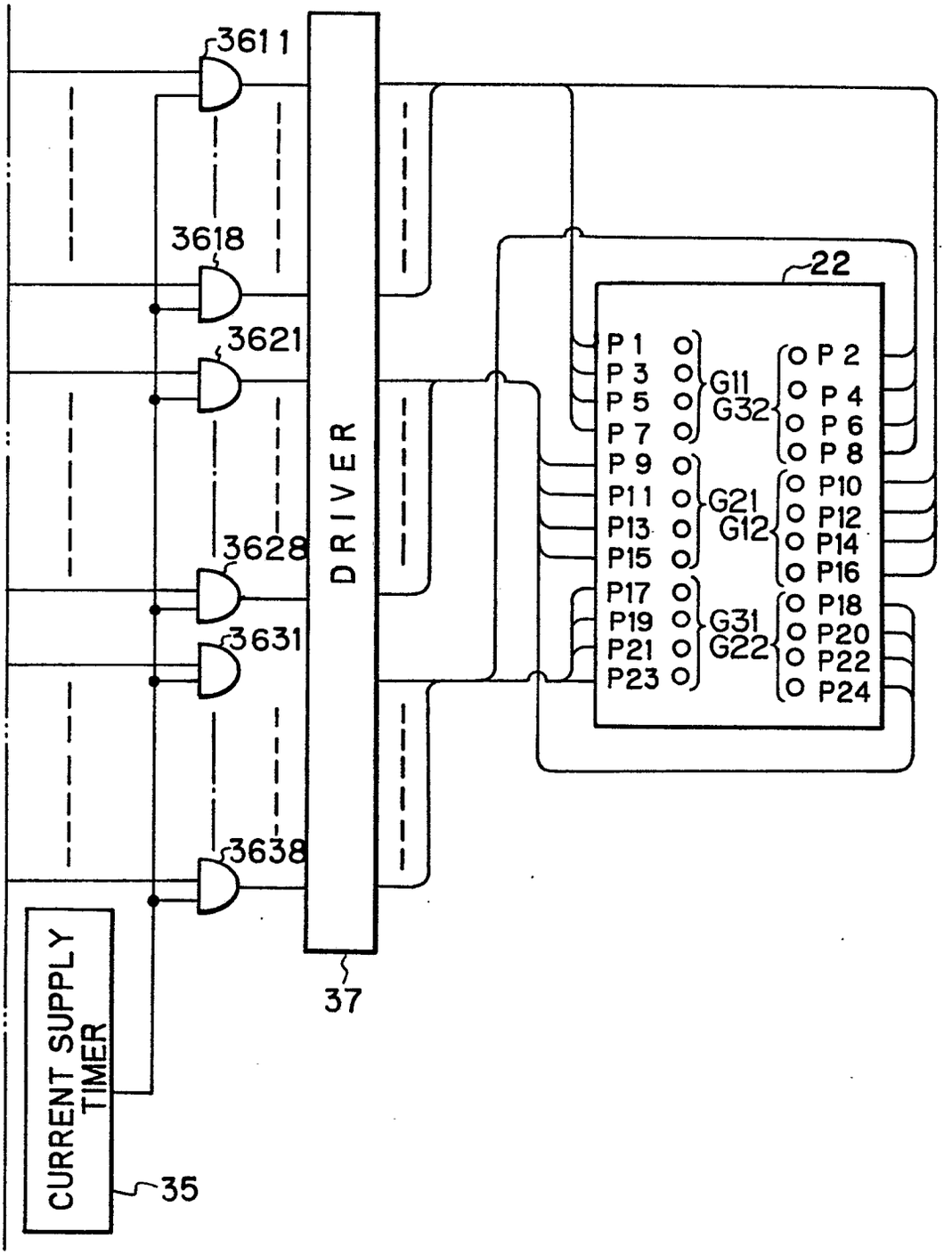
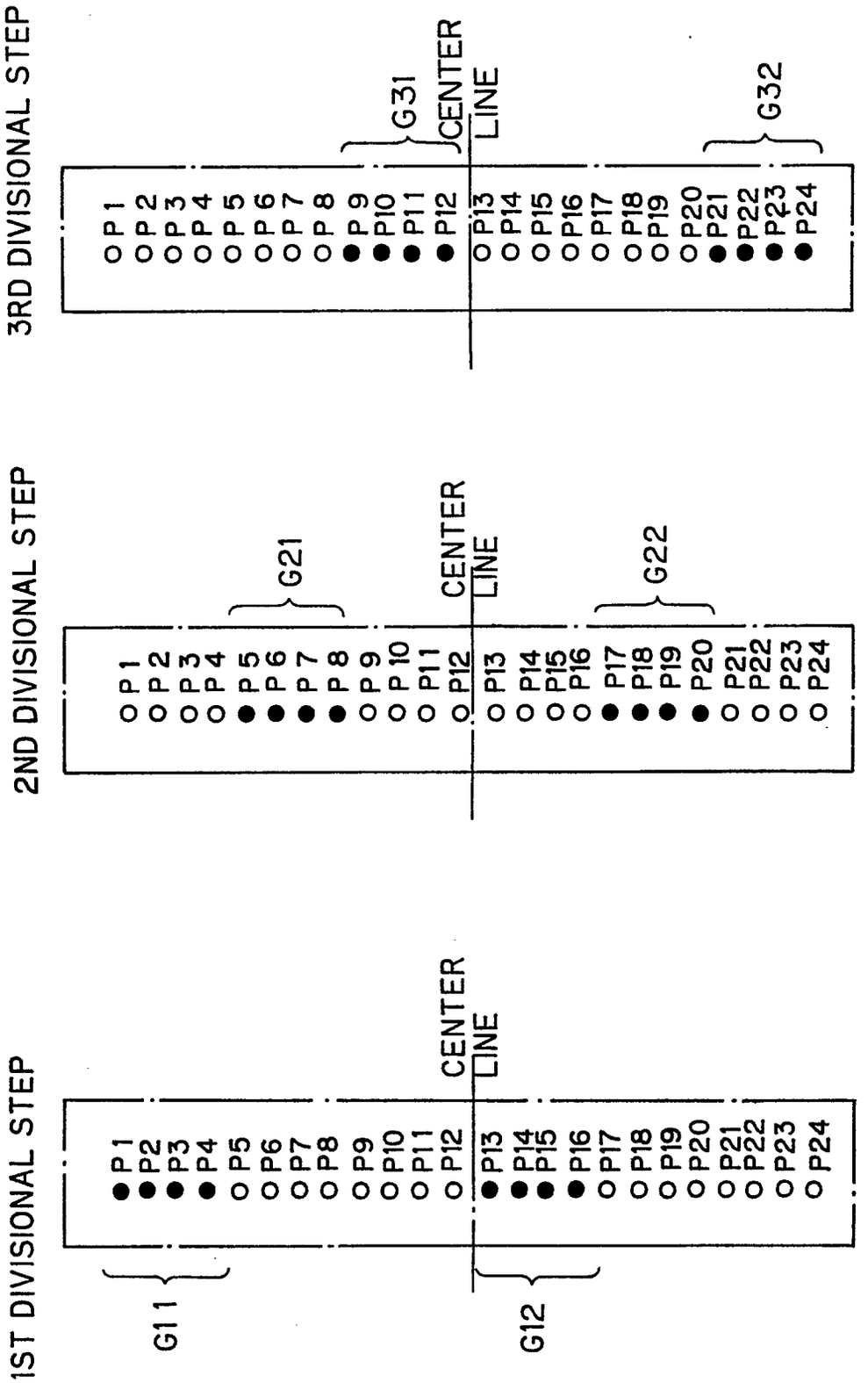

3611
3618
3621
3628
3631
3638
DRIVER
37
CURRENT SUPPLY TIMER
35
22
P 1
P 3
P 5
P 7
G11
G32
P 2
P 4
P 6
P 8
P 9
P11
P13
P15
G21
G12
P10
P12
P14
P16
P17
P19
P21
P23
G31
G22
P18
P20
P22
P24

Fig. 12


1ST DIVISIONAL STEP
2ND DIVISIONAL STEP
3RD DIVISIONAL STEP
CENTER LINE
G11
G12
G21
G22
G31
G32
P1 P2 P3 P4 P5 P6 P7 P8 P9 P10 P11 P12 P13 P14 P15 P16 P17 P18 P19 P20 P21 P22 P23 P24

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 90302525.2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl.)
D,A	US - A - 4 743 127 (UEMATSU) * Totality * --	1,2,4	B 41 J 2/23 B 41 J 2/505
A	EP - A2 - 0 104 628 (SIEMENS AG) * Claims * --	1,2,4	
A	US - A - 4 758 103 (ANGST) * Totality * ----	1,2,4	

TECHNICAL FIELDS SEARCHED (Int Cl.)

B 41 J
G 06 K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	08-06-1990	WITTMANN

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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