



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) **EP 1 013 475 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**28.06.2000 Bulletin 2000/26**

(51) Int. Cl.<sup>7</sup>: **B43L 13/00, G06K 9/00**

(21) Application number: **99125796.5**

(22) Date of filing: **23.12.1999**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE**  
Designated Extension States:  
**AL LT LV MK RO SI**

(30) Priority: **25.12.1998 JP 37156798**

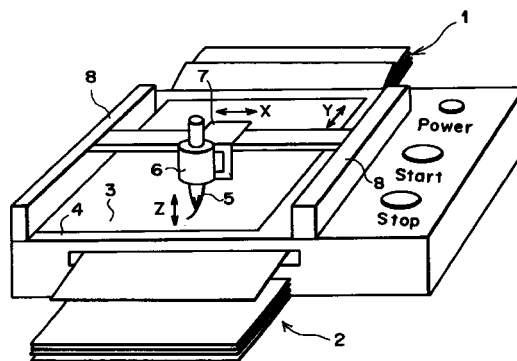
(71) Applicant:  
**RISO KAGAKU CORPORATION**  
**Tokyo (JP)**

(72) Inventor:  
**Hiroyuki, Ikeda,**  
**c/o Riso Kagaku Corporation R&D**  
**Inashiki-gun, Ibaraki-ken (JP)**

(74) Representative:  
**Klunker . Schmitt-Nilson . Hirsch**  
**Winzererstrasse 106**  
**80797 München (DE)**

(54) **Drawing apparatus and drawing-data output apparatus**

(57) A writing-implement hold unit 12 holds a writing implement whose drawing density or drawing size varies according to drawing pressure or drawing speed. A paper hold unit 13 holds a sheet of paper. A drawing-data generation section 10 generates drawing data an image drawn on a sheet. A drawing control section 11 controls a drawing drive unit 14 by using the drawing data generated by the drawing-data generation section 10. The drawing drive unit 14 drives the writing-implement hold unit 12 in accordance with control of the drawing control section 11. The drawing drive unit 14 moves in at least three directions by varying a relative positional relationship between the writing implement held by the writing-implement hold unit 12 and the paper held by the paper hold unit 13. With this movement, the drawing drive unit 14 draws characters like those written by a person with a writing implement.



**F I G . 1**

**EP 1 013 475 A2**

## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

[0001] This invention relates to a drawing apparatus, and more particularly to a drawing apparatus which is capable of drawing characters like those written by a person with a writing implement.

#### Description of the Related Art

[0002] A conventional drawing apparatus is known which is capable of writing characters like those that a person has actually addressed, for example a postcard, with a writing implement.

[0003] For instance, Japanese Unexamined Patent Publication No. 7(1995)-68993 discloses a calligraphic style generation system, which reads out a stored document and controls drive of a writing brush, based on the calligraphic style information (such as the order of making strokes in a Japanese character, brush pressure, the development of a writing brush and the like) and layout information of each character in the document.

[0004] However, the system disclosed in the above-mentioned publication has the disadvantage that it cannot easily perform an operation of adopting or rejecting data from a document database and rearranging data, because the system requires an operation of selecting a desired document from a plurality of documents by a personal computer (PC) or a word processor.

### SUMMARY OF THE INVENTION

[0005] In view of the aforementioned disadvantage, an object of the present invention is to provide a drawing apparatus which is capable of drawing characters like those written by a person with a writing implement and easily performing an operation, such as rearrangement, insertion, sampling and the like, when a database is repeatedly used. Another object of the invention is to provide a drawing-data output apparatus that makes the drawing apparatus possible. To achieve the aforementioned objects and in accordance with one aspect of the present invention, there is provided a drawing apparatus comprising

writing-implement holding means which holds a writing implement whose drawing density or drawing size varies according to brush pressure and/or drawing speed,  
paper holding means which holds a sheet of paper,  
drawing drive means which moves in at least three directions to perform drawing by varying a relative positional relationship between the writing implement held by the writing-implement hold means and

the paper held by the paper hold means,  
drawing control means which controls drive of the drawing drive means, and  
drawing-data generation means which generates drawing data, which is supplied to the drawing control means.

[0006] Here, the "drawing data" means the position information and brush-pressure or drawing pressure information on a sheet, the moving-speed information and angle information of a writing implement, and the like. The "perform drawing" means to move a brush, pen or the like in at least three directions, X-axis direction, Y-axis direction, and Z-axis direction.

[0007] According to this construction, a data sheet can be used as a database for moving a writing implement (a brush pen, a signature pen or the like whose drawing density or drawing size varies according to drawing pressure and/or drawing speed) in at least three directions, X-axis direction, Y-axis direction, and Z-axis direction.

[0008] The drawing-data generation means comprises

image reading means which reads an image drawn on a sheet,  
character recognition means which performs character recognition on the image data obtained by the image reading means,  
a character database which stores a plurality of character data constituting the drawing data,  
layout information generation means which generates layout information from at least the result of character recognition, and  
data synthesis means which generates corresponding character data from the character database, based on the result of character recognition obtained by the character recognition means and also synthesizes drawing data, based on the layout information.

[0009] According to this construction, character recognition is first performed on the drawing data and then characters to be drawn are discriminated. Based on the result of discrimination, character data is extracted from the character database. The extracted character data is arranged according to layout information, whereby drawing data is synthesized. Therefore, for handwriting, if information of a user is registered in the character database, the user's own handwriting can be reproduced. Also, if information of a certain person with good handwriting is registered, that person's handwriting can be reproduced. For layout, if both drawing-position information and drawing-size information of an image read out from a sheet are used, the user's own layout can be reproduced. Note that automatic layout may be performed by storing layout information.

[0010] The drawing-data generation means may

comprise

image read means which reads an image drawn on a sheet,  
stroke analysis means which generates stroke information from the image data obtained by the image read means,  
drawing-pressure extraction means which extracts drawing-pressure information from at least either drawing information or drawing size of the image data and from the stroke information obtained by the stroke analysis means, and  
data synthesis means which synthesizes drawing data from the stroke information and the drawing-pressure information.

**[0011]** In addition, the drawing-data generation means may comprise

image read means which reads an image drawn on a sheet,  
stroke analysis means which generates stroke information from the image data obtained by the image read means,  
reference-stroke storage means in which a plurality of reference strokes are stored,  
stroke matching means which matches the stroke information obtained by the stroke analysis means with the reference stroke information stored in the reference-stroke storage means,  
drawing-pressure information storage means in which a plurality of items of drawing-pressure information are stored in accordance with the plurality of reference strokes, and  
data synthesis means which reads out the drawing-pressure information corresponding to the reference stroke, obtained by the matching performed by the stroke matching means, from the drawing-pressure information storage means and combines the drawing-pressure information and each stroke information, thereby synthesizing drawing data.

**[0012]** According to these constructions, stroke analysis is first performed and then the stroke information (relative position information with respect to a sheet) of an image drawn on the sheet is extracted. The drawing pressure, used in drawing the image on the sheet, is estimated from at least either drawing-density information or drawing-size information, or is replaced with reference stroke information. Therefore, a user's own layout can be reproduced and handwriting that is nearly the same as the user's own handwriting can be reproduced.

**[0013]** The drawing-data output apparatus of the present invention may further comprise second drawing-data storage means which stores drawing data. In this case, it is preferable that the second drawing-data storage means be writable after being partially erased,

when drawing data obtained from a newly read sheet is written.

**[0014]** In accordance with another aspect of the present invention, there is provided a drawing-data output apparatus for outputting drawing data which is supplied to drawing control means which controls drive of drawing drive means which moves in at least three directions to perform drawing by varying a relative positional relationship between a writing implement whose printing density or printing size varies according to drawing pressure and/or drawing speed, held by writing-implement hold means, and paper held by paper hold means, the drawing-data output apparatus comprising

drawing-data generation means which generates the drawing data,  
coding means which codes the drawing data generated by the drawing-data generation means, and  
code output means which outputs the code obtained by the coding means.

**[0015]** The drawing-data generation means in the drawing-data output apparatus may comprise

image read means which reads an image drawn on a sheet,  
character recognition means which performs character recognition on the image data obtained by the image read means,  
a character database which stores a plurality of character data constituting the drawing data,  
layout information generation means which generates layout information from at least the result of character recognition, and  
data synthesis means which generates corresponding character data from the character database, based on the result of character recognition obtained by the character recognition means and also synthesizes drawing data, based on the layout information.

**[0016]** Also, the drawing-data generation means in the drawing-data output apparatus may comprise

image read means which reads an image drawn to a sheet,  
stroke analysis means which generates stroke information from the image data obtained by the image read means,  
drawing-pressure extraction means which extracts drawing-pressure information from at least either drawing information or drawing size of the image data and from the stroke information obtained by the stroke analysis means, and  
data synthesis means which synthesizes drawing data from the stroke information and the drawing-pressure information.

**[0017]** In addition, the drawing-data generation means in the drawing-data output apparatus may comprise

image read means which reads an image drawn on a sheet,  
 stroke analysis means which generates stroke information from the image data obtained by the image read means,  
 reference-stroke storage means in which a plurality of reference strokes are stored,  
 stroke matching means which matches the stroke information obtained by the stroke analysis means with the reference stroke information stored in the reference-stroke storage means,  
 drawing-pressure information storage means in which a plurality of items of drawing-pressure information are stored in accordance with the plurality of reference strokes, and  
 data synthesis means which reads the drawing-pressure information corresponding to the reference stroke, obtained by the matching performed by the stroke matching means, from the drawing-pressure information storage means and combines the drawing-pressure information and each stroke information, thereby synthesizing drawing data.

**[0018]** Moreover, the drawing-data generation means in the drawing-data output apparatus may be a multidimensional digitizer which inputs data equivalent to drawing data.

**[0019]** According to this construction, both a user's own layout and the user's own handwriting can be reproduced.

**[0020]** Furthermore, the drawing-data generation means in the drawing-data output apparatus may comprise

character recognition means which performs character recognition, based on the data input by the multidimensional digitizer,  
 a character database which stores a plurality of character data constituting the drawing data,  
 layout information generation means which generates layout information from at least the result of character recognition, and  
 data synthesis means which generates corresponding character data from the character database, based on the result of character recognition obtained by the character recognition means and also synthesizes drawing data, based on the layout information.

**[0021]** In accordance with still another aspect of the present invention, there is provided a drawing apparatus comprising

writing-implement hold means which holds a writing

implement whose drawing density or drawing size varies according to drawing pressure and/or drawing speed,

paper hold means which holds a sheet of paper,  
 drawing drive means which moves in at least three directions to perform drawing by varying a relative positional relationship between the writing implement held by the writing-implement hold means and the paper held by the paper hold means,

code read means which reads a code from a sheet in which drawing data to be supplied to the drawing control means along with image or character information recognizable by a person is pervasively coded and stored,

decoding means which decodes the read code, and  
 drawing-data storage means which stores the drawing data obtained by the decoding means.

**[0022]** According to this construction, it becomes possible to use the data sheet as a database for moving a writing implement (a brush pen, a signature pen or the like whose drawing density or drawing size varies according to drawing pressure and/or drawing speed) in at least three directions, X-axis direction, Y-axis direction, and Z-axis direction.

**[0023]** It is preferable that the drawing-data storage means be writable after being partially erased, when drawing data obtained from a newly read sheet is written.

**[0024]** According to the present invention, a user's own handwriting and layout can be reproduced.

**[0025]** In addition, according to the present invention, the process from generation of drawing data to drawing is divided into the process of generating drawing data and coding and outputting the drawing data, and the process of performing drawing, based on the codes stored in a sheet along with an image recognizable by a person, and a user purchases only an apparatus which performs the latter process, whereby the same effect is obtainable. Therefore, expense incurred by a user for apparatus purchase can be suppressed.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0026]**

Figure 1 is a perspective view showing a drawing apparatus according to the present invention,  
 Figure 2A is a block diagram showing a drawing apparatus according to a first embodiment of the present invention,  
 Figure 2B is a block diagram showing the drawing-data generation means of the drawing apparatus shown in Figure 2A,  
 Figure 3A is a diagram showing reference points which represent the strokes of a writing implement,  
 Figure 3B is a diagram showing an example of the data stored in a character database,

Figure 4 is a conceptual diagram showing how data synthesis means converts character data to drawing data,

Figure 5 is a block diagram showing the drawing-data generation means of a drawing apparatus according to a second embodiment of the present invention,

Figure 6 is a diagram showing an example of a data sheet that the image read means shown in Figure 5 reads,

Figure 7 is a block diagram showing the drawing-data generation means of a drawing apparatus according to a third embodiment of the present invention,

Figure 8 is a block diagram showing how drawing data is coded by a drawing apparatus according to a fourth embodiment of the present invention,

Figure 9 is a block diagram showing how the drawing data coded by the drawing apparatus of Figure 8 is decoded,

Figure 10 is a block diagram showing an example of the drawing-data generation means of a drawing apparatus according to a fifth embodiment of the present invention, and

Figure 11 is a block diagram showing another example of the drawing-data generation means according to the fifth embodiment.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

### (First Embodiment)

**[0027]** Referring to Figures 1 and 2, there is shown a drawing apparatus in accordance with a first embodiment of the present invention.

**[0028]** As shown in Figure. 1, the drawing apparatus includes a paper supply section 1 which places manuscript sheets, a feeder (not shown) which conveys the manuscript sheets placed on the paper supply section 1 one by one, and a paper discharge section 2 which discharges the manuscript conveyed by the feeder.

**[0029]** The drawing apparatus further includes (1) a paper hold section 4 (equivalent to paper hold means 13 in Figure. 2A) which holds a sheet of paper 3; (2) a Z-axis slide section 6 (equivalent to writing-implement hold means 12 and drawing drive means 14 in Figure. 2A) which holds a writing implement 5 (such as a writing brush, a pen and the like) whose drawing density or drawing size varies according to drawing pressure and slides (or moves by multiple stages) the writing implement 5 in the Z-axis direction shown in Figure. 1; (3) an X-axis slide section 7 (equivalent to the drawing drive means 14 in Figure. 2A) which slides the Z-axis slide section 6 in the X-axis direction shown in Figure. 1; and (4) a pair of Y-axis slide sections 8 (equivalent to the drawing drive means 14 in Figure. 2A) which slide the X-

axis slide section 7 in the Y direction shown in Figure. 1. Moreover, the drawing apparatus includes a drawing-data generation circuit (equivalent to drawing-data generation means 10 in Figure. 2A) in the interior thereof. The drawing-data generation circuit generates drawing data that is supplied to a driver (not shown and equivalent to drawing control means 11 in Figure. 2A) which controls drive of the slide sections 6 to 8. Note that the drawing data will be described in detail later.

**[0030]** As shown in Figure. 2B, the drawing-data generation means 10 is constituted by image read means 20, character recognition means 21, layout information generation means 22, a character database 23, and data synthesis means 24.

**[0031]** The image read means 20 is constituted by a charge-coupled device (CCD) or the like, and reads out an image on the manuscript conveyed from the paper supply section 1 toward the paper discharge section 2 by the feeder and outputs bitmap data.

**[0032]** The character recognition means 21 performs pattern matching between a pattern cut in a character unit from the bitmap data obtained by the image read means 20 and a previously stored character pattern for character recognition, that is, performs character recognition and outputs a corresponding character code.

**[0033]** The layout information generation means 22 is provided with an automatic layout function, and generates layout information, based on layout information stored in advance and the character code obtained by the character recognition means 21. Note that the position information and size information of the pattern, cut for character recognition in a character unit, with respect to a manuscript may be extracted and input to the layout information generation means 22. This makes it possible to reproduce the layout of the manuscript.

**[0034]** In the character database 23, a combination of a character code, position information (hereinafter referred to as absolute position information) X, Y of reference points P1 to P9 (a start point, a plurality of intermediate points on a stroke such as a bent point and the minimum and maximum points of drawing pressure, and an end point), and corresponding drawing-pressure information (equivalent to Z coordinates) Z is stored as character data such as that shown in Figure 3B. The reference points P1 to P9 represent strokes (strokes S1, S2) of a writing implement, such as the one shown in Figure 3A. If information of a user has been registered as this character data in advance, the user's handwriting can be reproduced. In addition, information of a certain person with good handwriting may be registered so that that handwriting can be reproduced. Furthermore, information of a plurality of persons may be registered so that a user can arbitrarily select the plurality of persons' handwriting.

**[0035]** The data synthesis means 24 reads out corresponding character data stored in the character database 23, based on a character code for each character

obtained by the character recognition means 21. The data synthesis means 24 also converts the character data to drawing data, based on the layout information obtained by the layout information generation means 22. More specifically, as shown in a conceptual diagram of Figure 4, the absolute position information and drawing-pressure information corresponding to this are converted to relative position information with respect to the paper 3 held by the paper hold section 4 (hereinafter referred to as relative position information) and drawing-pressure information corresponding to this. The obtained relative position information and drawing-pressure information are supplied to the drawing control means 11 as drawing data.

**[0036]** Now, the operation of the drawing apparatus constructed as mentioned above will be described with postal addressing as an example.

(1) The user selects address data sheets for postcards to be sent, from a bundle of address data sheets with addresses written thereon. The addresses may be written by hand or may be typed with a personal computer, a word processor or the like. Furthermore, the user rearranges the selected address data sheets in the order of making postcards earlier, places the rearranged address data sheets on the paper supply sheets 1, and instructs reading. In response to this instruction, the image read means 20 reads out the address data sheet conveyed by the feeder and outputs bitmap data.

(2) The character recognition means 21 performs pattern matching between a pattern cut in a character unit from the input bitmap data (e.g., a pattern consisting of various characters as shown in Figure 6) and a character recognition pattern stored in advance and outputs a character code corresponding to each recognition pattern. Note that if character recognition is performed in city, town, and name units, not in a character unit, when characters written on a manuscript are specified to some degree, as in an address, the recognition rate can be enhanced. In addition, city, town, and village names may be discriminated, by storing a table representing a corresponding relationship between a postal code number and a city or town name and by making reference to this table from the character recognition result of a numerical number having a high recognition rate.

(3) The layout information generation means 22 generates layout information, based on address layout information stored in advance and the character code obtained by the character recognition means 21. Here, the address layout information includes, for example, the position information of the address column on a postcard, and the size information of each character of city, town, and street names and a house number (both can be discriminated by a character code), the character allo-

cation information and the like in this column.

(4) The data synthesis means 24 reads out character data stored in the character data base 23, based on the character code for each character obtained by the character recognition means 21. For instance, when character code 002 is obtained, the data synthesis means 24 reads out the absolute position information of the reference points P1 to P9 of the strokes S1, S2 corresponding to the character code 002 and the corresponding drawing-pressure information, shown in Figure 3B. Furthermore, the data synthesis means 24 converts the absolute position information and the drawing-pressure information corresponding to this to the relative position information with respect to the paper 3 held by the paper hold means 3 and the drawing-pressure information corresponding to this, based on the layout information obtained by the layout information generation means 22. That is, character data is converted to drawing data.

(5) The drawing control means 11 converts the drawing data to drive data for driving the drawing drive means 14 and outputs the drive data.

(6) The X-axis direction, Y-axis direction, and Z-axis direction sliders 6 to 8 as the drawing drive means 14 slide according to the drive data. As a result, the relative positions of the writing implement 5 with respect to the postcard 3 vary and an address is drawn on the postcard 3 in characters like those written by a person with a writing implement.

**[0037]** Here, when a sender is simultaneously drawn on a sheet of paper, the following method, for example, is considered.

**[0038]** The user previously prepares a sender data sheet with only senders drawn thereon and an address data sheet with only addresses drawn thereon. The discrimination between the two data sheets by a person and the drawing apparatus can be performed by setting an identification mark in the head portion of each data sheet.

**[0039]** If the drawing apparatus identifies the sender data sheet from its identification mark, the drawing apparatus erases only a portion of memory corresponding to the sender portion and then stores sender-drawing data. If, on the other hand, the drawing apparatus identifies the address data sheet from its identification mark, the drawing apparatus erases only a portion of memory corresponding to the address portion and then stores address-drawing data and synthesizes the sender-drawing data previously stored and this address-drawing data, thereby generating synthesized drawing data. Using the obtained synthesized drawing data, drawing is performed on paper.

**[0040]** With this function, the user can save time for filling in sender columns with respect to all addresses.

**[0041]** In addition, it becomes possible to change a sender column with respect to the same address.

(Second Embodiment)

**[0042]** In the first embodiment, while character recognition has been performed in order to generate drawing data from a sheet, this process is not necessarily needed. A drawing apparatus according to a second embodiment without character recognition will hereinafter be described. Note that the exterior construction of the drawing apparatus according to the second embodiment is substantially the same as that shown in Figure 1.

**[0043]** Figure 5 schematically shows the drawing-data generation means 10a of the drawing apparatus according to the second embodiment. This drawing-data generation means 10a is constituted by image read means 30, stroke analysis means 31, drawing-pressure information extraction means 32, and data synthesis means 33.

**[0044]** The image read means 30 reads out, in a range of multiple gradation, an image on a manuscript conveyed from the paper supply section 1 toward the paper discharge section 2 by the feeder and outputs bitmap data. Note that in the second embodiment, an image on a manuscript needs to be drawn with a writing implement (e.g., a pencil, a fluorescent marker, etc.) whose drawing density varies according to drawing pressure, because drawing pressure is estimated from the drawing density.

**[0045]** The stroke analysis means 31 performs stroke analysis on the bitmap data obtained by the image read means 30 and outputs the pattern of each stroke and the relative position information of the reference points of the stroke (relative position information with respect to a manuscript) as stroke information.

**[0046]** The drawing-pressure information extraction means 32 converts the drawing density at the reference point of each stroke obtained by the image read means 30 and the stroke analysis means 31 to drawing-pressure information, by making reference to a table representing a relationship between drawing density and drawing pressure, stored in advance. Note that when, in 1 stroke, a turnover point, an intersection with another stroke and the like are extracted based on the pattern of each stroke obtained by the stroke analysis means 31, there is a need to estimate the drawing density of a stroke alone in view of the development of a brush and to convert the estimated drawing density to drawing-pressure information.

**[0047]** The data synthesis means 33 combines the relative position information of the reference points of each stroke obtained by the stroke analysis means 31 with the drawing-pressure information corresponding to the reference point, obtained by the stroke analysis means 31. The synthesized information is supplied to the drawing control means 11 as drawing data.

**[0048]** Now, the operation of the drawing apparatus constructed as mentioned above will be described with postal addressing as an example.

(1) The user selects address data sheets for postcards to be sent, from a bundle of address data sheets with addresses written thereon. The addresses may be written with a writing implement whose drawing density varies according to drawing pressure and may be typed by a personal computer or the like so that the drawing density varies according to drawing pressure. Furthermore, the user rearranges the selected address data sheets in the order of making postcards earlier, places the rearranged address data sheets on the paper supply sheets 1, and instructs reading. In response to this instruction, the image read means 30 reads, in a range of multiple gradation, the address data sheet shown in Figure 6, conveyed by the feeder and outputs bitmap data.

(2) The stroke analysis means 31 performs stroke analysis on the bitmap pattern obtained by the image read means 30 and outputs the pattern of each stroke and the relative position information of the reference points (e.g., the reference points P1 to P6 of a stroke in the left side piece of the Japanese character shown in Figure 3A) of each stroke.

(3) The drawing-pressure information extraction means 32 judges if there is a turnover point, an intersection with another stroke or the like in 1 stroke, from each pattern stroke obtained by the stroke analysis means 31. For example, the left side piece of the Japanese character shown in Figure 3A going to the swept-up portion has a turnover portion at point P4 and the third Japanese character as shown in the right side of a postcard illustrated in Figure 6 has an intersection at the upper right portion. When it is judged that there is no turnover point or the like, the drawing-pressure information extraction means 32 converts the drawing density obtained by the image read means 30 to drawing-pressure information, by making reference to the previously stored table representing a relationship between drawing density and drawing pressure. When, on the other hand, it is judged that there is a turnover or the like, the drawing-pressure information extraction means 32 estimates the density of the turnover point or the intersection from the peripheral drawing density of the turnover point or the intersection and converts the estimated density to drawing pressure.

(4) The data synthesis means 33 combines the relative position information of the reference points of each stroke obtained by the stroke analysis means 31 with the drawing-pressure information corresponding to the reference points, obtained by the drawing-pressure information extraction means 32 and outputs the combined information as drawing data.

(5) The drawing control means 11 converts the drawing data to drive data for driving the drawing drive means 14 and outputs the drive data.

(6) The X-axis direction, Y-axis direction, and Z-axis direction sliders 6 to 8 as the drawing drive means 14 slide according to the drive data. As a result, the relative positions of the writing implement 5 with respect to the postcard 3 vary and an address is drawn on the postcard 3 in characters like those written by a person with a writing implement.

**[0049]** Note that while in the above-mentioned description drawing pressure has been estimated from drawing density, drawing pressure may also be estimated from the drawing size that is produced by a writing implement whose drawing pressure is reflected in drawing size. In this case, the drawing-pressure information extraction means 32 in Figure 5 converts size information extracted from a distance between the center line and the outline of a stroke to drawing-pressure information, by making reference to a previously stored table representing a relationship between drawing size and drawing pressure. Note that as with the case of the drawing density, it is also desirable to take a turnover point, an intersection with another stroke and the like into consideration for the case of the drawing size. In addition, both drawing density and drawing size may be used in estimating drawing pressure.

(Third Embodiment)

**[0050]** In the second embodiment, although the table representing a corresponding relationship between drawing density (or drawing size) and drawing pressure has been employed in order to estimate drawing pressure at the reference point of each stroke, drawing pressure at the reference point of a representative stroke may be measured in advance and this pressure may be stored. A description will hereinafter be given of a drawing apparatus according to a third embodiment in which drawing pressure at the reference point of a representative stroke is measured and stored in advance. Note that the exterior construction of the drawing apparatus according to the third embodiment is substantially the same as the one shown in Figure 1.

**[0051]** Figure 7 schematically shows the drawing-data generation means 10b of the drawing apparatus according to the third embodiment. This drawing-data generation means 10b is constituted by image read means 40, stroke analysis means 41, reference-stroke storage means 42, stroke matching means 43, drawing-pressure information extraction means 44, and data synthesis means 45.

**[0052]** The image read means 40, as with the first embodiment, reads out an image on a manuscript conveyed from the paper supply section 1 toward the paper discharge section 2 by the feeder, and outputs bitmap data.

**[0053]** The stroke analysis means 41, as with the second embodiment, performs stroke analysis on the bitmap pattern obtained by the image read means 30

and outputs the pattern of each stroke and the relative position information of the reference points of the stroke.

**[0054]** The reference-stroke storage means 42 stores both the bitmap data of a representative stroke (hereinafter referred to as a reference stroke) and the corresponding code.

**[0055]** The stroke matching means 43 performs pattern matching between each stroke obtained by the stroke analysis means 41 and the reference stroke stored in the reference-stroke storage means 42 and outputs a corresponding code.

**[0056]** The drawing-pressure information extraction means 44 stores both a code corresponding to each stroke and drawing-pressure information of the reference points of the stroke.

**[0057]** The data synthesis means 45 combines the relative position information of the reference points of each stroke obtained by the stroke analysis means 41 with the drawing-pressure information read out from the drawing-pressure information extraction means 44 in accordance with the code obtained by the stroke match means 42 and supplies the combined information to the drawing control means 11 as drawing data.

(Fourth Embodiment)

**[0058]** Though the above-mentioned first through third embodiments perform drawing by supplying the drawing data generated by the drawing-data generation means 10c directly to the drawing control means 11, the generation of the drawing data may differ in place and timing from the drawing operation that employs the generated drawing data.

**[0059]** For instance, as shown in Figure 8, the drawing data generated by each drawing-data generation means 10 of the first through third embodiments may be coded by coding means 51 such as an encoder and the coded data may be output to a paper sheet at the code output means 52 as a bar code, a two-dimensional code or the like. Note that the coded data may be output directly to a paper sheet or may be output to a tacking sheet.

**[0060]** In this case, thereafter, as shown in Figure 9, the code (code information of drawing data) stored on a sheet is read out by code read means 16 (which performs reading optically or magnetically according to cord form) as needed, and the read code is decoded by decoding means 17. After the decoded drawing data has been temporarily stored in the drawing-data storage means 18, the data is supplied to drawing control means 11.

**[0061]** According to this construction, processing can be suitably performed as occasion demands. Thus, for example, the following method of usage becomes possible.

**[0062]** If a user sends a manuscript, written by hand or with a personal computer or a word processor, to a



predetermined center by mail, an operator will perform an operation of outputting a drawing code with a drawing-code output unit shown in Figure 8, equipped in the center. After this operation, a manuscript with codes stored on the reverse side is sent back from the center to the user. The user purchases only a drawing apparatus shown in Figure 9, then selects and rearranges necessary codes from the manuscript with codes stored thereon, along with characters recognizable by a person, and operates the drawing apparatus.

#### (Fifth Embodiment)

**[0063]** In the fourth embodiment, an image previously drawn on a sheet is employed as drawing data and therefore image read means is required for inputting the image. However, it is possible to use other input means in order to input the image.

**[0064]** For example, a pen-input digitizer (three-dimensional input is preferable) which is used as a pointing device can be used as a unit for handwritten input. When this digitizer is capable of detecting position information and drawing-pressure information that were input, the digitizer alone functions as the drawing-data generation means 10d (see Figure 10). Note that because of repetitive use of the database, characters recognizable by a person must be written on a manuscript along with codes, and it is therefore preferable that an image, input with a pen, can also be drawn on paper placed on the digitizer.

**[0065]** In addition, as shown in Figure 11, in the drawing-data generation means 10e, a two- or more-dimensional digitizer 60 of a pen input type may function as means for assisting image input means and character recognition. In this case, character recognition means 61 stores, for example, information such as the strokes of a Japanese character, the order of making strokes in a Japanese character, and the drawing speed. Note that layout information generation means 62, a character database 63, and data synthesis means 64 are substantially the same as those shown in the first embodiment.

**[0066]** As with the fourth embodiment, processing can be suitably performed even by a construction of using a tablet, as occasion demands. However, when reproduction of a user's handwriting is desired, it is preferable that the user go to a predetermined center to input an image with a pen-type digitizer equipped at the center.

**[0067]** According to the first through fifth embodiments, as described above, characters like those written by a person with a writing implement can be drawn. In addition, if a sheet with recognizable characters written thereon (in the fourth and fifth embodiments, a sheet with code information of drawing data stored therein along with recognizable characters) is used as a database, rearrangement, insertion, and sampling operations can be easily performed when the database is

repeatedly used. Therefore, the first through fifth embodiments are convenient to use in addressing mail from an office to customers.

**[0068]** In addition, according to the second and third embodiments, processing is speeded up compared with the first embodiment, because there is no need to perform character recognition. Moreover, in the second embodiment, memory capacity can be reduced, because memory for storing character data and drawing-pressure information is not needed.

**[0069]** Furthermore, according to the fourth or fifth embodiments, the operation from generation of drawing data to drawing can be divided into the operation of generating drawing data from a sheet and coding the drawing data and the operation of actually drawing an image based on the code. In this way, all that is required is to purchase only a unit for the latter operation and therefore a user's expense for purchasing the apparatus can be suppressed.

**[0070]** Although the apparatuses described in detail above have been found to be most satisfactory and preferred, many variations in structure are possible. Because many variations and different embodiments may be made within the scope of the inventive concept herein taught, it should be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.

#### Claims

##### 1. A drawing apparatus comprising

writing-implement hold means which holds a writing implement whose drawing density or drawing size varies according to drawing pressure and/or drawing speed,  
paper hold means which holds a sheet of paper,  
drawing drive means which moves in at least three directions to perform drawing by varying a relative positional relationship between the writing implement held by the writing-implement hold means and the paper held by the paper hold means,  
drawing control means which controls drive of the drawing drive means, and  
drawing-data generation means which generates drawing data, which is supplied to the drawing control means,

##### 2. A drawing apparatus as defined in claim 1 wherein the drawing-data generation means comprises

image read means which reads an image drawn on a sheet,  
character recognition means which performs character recognition on the image data obtained by the image read means,

a character database which stores a plurality of character data constituting the drawing data, layout information generation means which generates layout information from at least the result of character recognition, and data synthesis means which generates corresponding character data from the character database, based on the result of character recognition obtained by the character recognition means and also synthesizes drawing data, based on the layout information.

3. A drawing apparatus as defined in claim 1 wherein the drawing-data generation means comprises

image read means which reads an image drawn on a sheet,  
stroke analysis means which generates stroke information from the image data obtained by the image read means,  
drawing-pressure extraction means which extracts drawing-pressure information from at least either drawing information or drawing size of the image data and from the stroke information obtained by the stroke analysis means, and  
data synthesis means which synthesizes drawing data from the stroke information and the drawing-pressure information.

4. A drawing apparatus as defined in claim 1 wherein the drawing-data generation means comprises

image read means which reads an image drawn on a sheet,  
stroke analysis means which generates stroke information from the image data obtained by the image read means,  
reference-stroke storage means in which a plurality of reference strokes are stored,  
stroke matching means which matches the stroke information obtained by the stroke analysis means with the reference stroke information stored in the reference-stroke storage means,  
drawing-pressure information storage means in which a plurality of items of drawing-pressure information are stored in accordance with the plurality of reference strokes, and  
data synthesis means which reads out the drawing-pressure information corresponding to the reference stroke, obtained by the matching performed by the stroke matching means, from the drawing-pressure information storage means and combines the drawing-pressure information and each stroke information, thereby synthesizing drawing data.

5. A drawing-data output apparatus for outputting drawing data which is supplied to drawing control means which controls drive of drawing drive means which moves in at least three directions to perform drawing by varying a relative positional relationship between a writing implement whose printing density or printing size varies according to drawing pressure and/or drawing speed, held by writing-implement hold means, and paper held by paper hold means, the drawing-data output apparatus comprising

drawing-data generation means which generates the drawing data,  
coding means which codes the drawing data generated by the drawing-data generation means, and  
code output means which outputs the code obtained by the coding means.

6. A drawing-data output apparatus as defined in claim 5 wherein the drawing-data generation means comprises

image read means which reads an image drawn on a sheet,  
character recognition means which performs character recognition on the image data obtained by the image read means,  
a character database which stores a plurality of character data constituting the drawing data, layout information generation means which generates layout information from at least the result of character recognition, and  
data synthesis means which generates corresponding character data from the character database, based on the result of character recognition obtained by the character recognition means and also synthesizes drawing data, based on the layout information.

7. A drawing-data output apparatus as defined in claim 5 wherein the drawing-data generation means comprises

image read means which reads an image drawn on a sheet,  
stroke analysis means which generates stroke information from the image data obtained by the image read means,  
drawing-pressure extraction means which extracts drawing-pressure information from at least either drawing information or drawing size of the image data and from the stroke information obtained by the stroke analysis means, and  
data synthesis means which synthesizes drawing data from the stroke information and the

drawing-pressure information.

8. A drawing-data output apparatus as defined in claim 5 wherein the drawing-data generation means comprises

image read means which reads an image drawn on a sheet,  
stroke analysis means which generates stroke intonation from the image data obtained by the image read means,  
reference-stroke storage means in which a plurality of reference strokes are stored,  
stroke matching means which matches the stroke intonation obtained by the stroke analysis means with the reference stroke intonation stored in the reference-stroke storage means,  
drawing-pressure information storage means in which a plurality of items of drawing-pressure intonation are stored in accordance with the plurality of reference strokes, and  
data synthesis means which reads the drawing-pressure intonation corresponding to the reference stroke, obtained by the matching performed by the stroke matching means, from the drawing-pressure information storage means and combines the drawing-pressure information and each stroke information, thereby synthesizing drawing data.

9. A drawing-data output apparatus as defined in claim 5 wherein the drawing-data generation means is a multidimensional digitizer which inputs data equivalent to drawing data.

10. A drawing-data output apparatus as defined in claim 9 wherein the drawing-data generation means comprises

character recognition means which performs character recognition, based on the data input by the multidimensional digitizer,  
a character database which stores a plurality of character data constituting the drawing data,  
layout information generation means which generates layout information from at least the result of character recognition, and  
data synthesis means which generates corresponding character data from the character database, based on the result of character recognition obtained by the character recognition means and also synthesizes drawing data, based on the layout information.

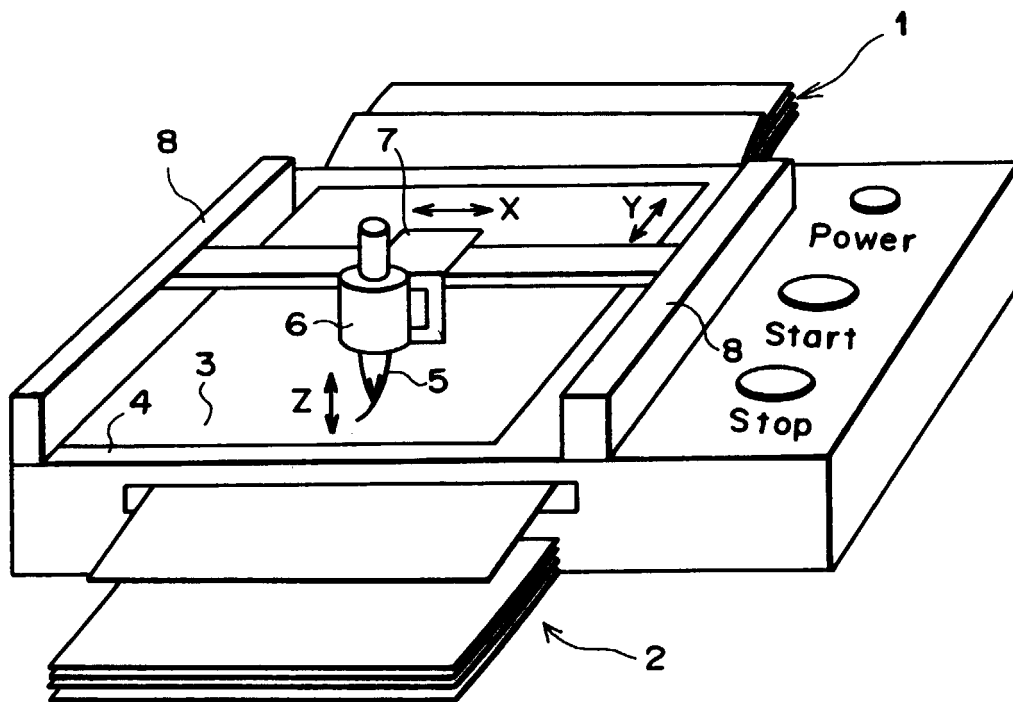
11. A drawing apparatus comprising

writing-implement hold means which holds a writing implement whose drawing density or

drawing size varies according to drawing pressure and/or drawing speed,  
paper hold means which holds a sheet of paper,  
drawing drive means which moves in at least three directions to perform drawing by varying a relative positional relationship between the writing implement held by the writing-implement hold means and the paper held by the paper hold means,  
drawing control means which controls drive of the drawing drive means,  
code read means which reads a code from a sheet in which drawing data to be supplied to the drawing control means along with image or character information recognizable by a person is coded and stored,  
decoding means which decodes the read code, and  
drawing-data storage means which stores the drawing data obtained by the decoding means.

12. A drawing-data output apparatus as defined in claim 11, further comprising second drawing-data storage means which stores drawing data, wherein the second drawing-data storage means is writable after being partially erased, when drawing data obtained from a newly read sheet is written.

13. A drawing-data output apparatus as defined in claim 11 wherein the drawing-data storage means is writable after being partially erased, when drawing data obtained from a newly read sheet is written.



F I G . 1

FIG. 2A

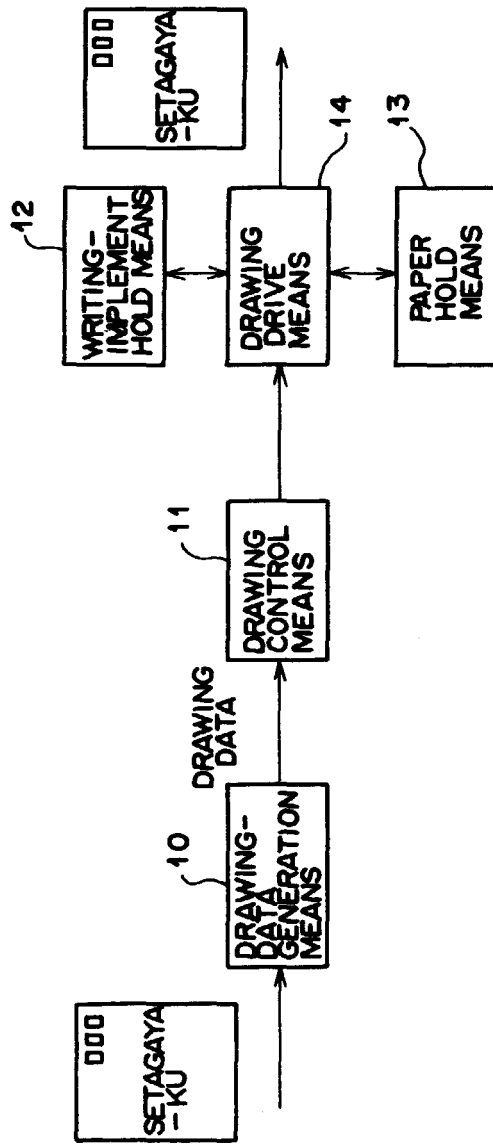
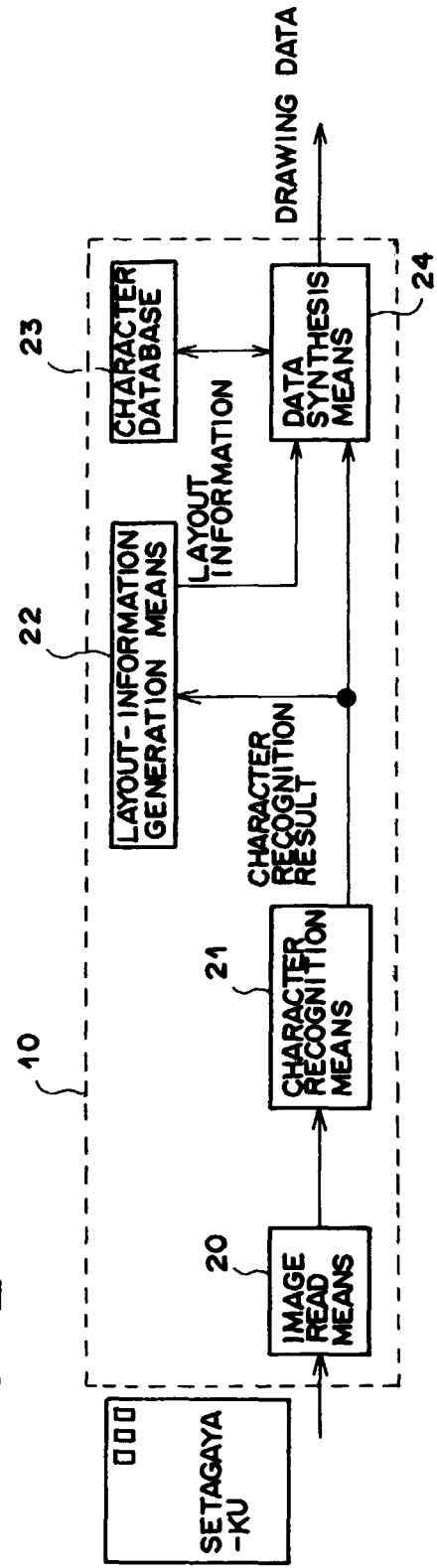
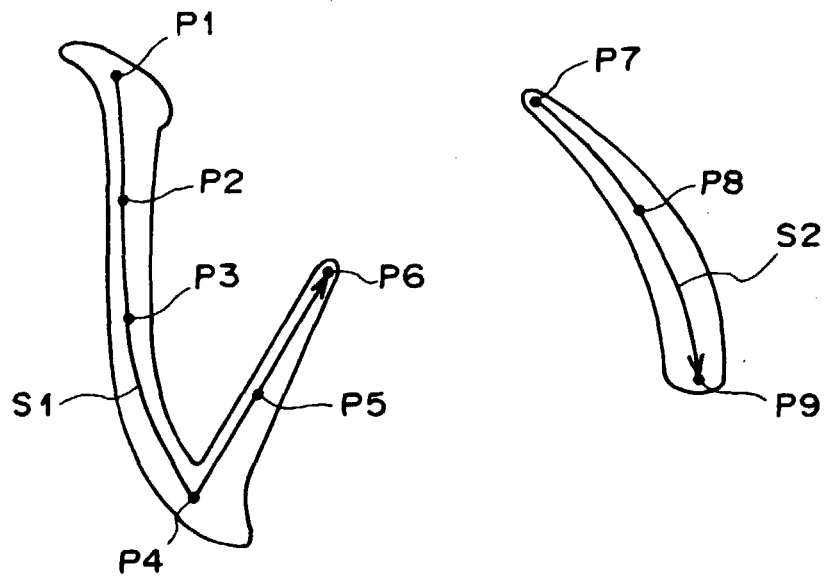


FIG. 2B

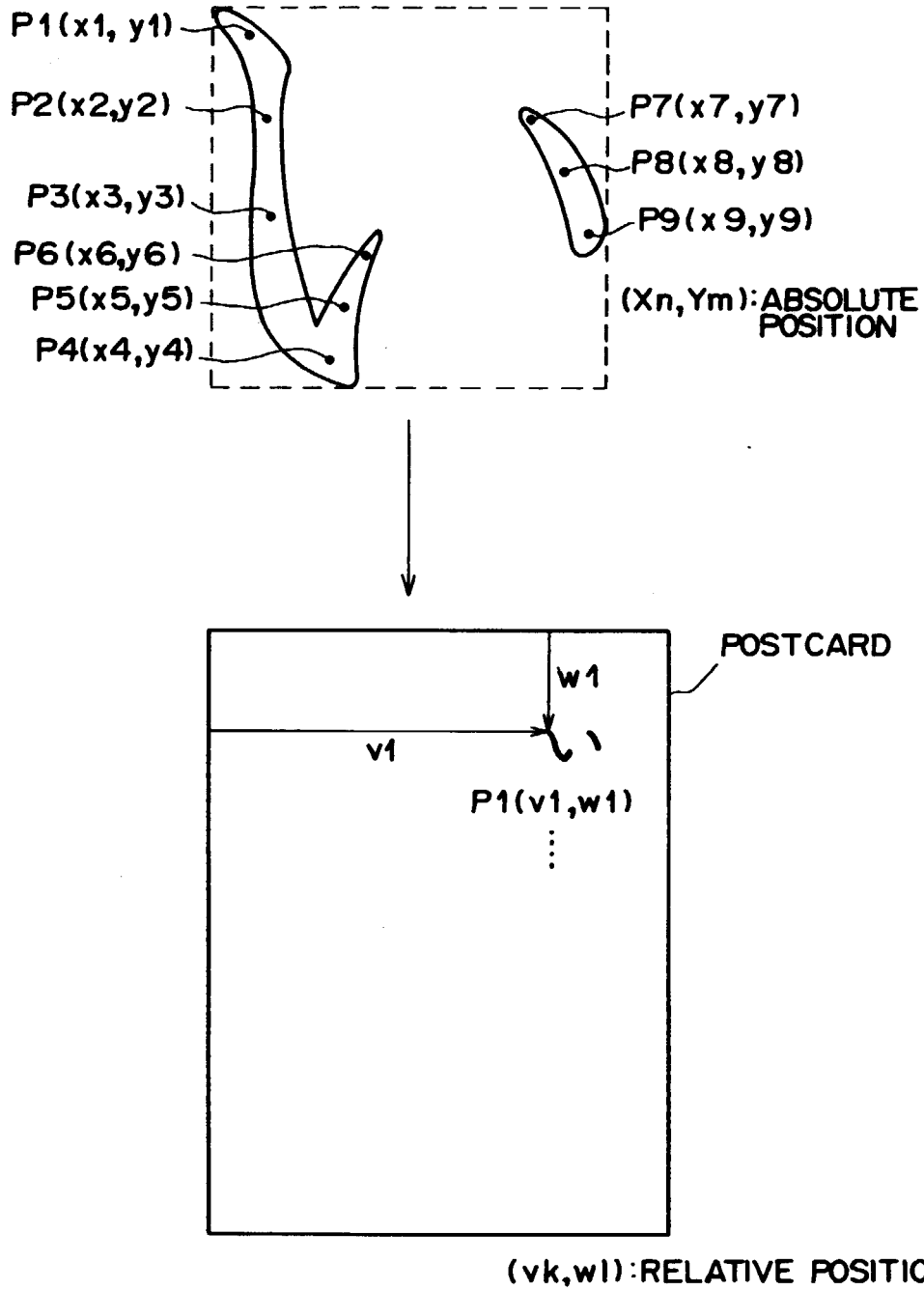


## F I G. 3A

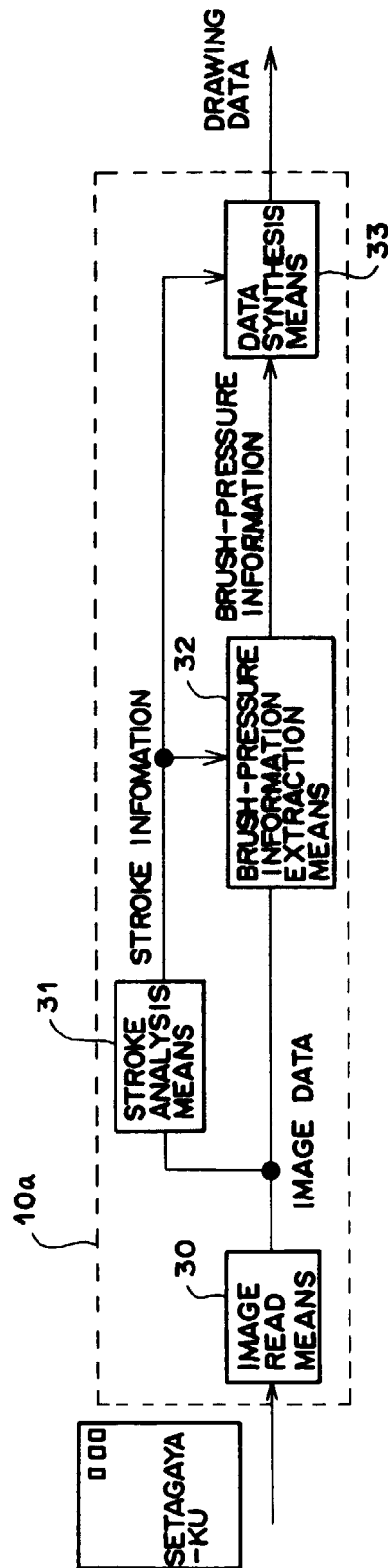


## F I G. 3B

CHARACTER CODE	STROKE	REFERENCE POINT	CHARACTER DATA		
			X	Y	BRUSH PRESSURE(Z)
002	S1	P1	$x_1$	$y_1$	$z_1$
		P2	$x_2$	$y_2$	$z_2$
		P3	$x_3$	$y_3$	$z_3$
		P4	$x_4$	$y_4$	$z_4$
		P5	$x_5$	$y_5$	$z_5$
		P6	$x_6$	$y_6$	$z_6$
	S2	P7	$x_7$	$y_7$	$z_7$
		P8	$x_8$	$y_8$	$z_8$
		P9	$x_9$	$y_9$	$z_9$

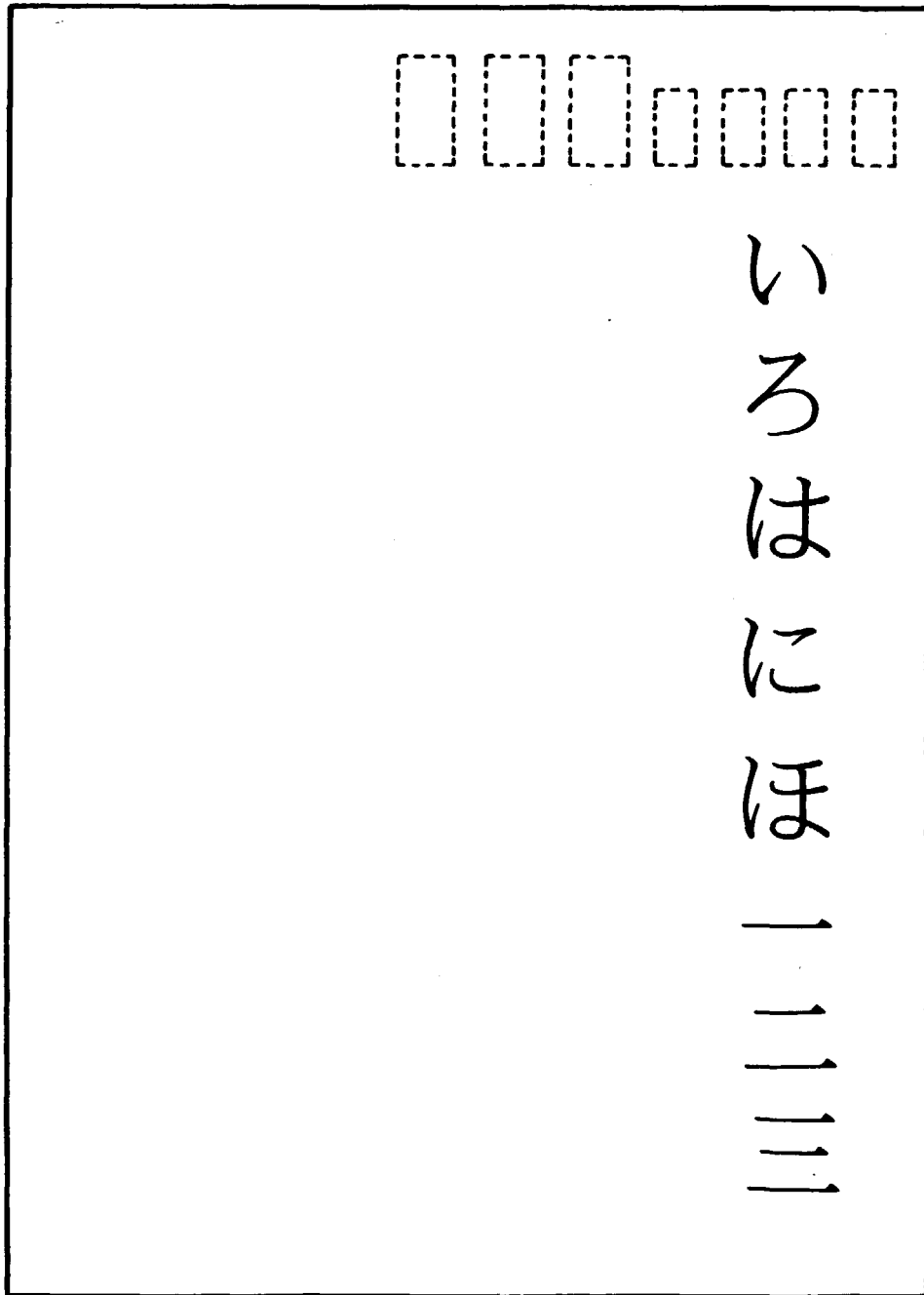


**F I G . 4**



F I G . 5





F I G . 6

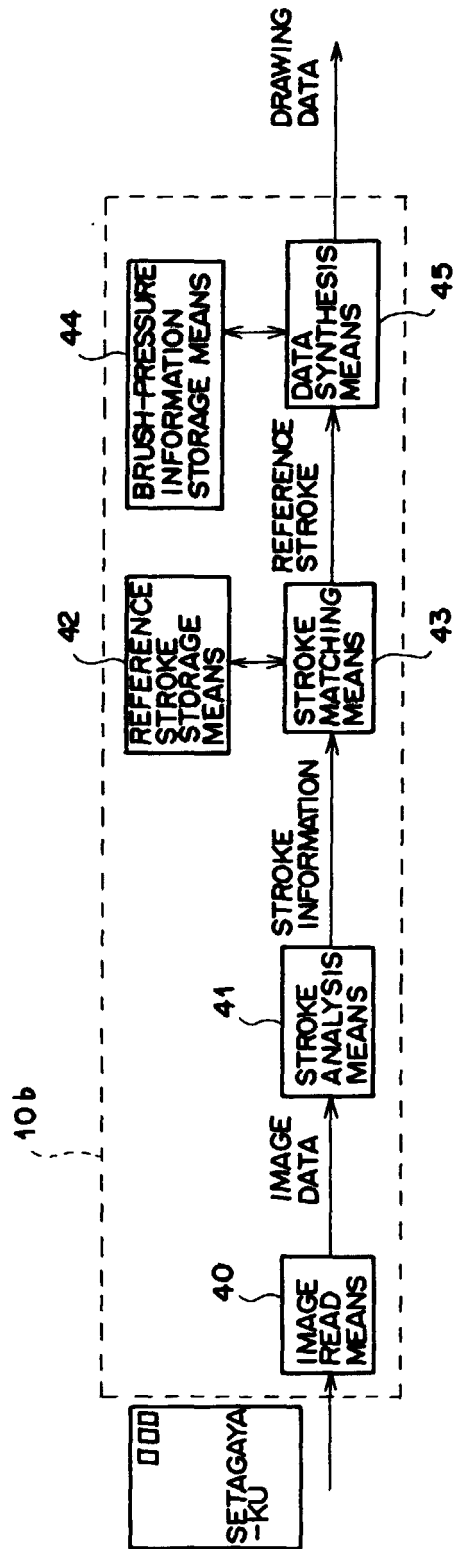


FIG. 7

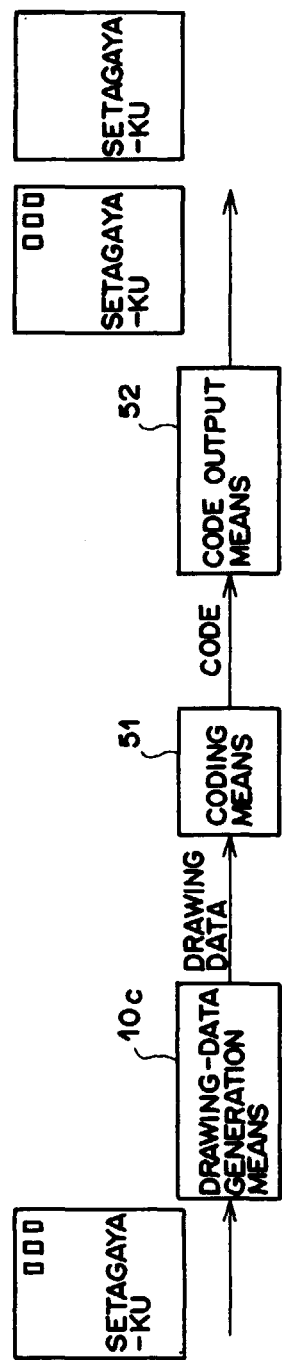


FIG. 8

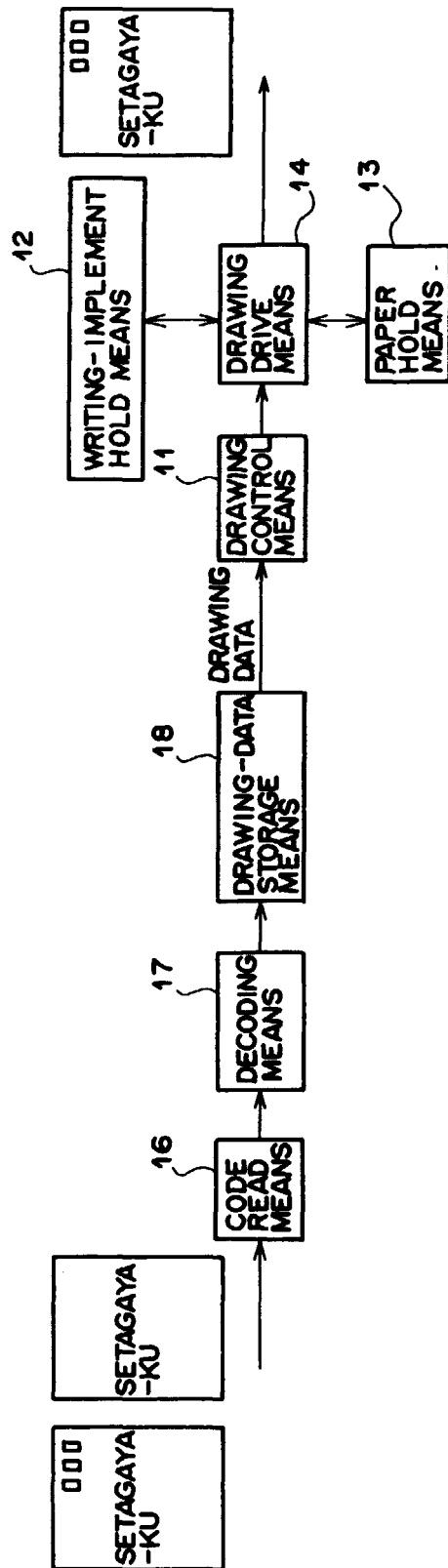
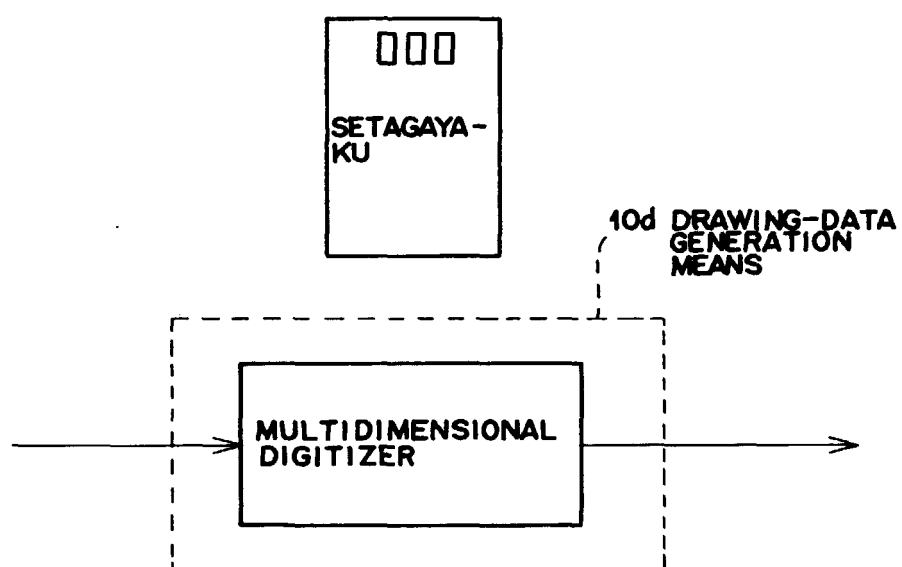
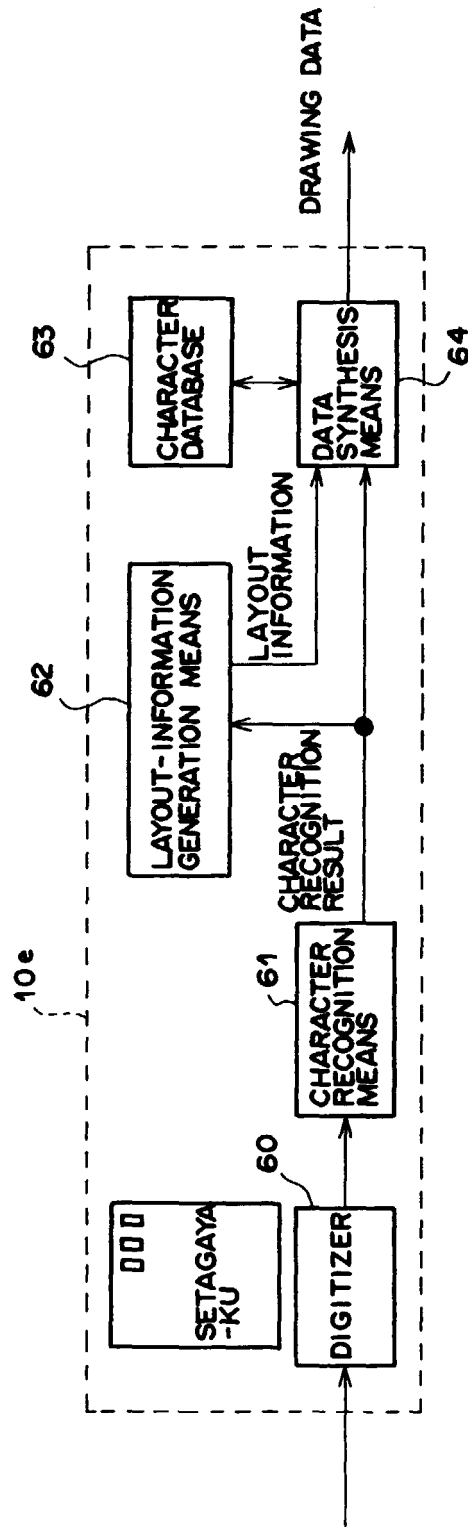


FIG. 9



F I G . 10



F I G . 11