

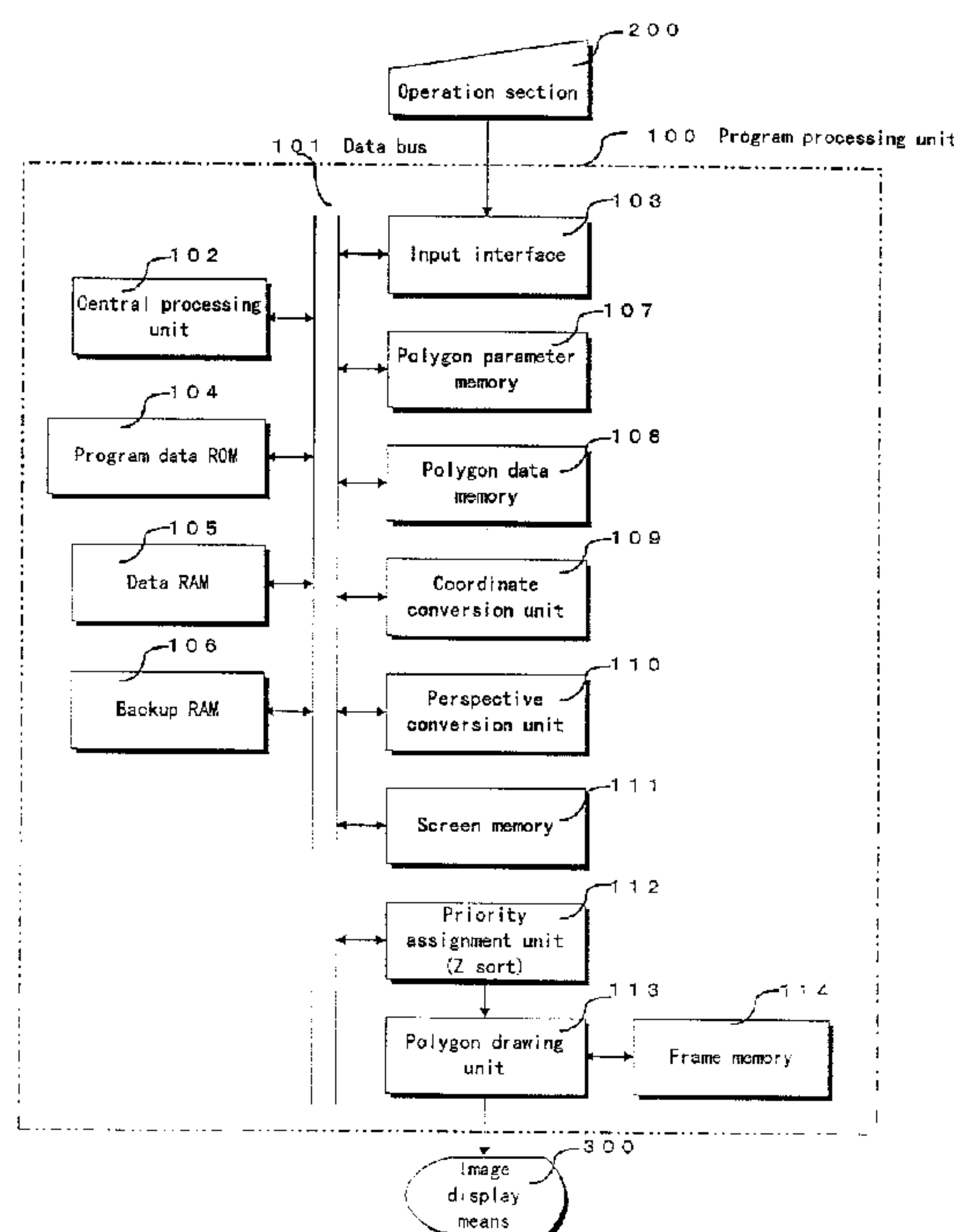


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(54) Titre : PROCEDE DE TRAITEMENT DE L'IMAGE, PROCESSEUR D'IMAGES ET DISPOSITIF A PSEUDO-EXPERIENCES

(54) Title: IMAGE PROCESSING METHOD, IMAGE PROCESSOR, AND PSEUDO-EXPERIENCE DEVICE



(57) Abrégé/Abstract:

A system according to this invention comprises an image display means 300, a central processing unit 102, memories 103 - 108, a program processing section 100 which executes a game program which moves a moving object in a virtual three-dimensional space in which three-dimensional objects are arranged, and an operation section 200 which accepts speed data about the moving objects in the virtual three-dimensional space and outputs the data to the program processing unit. The operation section 200 outputs moving-object speed data to a perspective conversion unit 110. The perspective conversion unit 110 varies the distance between a viewpoint and a projection screen according to the relative speed of the moving object. As the effective visual area on the projection screen decreases, the range of the virtual three-dimensional space displayed in the effective visual area increases. This makes the field view angle of the projection screen variable according to the speed of the moving object.



ABSTRACT

A system according to this invention comprises an image display means 300, a central processing unit 102, memories 103 - 108, a program processing section 100 which executes a game program which moves a moving object in a virtual three-dimensional space in which three-dimensional objects are arranged, and an operation section 200 which accepts speed data about the moving objects in the virtual three-dimensional space and outputs the data to the program processing unit. The operation section 200 outputs moving-object speed data to a perspective conversion unit 110. The perspective conversion unit 110 varies the distance between a viewpoint and a projection screen according to the relative speed of the moving object. As the effective visual area on the projection screen decreases, the range of the virtual three-dimensional space displayed in the effective visual area increases. This makes the field view angle of the projection screen variable according to the speed of the moving object.

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IMAGE PROCESSING METHOD, IMAGE PROCESSOR, AND
PSEUDO-EXPERIENCE DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an image processing method and an image processing system which project computer-controlled images on image display means and to an experience simulation system which uses the method and the system.

2. Description of the Prior Art

Simulation systems such as computer-controlled video game systems and experience-simulation systems have been used. In particular, experience-simulation systems for controlling an object such as a car or an airplane to move in the three dimensional space for competing for scores and times or experiencing unusual experiences such as motorcycles games, driving games, and flight simulation games are popular. This type of experience simulation system has a program processing unit which processes programs and data, an image display means such as a CRT or liquid crystal display screen on which computer-generated video is projected, and an operation section which allows the player to control the program processing unit. There are many types of operation unit. That is, not only a control panel on which buttons and levers are provided but also models of vehicles, such as the body of a motorcycle or the cockpit of a racing car or an airplane, are used depending upon the type or operation of the game.

Video images are displayed on the image display means of the experience simulation system. For example, in a driving game, a plurality of previously-stored, three-dimensional objects are arranged in a virtual three-dimensional space called a game field. Fig. 5 is an example of a game field where three-dimensional objects are arranged. Along the driving course are arranged three-dimensional objects such as

the building 500, trees 501, guardrail 502, and vehicle 503.

The experience simulation system displays the three-dimensional objects on the image display means as follows: that is, it provides a view of the virtual three-dimensional space containing the three-dimensional objects from a given viewpoint, projects image information about each object represented as perspective coordinates onto the projection screen some distance away from the viewpoint, and draws the two-dimensional projection images on the projection screen in the image display means. For example, as shown in Fig. 6, the system provides a view of the object 301 arranged in the three-dimensional space from the viewpoint 0 and projects it onto the projection screen 300 that is "h" away from the viewpoint 0 in the form of two-dimensional projection image 302. In this case, the system divides the three-dimensional object 301 into a plurality of polygons and, based on the coordinates (X,Y,Z) of the vertexes of each polygon, calculates the coordinates (XS,YS) of each vertex of the image to be displayed on the projection screen, using the formula (1).

[Formula 1]

$$XS = (X/Z) \times h$$

$$YS = (Y/Z) \times h \dots (1)$$

The player controls the operation section of the experience simulation system to drive a motorcycle or a racing car or to pilot an airplane to participate in a race or a combat, and competes for times and scores. In this case, as the moving object moves around in the virtual three-dimensional space, the position of the viewpoint 0, which is relatively associated with the moving object, also moves. That is, as the distance between the viewpoint 0 and each object 301 changes, the shape of the two-dimensional projection image 302 displayed on the image display means 300 also changes, giving the player an illusion that the object moves in the three-dimensional space.

However, in the traditional experience simulation system, the distance H1 from the viewpoint 0 to the

projection screen Z1 with the view field angle of α is fixed, as shown in Fig. 7. Because of this, the speed of a moving object is directly reflected on the screen; it can be neither increased nor decreased. A speed higher or lower than that of the moving object, if projected on the screen, would give the player a more realistic feeling. However, such a technology has not been introduced.

In addition, in a system where this type of perspective conversion technology is used, moving an object as well as the viewpoint at a high speed reduces the effective visual area on the projection screen, makes three-dimensional objects difficult to recognize in the three-dimensional space, and decreases the reality of the image produced by the experience simulation system.

It is difficult for the human eye to recognize moving objects which travel faster than a given speed. This also applies when a three-dimensional object is projected on the projection screen. And, the faster a three-dimensional object moves within a unit time (T), the more difficult it becomes to recognize the object. In Fig. 7, assume that the two objects, the object P and the object R which is more distant from the viewpoint along the z axis but which has the same coordinates X and Y as those of P, have moved toward the viewpoint O for a distance of M and that they have reached P and Q respectively. The new positions of the points on the projection screen Z1 are P1, Q1, and R1, and the movement distances of objects P and R are DP1 and DR1. As shown in this figure, although the two objects have moved toward the viewpoint by the same distance along the z axis, the movement distance of the object closer to the viewpoint is greater than that of the object more distant from the viewpoint. And, the object closer to the projection screen is projected in a location closer to the edge of the projection screen.

This indicates that, even when the amount of movement (M) toward the viewpoint within a specified time (T) (speed of movement toward the viewpoint) is the same, the movement distance on the projection screen (DP1) within the same time

(T) of an object located closer to the viewpoint and projected closer to the edge of the projection screen is increased. This makes it more difficult for humans to recognize a moving object located closer to the edge of the screen. Conversely, the movement distance on the projection screen (DR1) of an object located further away from the viewpoint and projected smaller on the projection screen is smaller in relation to the amount of movement (M). This makes it less difficult for humans to recognize a moving object even when the object moves faster in relation to the viewpoint and the object moves faster over the distance M. As a result, faster movement of an object reduces the effective visual area on the projection screen.

This fact is evidenced by a phenomenon, called constriction of a view field (an effective-visual area reduction), we usually experience while driving a car. When we are driving a car at a high speed, the effective visual area is reduced. As a result, we find it difficult to recognize objects closer to our viewpoint but find it less difficult to recognize distant objects. But, in fact, when we are driving a car, we look not only at the objects right in front but those surrounding them. This compensates for the reduction in the effective visual area, allowing us to view a broad landscape.

In an experience simulation system, the viewpoint is always associated with a moving object and the projected direction always tracks an object that is moving. Thus, the image processing method used in the traditional experience simulation system reduces the visual area as the speed of a moving object increases, because it does not allow the player to look at anything surrounding the moving object. It permits the player to recognize only objects in the center of the image display means and therefore degrades the reality of the game when the moving object is moving at high speed.

This invention seeks to solve the problems associated with the prior art described above. It is an object of this invention to provide an experience simulation system which

makes a player experience an object moving faster or slower than it actually does at virtual speed. It is another object of this invention to provide an experience simulation system which does not reduce the effective visual area on the projection screen even when a moving object moves fast, as well as an image processing method and an image processing system for use with the above-mentioned experience simulation system and other types of image display systems.

SUMMARY OF THE INVENTION

To achieve the above object, an image processing method according to this invention is an image processing method which comprises: providing a virtual three-dimensional space containing three-dimensional objects, providing a virtual viewpoint relatively associated with a virtual moving object moving in the virtual three-dimensional space, providing a virtual projection screen on which the objects in the virtual space viewed from the viewpoint are projected, and displaying the two-dimensional projection image of the three-dimensional objects, projected on the projection screen, onto image display means, in which the relative distance between the viewpoint and the projection screen varies according to the velocity of the virtual moving object.

And, the image processing method comprises: providing a virtual three-dimensional space containing three-dimensional objects, providing a virtual viewpoint relatively associated with a virtual moving object moving in the virtual three-dimensional space, providing a virtual projection screen on which the objects in the virtual space viewed from the viewpoint are projected, and displaying the two-dimensional projection image of the three-dimensional objects, projected on the projection screen, onto image display means, in which the view field angle of the viewpoint to the projection screen, viewed from the viewpoint, varies according to the velocity of the virtual moving object and in which the two-dimensional projection image on the projection screen is displayed in a fixed-sized display area on the image display means.

The method according to this invention with the above configuration produces the following effects:

(1) The view field angle of the viewpoint to the projection screen may be changed according to the speed of a moving object. For example, when the moving object moves faster, the visual angle to the projection screen is increased, permitting a larger range of the three-dimensional space to be projected in the same area on the projection screen. As a result, even if the view field is constricted as the moving object speeds up, the view field angle is increased and, therefore, a larger range of the three-dimensional space is projected in the same area on the projection screen. This eliminates an extreme reduction in perceptibility of the object that is displayed even as the moving object moves faster.

(2) A larger view field angle results in a smaller projection image on the projection screen or on the display means. This reduces the relative distance moved by a moving object on the projection screen or on the display means as the moving object approaches another object. As a result, a moving object that moves too fast to be recognized on a projection screen which has a smaller view field angle and on which the relative distance moved is large can be recognized.

(3) A larger view field angle for the projection screen makes an object look smaller on the projection screen or on the image display means, making the player feel that the object is in the distance. Actually, however, because the distance between the viewed object and the viewpoint is the same and the velocity of the moving object is constant, the time required for the moving object to reach the viewed object remains unchanged. This makes the player feel as if the distant object was approaching the moving object in less time at a faster rate.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the preferred embodiment of an experience simulation system according to

this invention.

Fig. 2 is a schematic side view of the embodiment in Fig. 1, illustrating the relationship among the viewpoint, projection screen, and the object.

Fig. 3 is a diagram showing some examples of images projected on the image display means on a video game system according to this invention. (A) is a diagram showing an image projected when a moving object travels slowly. (B) is a diagram showing an image projected when the moving object travels rapidly.

Fig. 4 is a schematic side view of another embodiment according to this invention, illustrating the relationship among the viewpoint, projection screen, and the object.

Fig. 5 is a perspective view showing the virtual three-dimensional space of the experience simulation system and an example of the objects contained in the system.

Fig. 6 is a perspective view showing the principle of the perspective conversion unit used in the experience simulation system.

Fig. 7 is a schematic side view showing the relationship among the viewpoint, image display means, and the object.

DETAILED DESCRIPTION

The attached drawings show a preferred embodiment of the present invention.

(1) Configuration of the embodiment

Referring to Fig. 1, there is shown an embodiment in which the present invention is used in a video game system.

The experience simulation system in this embodiment comprises the program processing section 100 which includes a computer, operation section 200 which is an input means for the program processing section 100, and image display means 300, such as a CRT, on which output images from the program processing section 100 are displayed.

A unit used for the operation section 200 varies according to the game system. In a home video game system, it is a small control panel such as a control pad or a

keyboard; in a game system in a penny arcade, it is a control panel modeled after that in a vehicle used in the game in order to provide a more realistic experience. For example, in a motorcycle game, controls usually provided on a handlebar, such as an accelerator grip and a brake lever, as well as an angle meter are used. In a driving game system, a steering wheel, brake pedal, gear shift, etc., are used. In a flight simulation system, a control stick and a launch switch modeled after those in a cockpit are used. A game player operates the operation section 200 to output to the program processing section 100 the signals necessary for game program execution. Those signals are required to start or end the game, select the contents of the game, and control the direction, speed, and acceleration of the moving object.

The program processing section 100 comprises the central processing unit 102 connected to the data bus 101, the input interface 103 connecting the operation section 200 to the data bus 101, and various memory sections and processing units controlled by the central processing unit 102 via the data bus 101. That is, the system has the program data ROM 104, data RAM 105, and backup RAM 106 that are used by the central processing unit 102 to execute the game program. The program data ROM 104 contains the game program, while the data RAM 105 contains data that is read or written during the execution of the game program. The backup RAM 106 contains data such as program setup data and other information.

Meanwhile, the polygon parameter memory 107 and the polygon data memory 108 are provided to arrange the objects in the virtual three-dimensional space and to represent each object as a polygon. The polygon parameter memory 107 contains the parameters specifying the points in the absolute coordinate system for each object in the virtual three-dimensional space, information on the moving object location sent from the central processing unit 102, information on the viewpoint location, and associated coordinate conversion formulas. The polygon data memory 108 contains polygon data on each object. Each polygon data item is composed of the

vertex locations of the polygon and its associated data. The coordinate conversion unit 109 converts the coordinates of the vertexes of each polygon in the three-dimensional space into the viewpoint coordinates (viewpoint-based coordinate system) according to the parameters stored in the parameter memory.

The perspective conversion unit 110 converts polygon data, already converted to the viewpoint coordinates by the coordinate conversion unit 109, into the two-dimensional coordinates on the projection screen some distance away from the view point. This perspective conversion unit 110 uses the following formulas to convert the viewpoint coordinates (X,Y,Z) of each polygon in the three-dimensional space into the coordinates of the vertexes (XS,YS) of the graphic displayed on the projection screen.

[Formula 2]

$$XS = (X/Z) \times h$$

$$YS = (Y/Z) \times h$$

$$h = H - S/d \dots (2)$$

In the above formula, S is the velocity of the moving object entered from the operation section 200, that is, the speed at which the three-dimensional object moves relative to the viewpoint 0 in the viewpoint coordinate system. h is the distance between the viewpoint 0 and the projection screen, H is the base distance between the viewpoint 0 and the projection screen, and d is the change ratio of the focal distance h to the velocity S.

The screen memory 111 contains two-dimensional projection data, coordinates (XS,YS), about each polygon output by the perspective conversion unit 110. The priority assignment unit 112 checks the Z values of a plurality of polygons stored in the screen memory, and sorts the polygons into the ascending order of Z values; that is, the closer to the viewpoint, the higher the priority. Usually, this is called Z sorting. The polygon drawing unit 113 writes the polygons into the frame memory 114 in the order in which they are Z-sorted. Then, the polygon drawing unit 113 reads the

polygons from the frame memory 114 and outputs them to the image display means 300. The frame memory 114 contains image data, one screenful of data at a time, which is output to the image display means 300 when the image display means 300 draws a polygon.

(2) Operation of the embodiment

The embodiment with the above described configuration operates as follows:

When a player turns the steering wheel or steps on the accelerator, control data entered from the operation section 200 is output to the central processing unit 102 via the input interface 103 and the data bus 101. The central processing unit 102 executes the game program stored in the program data ROM 104 based on data from the data RAM 105 and the backup RAM 106. That is, the central processing unit 102 creates a virtual three-dimensional space based on control data from the operation section 200, reads the game program, and reads parameters from the polygon parameter memory 107. The central processing unit 102 then fetches polygon data from the polygon data memory 108, processes (magnifies, rotates, or moves) it in the virtual three-dimensional space to arrange each object in the three-dimensional space. As the game program proceeds, the central processing unit 102 also stores the parameters, such as moving object positions, viewpoint position, and associated coordinate conversion formulas, in the polygon parameter memory 107. In this case, the position of a moving object moving in the virtual three-dimensional space and polygon data about each object are represented using the absolute coordinate system with a particular point in the virtual three-dimensional space as its origin.

The coordinate conversion unit 109 reads polygon data about each three-dimensional object from the polygon data memory 108 and reads data about the position of a moving object and the viewpoint as well as the associated coordinate formulas from the polygon parameter memory 107. The coordinate conversion unit 109 then converts polygon

coordinate data from the absolute coordinate system in the virtual three-dimensional space into the viewpoint coordinate system, based on the viewpoint which is fixed relative to the moving object.

The perspective conversion unit 110 projects polygon coordinate data, represented in the viewpoint coordinate system, onto the projection screen some distance away from the viewpoint. In this embodiment, the distance h from the projection screen to the viewpoint 0 is determined using the formulas (2) with the speed of the moving object entered from the operation section 200 as the parameter. More specifically, when the player operates the game machine, for example, by applying the accelerator, the speed data S about the moving object is output from the operation section 200 to the perspective conversion unit 110. The base distance H and the change ratio d of the distance h to the velocity, which are determined by the program stored in the program data ROM 104.

The perspective conversion unit 110 generates two-dimensional data for each polygon on the projection screen as described above and stores it in the screen memory 111. Then, the priority assignment unit 112 references polygon data stored in the screen memory 111 to check the Z value, and performs Z sorting on polygon data to arrange a plurality of polygon data items in ascending order with respect to the viewpoint 0. The polygon drawing unit 113 writes Z -sorted polygon data into the frame memory 114 in the priority order. The frame memory 114 contains image data, one screenful of data for the image display means 300 at a time, and outputs it as the image display means 300 displays it.

(3) Effects of the embodiment

When an object moves fast, as shown in Fig. 2, the experience simulation system with the above configuration projects the object in the virtual three-dimensional space onto the projection screen Z_2 which is set closer to the viewpoint than the projection screen Z_1 onto which the system projects when an object moves slowly. In Fig. 2,

assume that the two objects, the object P and the object R which is more distant from the viewpoint along the z axis but which has the same coordinates X and Y as those of P, have moved toward the viewpoint O by the distance of M and that they have reached P and Q respectively. The new positions of the points on the projection screen Z2 are P2, Q2, and R2, and the movement distances of the objects P and R are DP2 and DR2. Comparing the movement distances DP2 and DR2 on the projection screen Z2 which is closer to the viewpoint with the movement distances DP1 and DR1 on the projection screen Z1 which is more distant from the viewpoint shows that the movement distances DP2 and DR2 are smaller than DP1 and DR1. This means that, even in a situation where an object moves too fast for the player to recognize the movement distance DP1 on the projection screen Z1, the player can recognize the movement distance on the projection screen Z2 because the distance is short.

That is, the shorter the distance to the projection screen and the smaller the object on the projection screen, the smaller the movement per unit time. This enables our eyes to recognize a larger movement distance on the projection screen per unit time. This means that, when the projection screen is distant from the view point, an object that moves a large distance per unit time (high velocity) and an object out of the effective visual area can move into the effective visual area when the projection screen is closer to the viewpoint. Although the ineffective visual area is enlarged as the projection screen is moved closer to the viewpoint, the player can recognize an object that moves a longer distance in the three-dimensional space.

In the meanwhile, changing the projection screen from Z1 to Z2 changes the points P1, Q1, and R1 to P2, Q2, and R2 respectively, as shown in Fig. 2, while the distance between the viewpoint and the object P remains the same. As a result, the range of the virtual three-dimensional space projected on the projection screen Z2 is enlarged, but each object in the space becomes smaller when projected. This

makes the effective visual area on the projection screen Z2 smaller than that on the projection screen Z1. That is, the surrounding image becomes more difficult to recognize on the projection screen Z2 and, therefore, the surrounding landscape is displayed as if it were flowing, making the player feel that the object is moving faster. Thus, although this embodiment makes the effective visual area smaller and makes the player feel that the object is moving faster, it projects a larger three-dimensional virtual space in a smaller effective visual area. This makes the player feel that the object is moving faster by a constriction of a visual field and makes the game more realistic.

In this embodiment, because the visual angle 'a' to the projection screen is large, a larger part of the object 301 is displayed on the projection screen (B) which has a larger visual angle than on the projection screen (A) which has a smaller visual angle, as shown in Fig. 3. In addition, even if the distance between the viewpoint and the object 301 remain the same, a larger visual angle 'a' makes the object 301 look smaller on the projection screen (B) which has a larger visual angle than on the projection screen (A) which has a smaller visual angle. This makes the player feel as if the object is farther away. However, because it takes less time for a fast-moving object to reach the object 301, the player feels as if the moving object is approaching the distant object more rapidly. This change in the visual angle occurs while the moving object is moving in the three-dimensional space. Therefore, the player cannot distinguish between a change in the image that occurs when the moving object is approaching another object and a change in the image that is caused by the visual angle, thus making the player experience the speed increase more naturally.

(4) Other embodiments

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The invention includes an embodiment, such as the one shown in Fig. 4, in which the

distance between the viewpoint 0 and the projection screen Z is constant and the visual angle of the projection screen variable. In Fig. 4, when a moving object moves slowly, a virtual three-dimensional space is projected on the projection screen Za, which has a small visual angle. It is then displayed on the image display means 300. When a moving object moves fast, a virtual three-dimensional space is projected on a projection screen Zb which is located in the same position as the projection screen Za but has a larger visual angle 'b'. The projected image data is then reduced and is drawn within the same display area on the image display means 300 as that used for a slow moving object. As the moving object moves faster, this method makes the range of the virtual three-dimensional space displayed on the image display means larger and the projected image of each object in the virtual three-dimensional space smaller, giving the same effect as when the distance from the viewpoint to the projection screen is changed.

INDUSTRIAL APPLICABILITY

As described above, this invention uses the speed of an image of a moving object to control the visual angle of the projection screen, making the player feel that the object is moving faster or more slowly than it actually does at the virtual speed and thus making the game more realistic.

WHAT IS CLAIMED IS:

1. An image processing method, comprising:

providing a virtual three-dimensional space containing three-dimensional objects, providing a virtual viewpoint relatively associated with a virtual moving object moving in said virtual three-dimensional space, providing a virtual projection screen on which the three-dimensional objects in said virtual three-dimensional space viewed from said virtual viewpoint are projected, and displaying a two-dimensional projection image of said three-dimensional objects, projected on said virtual projection screen, onto an image display means, in which a relative distance between said virtual viewpoint and said virtual projection screen varies according to the velocity of said virtual moving object.

2. An image processing method, comprising:

providing a virtual three-dimensional space containing three-dimensional objects, providing a virtual viewpoint relatively associated with a virtual moving object moving in said virtual three-dimensional space, providing a virtual projection screen on which the three-dimensional objects in said virtual three-dimensional space viewed from said virtual viewpoint are projected, and displaying a two-dimensional projection image of said three-dimensional objects, projected on said virtual projection screen, onto an image display means, in which a view field angle of said virtual viewpoint to the virtual projection screen varies according to the velocity of said virtual moving object and in which the two-dimensional projection image on the virtual projection screen is displayed in a fixed-sized display area on the image display means.

3. The image processing method as claimed in claim 1 or 2, wherein each of said three-dimensional objects is composed of a plurality of polygons having polygon vertex coordinates

(X,Y,Z) in a viewpoint coordinate system based on said virtual viewpoint, which are converted into two-dimensional projection image coordinates (XS,YS) in a coordinate system on the virtual projection screen a distance h from said virtual viewpoint, the two-dimensional projection coordinates (XS,YS) being obtained according to $XS=(X/Z)h$, $YS=(Y/Z)h$ and $h=H-S/d$, where S is the velocity of said virtual moving object, h is a distance between the virtual viewpoint and the virtual projection screen, H is a base distance between the virtual viewpoint for a given velocity S and the virtual projection screen, and d is a change ratio of the distance h to the velocity S.

4. An image processing system, comprising:

a coordinate conversion unit providing a virtual three-dimensional space containing three-dimensional objects and providing a viewpoint coordinate system based on a viewpoint relatively associated with a virtual moving object moving in the virtual three-dimensional space; and

a perspective conversion unit outputting a two-dimensional projection image of said virtual moving object to an image display means based on a distance between the viewpoint and a projection screen and coordinates output from said coordinate conversion unit, in which said perspective conversion unit varies the distance according to a velocity of said virtual moving object.

5. An image processing system, comprising:

a coordinate conversion unit providing a virtual three-dimensional space containing three-dimensional objects and providing a viewpoint coordinate system based on a viewpoint relatively associated with a virtual moving object moving in the virtual three-dimensional space; and

a perspective conversion unit outputting a two-dimensional projection image of said virtual moving object on an image display means based on a distance between the viewpoint and a projection screen and coordinates output

from said coordinate conversion unit, in which said perspective conversion unit varies a view field angle of said viewpoint to the projection screen according to a velocity of said virtual moving object and displays the two-dimensional projection image in a fixed-size display area on the image display means.

6. An experience simulation system comprising:

a program processing unit executing a program causing a virtual moving object to move in a virtual three-dimensional space containing three-dimensional objects;

an operation section sending information on a velocity of the virtual moving object in the virtual three-dimensional space to said program processing unit; and

image display means on which a two-dimensional projection image, converted from said three-dimensional objects, is displayed, said program processing unit including:

a central processing unit;

a plurality of memories;

a coordinate conversion unit generating a viewpoint coordinate system based on a viewpoint relatively associated with the virtual moving object moving in said virtual three-dimensional space; and

a perspective conversion unit outputting to a projection screen a two-dimensional projection image of said virtual moving object based on a distance between said viewpoint and the projection screen and coordinates output from said coordinate conversion unit, in which said operation section sends information, on the velocity of the moving object for determining the distance between said viewpoint and the projection screen, to said perspective conversion unit, whereby said perspective conversion unit varies the distance between said viewpoint and the projection screen according to the velocity of said virtual moving object entered from said operation section.

7. An experience simulation system comprising:

- a program processing unit executing a program causing a virtual moving object to move in a virtual three-dimensional space containing three-dimensional objects;

- an operation section sending information about a velocity of the virtual moving object in the virtual three-dimensional space to said program processing unit; and

- image display means on which a two-dimensional projection image converted from said three-dimensional object created by said program processing unit is displayed, said program processing unit including:

- a central processing unit;

- a plurality of memories;

- a coordinate conversion unit generating a viewpoint coordinate system based on a viewpoint relatively associated with the virtual moving object moving in said virtual three-dimensional space; and

- a perspective conversion unit outputting to a projection screen a two-dimensional projection image of said virtual moving object based on a distance between said viewpoint and the projection screen, and coordinates output from said coordinate conversion unit, in which said operation section sends information about the velocity of the virtual moving object for determining the distance between said viewpoint and the projection screen, to said perspective conversion unit whereby said perspective conversion unit varies a visual angle of said viewpoint in relation to the projection screen according to the velocity of said virtual moving object entered from said operation section, and displays the two-dimensional projection image projected on the projection screen in a fixed-size area on the image display means.

8. An experience simulation system as claimed in claim 6 or 7, wherein said program processing unit comprises:

- a memory containing a game program;

- a polygon data memory containing data on a plurality of polygons constituting a three-dimensional object;

a polygon parameter memory containing parameters to be used by the central processing unit to process said polygon data and to arrange said three-dimensional objects in said virtual three-dimensional space; and

a coordinate conversion unit for converting the polygon data of the three-dimensional objects arranged in said virtual three-dimensional space into the viewpoint coordinate system based on the viewpoint in which said perspective conversion unit outputs to a display screen on the image display means the two-dimensional projection image of said objects based on the distance between the viewpoint and the projection screen and the coordinates output from said coordinate conversion unit.

9. An experience simulation system as claimed in claim 8, wherein, when said perspective conversion unit converts vertex coordinates (X, Y, Z) of each polygon in said viewpoint coordinate system into vertex coordinates (X_S, Y_S) of a two-dimensional image to be drawn on the projection screen a distance h from said viewpoint, the vertex coordinates (X_S, Y_S) being calculated according to $X_S = (X/Z)h$, $Y_S = (Y/Z)h$, $h = H - S/d$, where S is the velocity of the virtual moving object, h is the distance between the viewpoint and the projection screen, H is a base distance between the viewpoint and the projection screen for a given velocity S , and d is the change ratio of the distance h to the velocity S .

10. An image processing method, comprising:

providing a virtual three-dimensional space containing three-dimensional objects, providing a virtual viewpoint relatively associated with a virtual moving object moving in said virtual three-dimensional space, providing a virtual projection screen on which the three-dimensional objects viewed from said viewpoint are projected, and displaying a two-dimensional projection image of said three-dimensional objects, projected on said projection screen, onto an image

display means, in which a view field angle of said viewpoint relative to the projection screen varies according to a velocity of said virtual moving object to increase or decrease a projected range of said virtual three-dimensional space to be projected on said projection screen, and the two-dimensional projection image projected on the projection screen is displayed in a fixed-size area on the image display means.

11. An image processing system, comprising:

a coordinate conversion unit providing a virtual three-dimensional space containing three-dimensional objects and providing a virtual viewpoint coordinate system based on a viewpoint relatively associated with a virtual moving object moving in the virtual three-dimensional space; and

a perspective conversion unit outputting a two-dimensional projection image of said virtual moving object on an image display means based on a distance between the viewpoint and a projection screen, and coordinates output from said coordinate conversion unit, in which said perspective conversion unit varies a view field angle of said viewpoint relative to the projection screen according to a velocity of said virtual moving object to increase or decrease the projected range of said virtual three-dimensional space to be projected on said projection screen;

and displays a two-dimensional projection image projected on the projection screen in a fixed-size area on the image display means.

12. A computer-readable storage medium containing a program for executing an image processing method comprising: providing a virtual three-dimensional space containing three-dimensional objects, providing a virtual viewpoint relatively associated with a virtual moving object moving in said virtual three-dimensional space, providing a virtual projection screen on which the three-dimensional objects in said virtual three-dimensional space viewed from said

virtual viewpoint are projected, and displaying a two-dimensional projection image of said three-dimensional objects, projected on said virtual projection screen, onto an image display means, in which said image processing method varies a relative distance between said virtual viewpoint and said virtual projection screen according to a velocity of said virtual moving object.

13. A computer-readable storage medium containing a program for executing an image processing method comprising: providing a virtual three-dimensional space containing three-dimensional objects, providing a virtual viewpoint relatively associated with a virtual moving object moving in said virtual three-dimensional space, providing a virtual projection screen on which the three-dimensional objects in said virtual three-dimensional space viewed from said virtual viewpoint are projected, and displaying a two-dimensional projection image of said three-dimensional objects, projected on said projection screen, onto an image display means, in which said image processing method varies a view field angle of said virtual viewpoint relative to the virtual projection screen according to a velocity of said virtual moving object to increase or decrease the projected range of said virtual three-dimensional space to be projected on said virtual projection screen, and displays the two-dimensional projection image projected on the projection screen in a fixed-size area on the image display means.

Fig. 1

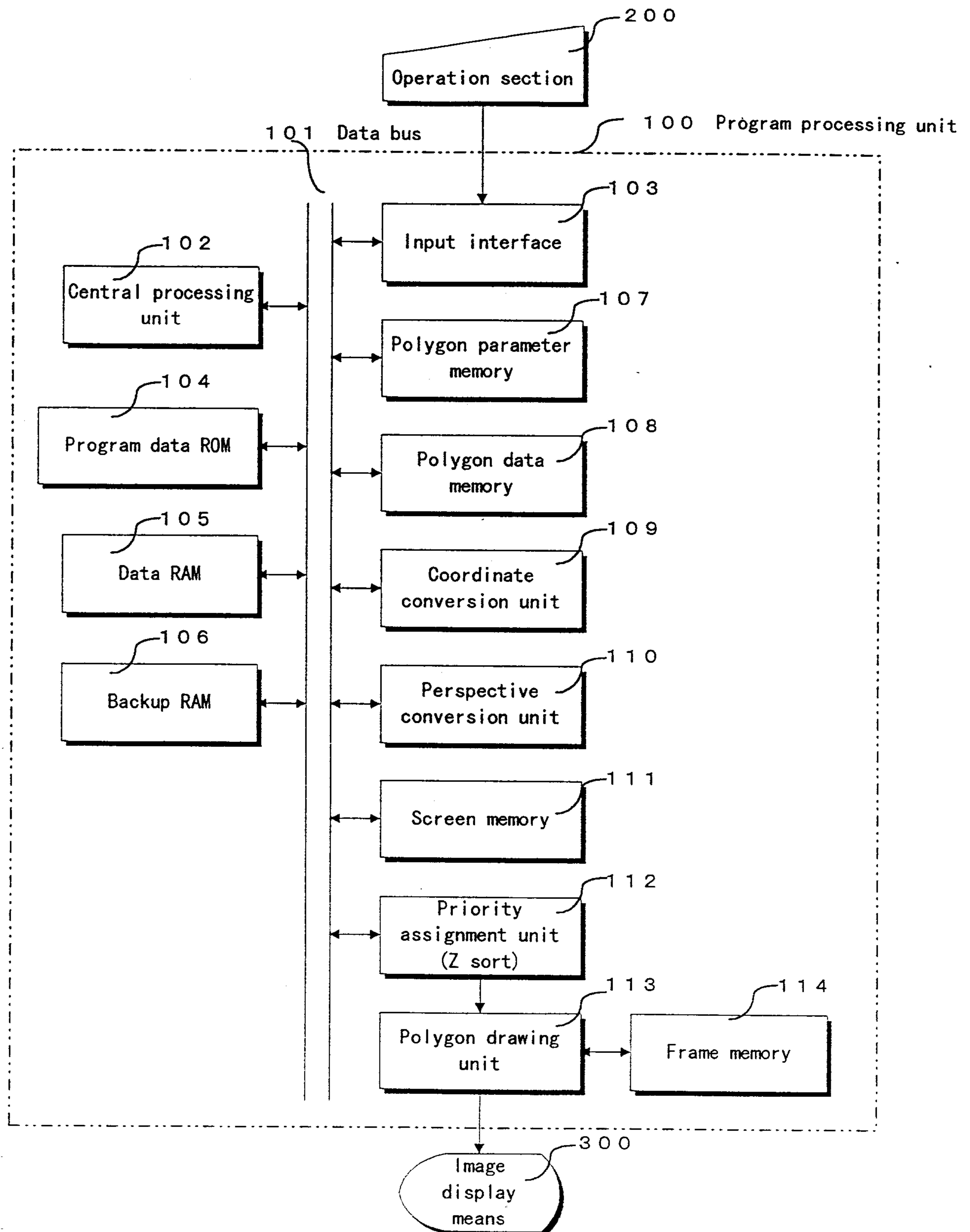


Fig. 2

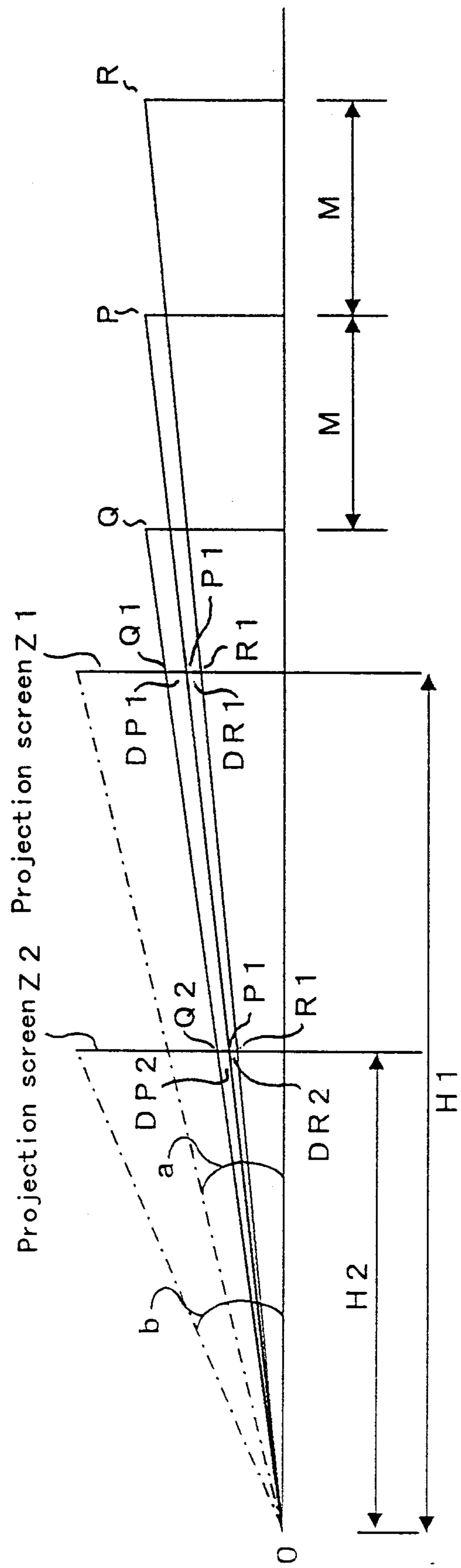


Fig. 3

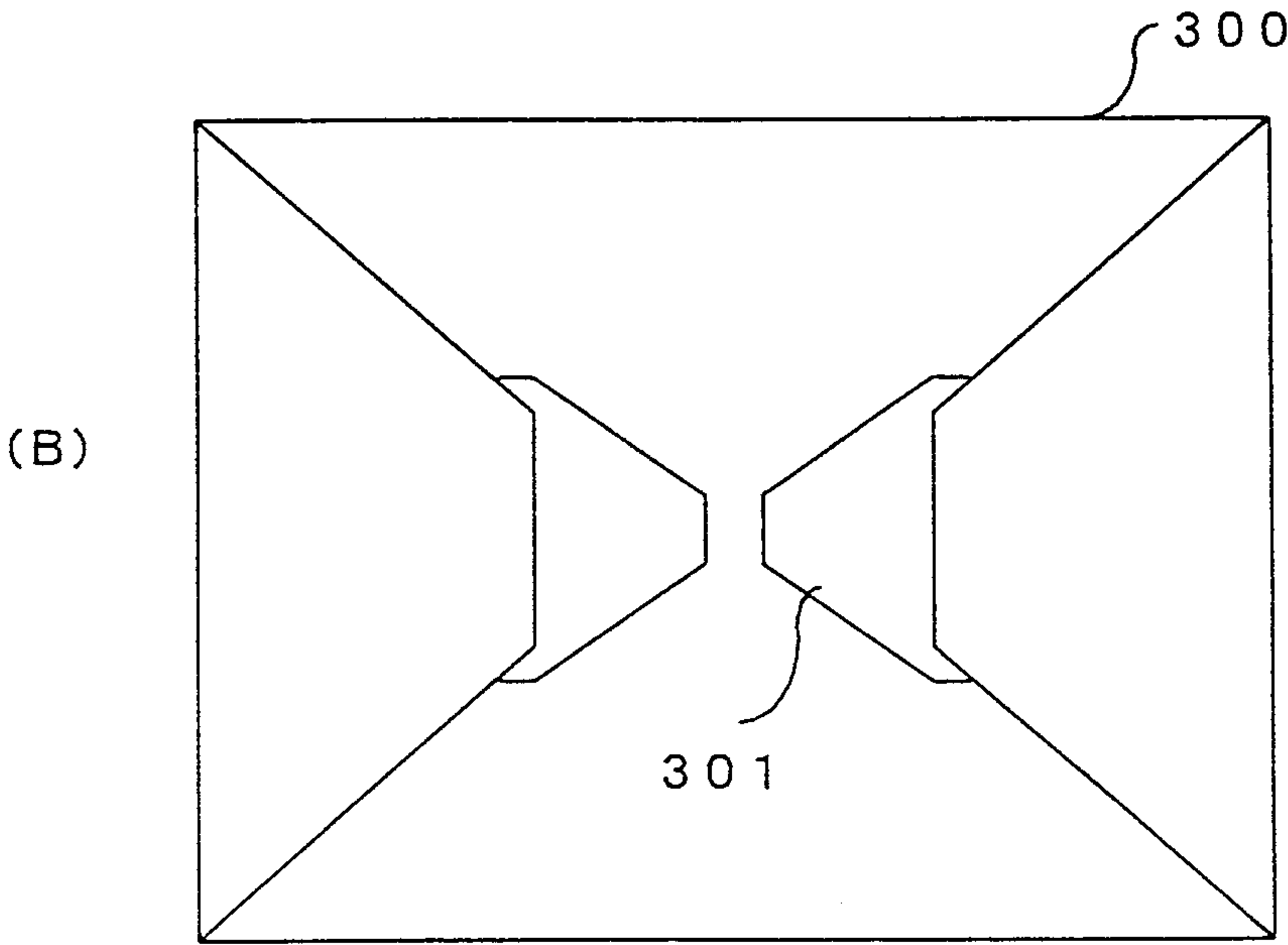
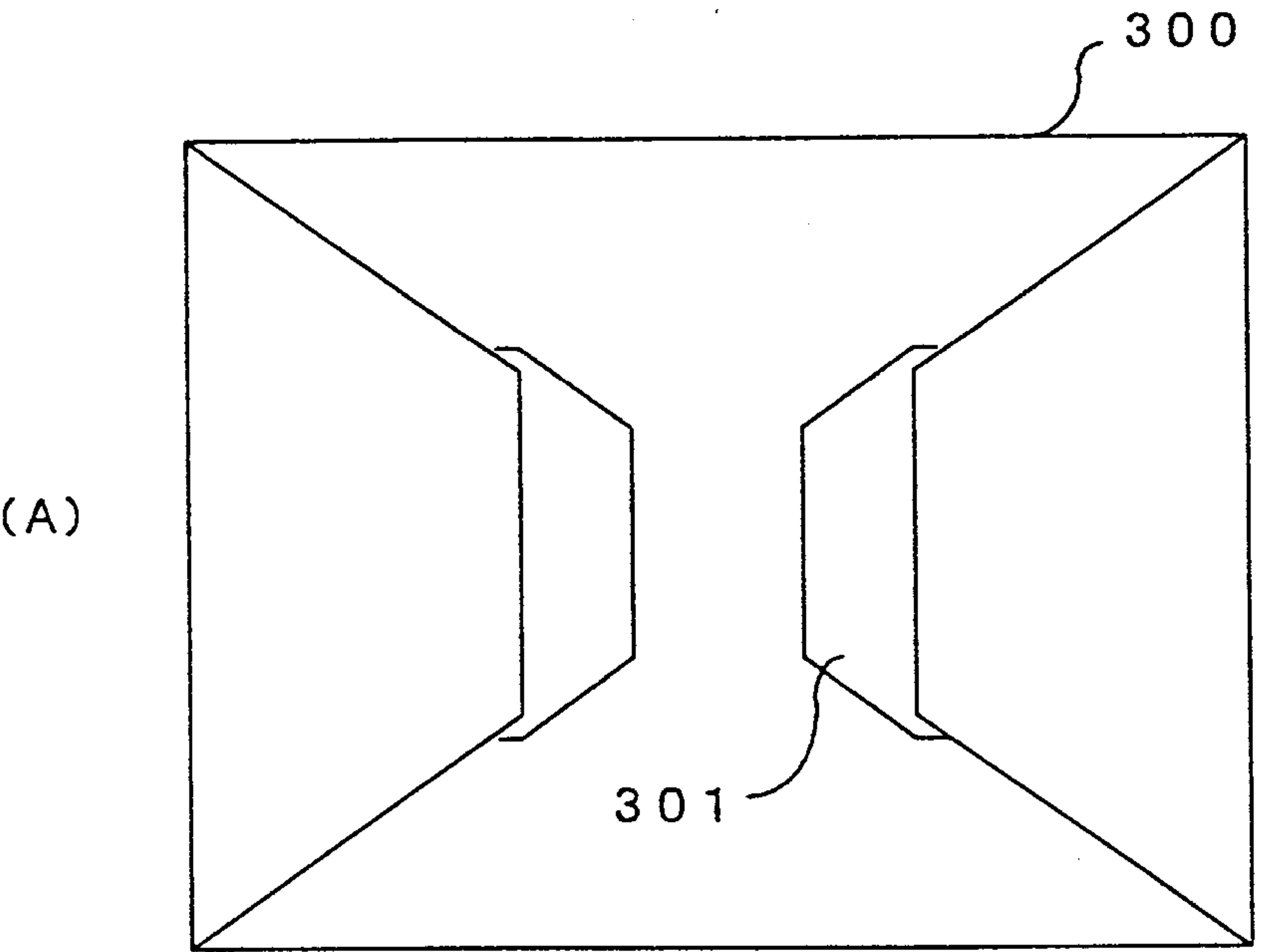


Fig. 4

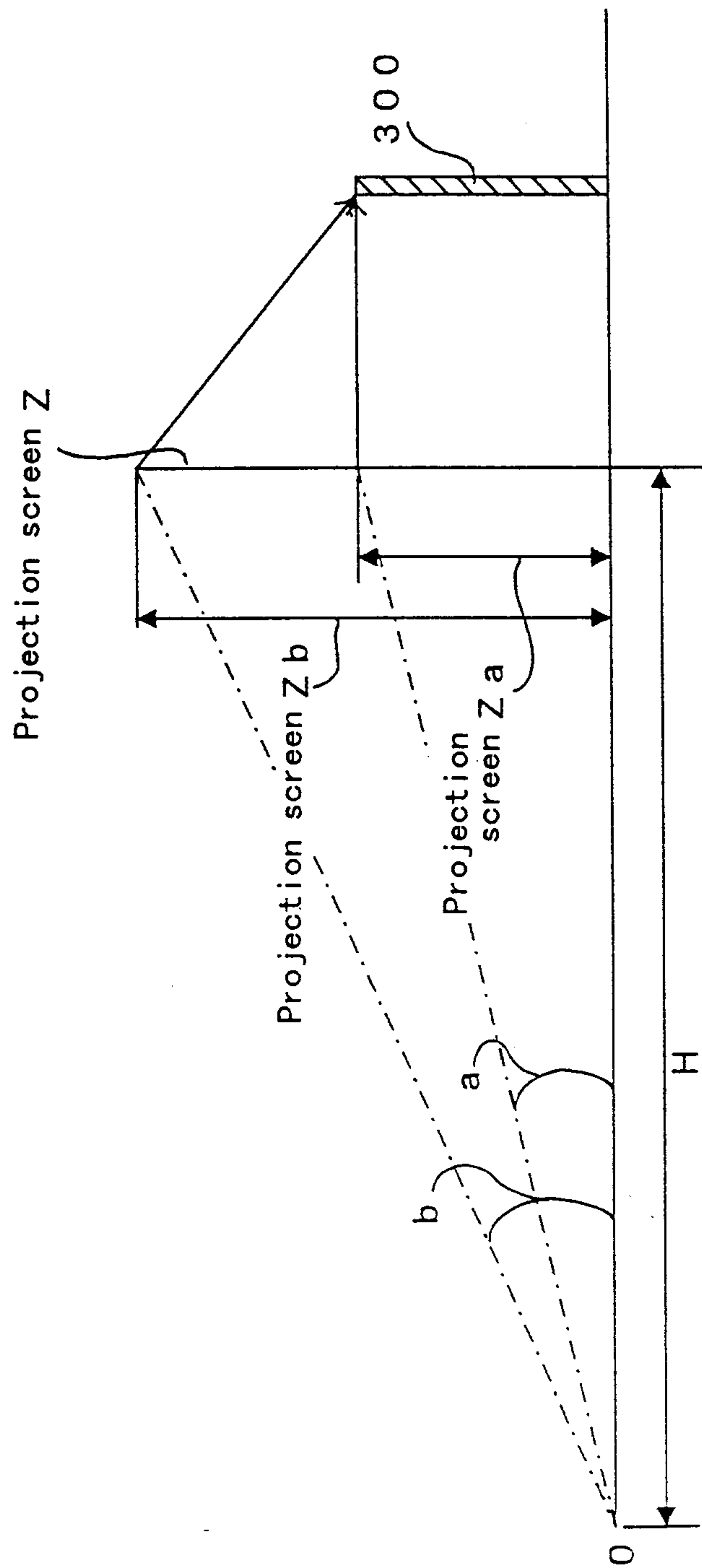
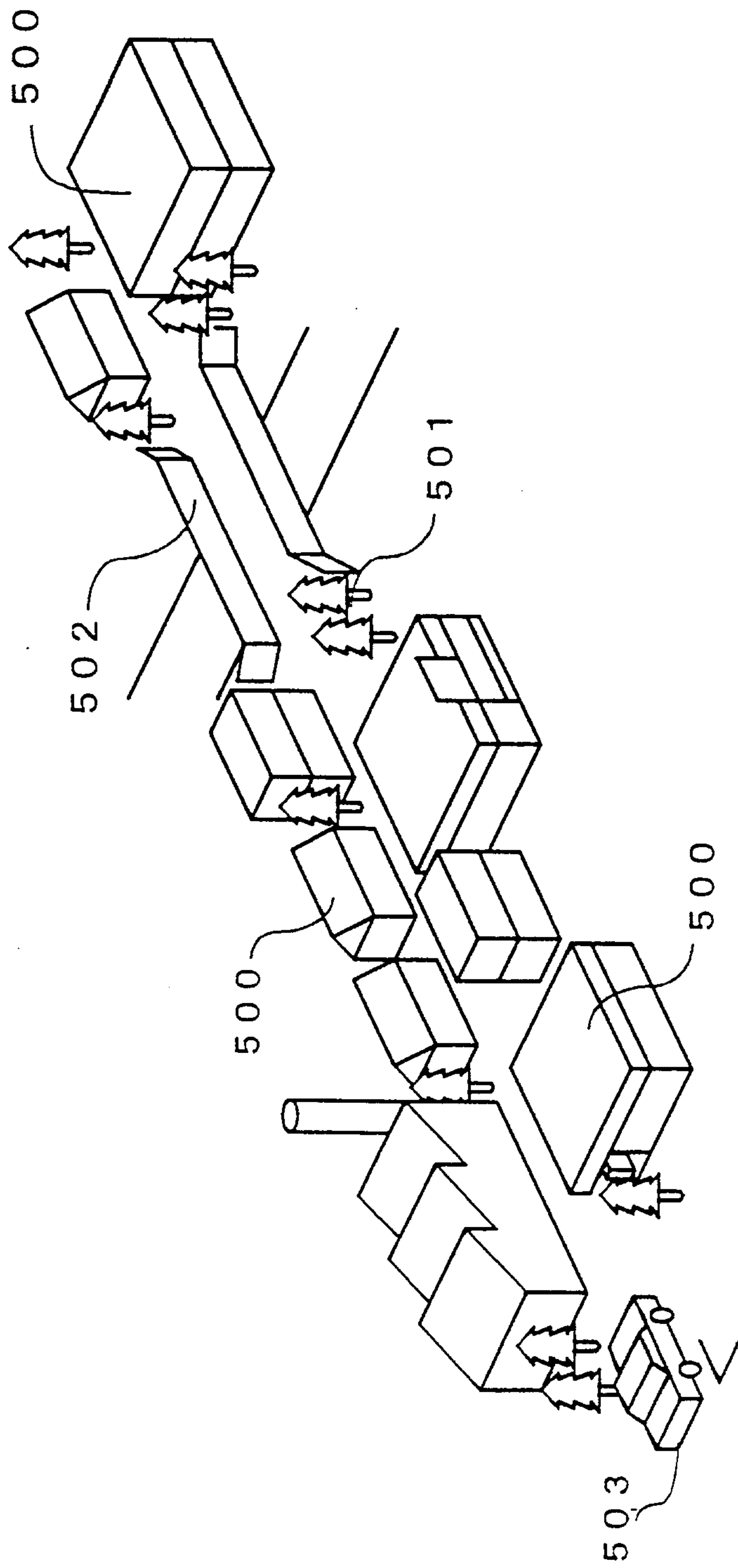


Fig. 5



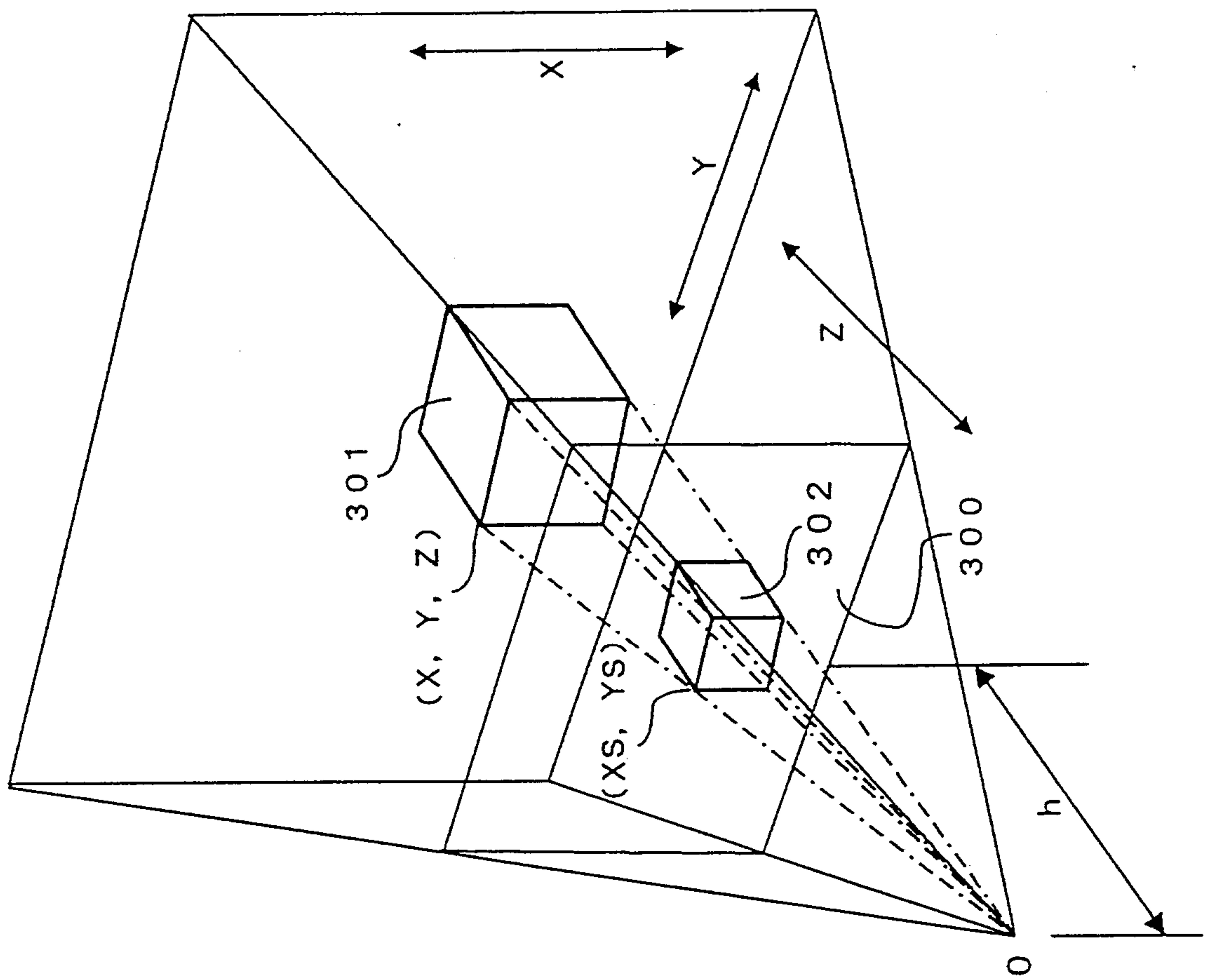


Fig. 6

Fig. 7

