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(54) Sample picture data processing method and sample inspection system and sample inspection method

(57) [Problem] To promptly display the picture data of a plurality of layers of different sample depths on display means. and to display the predeterminedplanar region of a picture having a very large imaging region, easily and promptly at a plurality of spots merely by transmitting the conditions of small data quantities.

[Means for Resolution] There are comprised means 653 for generating sample picture data of a plurality of layers of different sample depths from a sample 601 through electronic imaging devices 631 for the respective layers, and for storing the generated sample picture data, means for designating a planar region which is to be extracted from the respective sample picture data, means for extracting extraction picture data corresponding to the planar region, for the respective layers from the respective sample picture data upon receiving the designation of the planar region, and for storing the extraction picture data, and a picture processing apparatus 651 which displays the extracted pictures of the respective layers on display means 652 in an alternative way or simultaneously in a combination of two or more of them, on the basis of the respective extraction picture data of the respective layers. And A method and a system comprising the display layer setting step of setting a first condition which designates a single layer picture 42a to be displayed at a specified terminal 41, on the basis of picture data 42 that have been imaged for a plurality of respective layers of different sample depths from a sample; the display region setting step of setting a second condition which designates a predetermined planar region that is to be extracted from the layer picture 42a designated by the first condition; the first picture display step of displaying the predetermined planar region extracted from the layer picture 42a, at the specified terminal 41 in accordance with the first and second conditions; the condition transmission step of transmitting the first and second conditions to another terminal 52 ; and the second picture display step of displaying a predetermined correspondent planar region corresponding to the predetermined planar region, at the other terminal 51 in accordance with the first and second conditions that have been transmitted to the other terminal 51 and on the basis of correspondent picture data 52 that have been prestored at the other terminal 51 in

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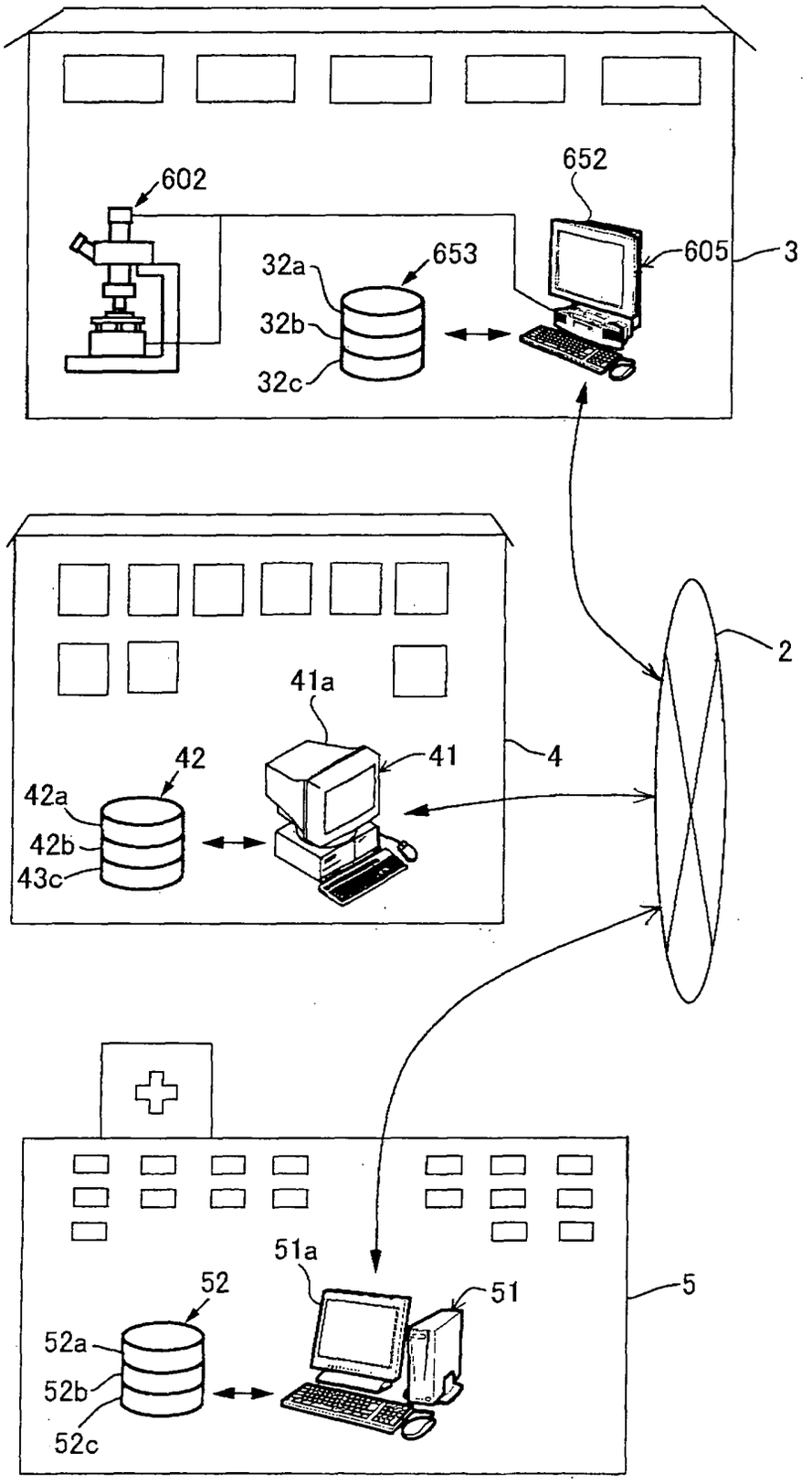
correspondence with the picture data 42.

FIG.1



Description

[Detailed Description of the Invention]

[Technical Field to which the Invention Belongs]

[0001] The present invention relates to a processing method and a sample inspection system for sample picture data which have been imaged for a plurality of respective layers of different sample depths and a sample inspection method and system with which a plurality of expert departments perform the sample inspections of the cells, tissues or the likes of a human being, in collaboration through a communication network.

[Prior Art]

[0002] In the laboratories of medical institutions such as hospitals, and universities, etc., the sample inspections of cells, tissues, etc. based on microscopes are frequently performed. In this regard, the sample inspection is performed in a state where the enormous number of cells are magnified by the microscope into an inspection region of very large area, so that much labor and a heavy burden have been expended. In the sample inspection of the cells, the tissues or the likes, therefore, the labor is divided for enhancing the overall efficiency of the inspection between an inspection department which inspects the existence or nonexistence of any malignant cell with the microscope or the like and which, when the malignant cell has been found out, images the corresponding part and specifies it by marking or the like, and a diagnosis department which makes a medial diagnosis on the specified part. Besides, as means for joining the individual departments between which the labor is divided, a data transmission medium such as a telephone line or the like public line, or an Internet dedicated line has come into use in recent years, and a sample picture has been converted into data so as to exchange the sample picture between the respective departments through the data transmission medium. The Applicants have therefore proposed as the ways of converting sample pictures into data, means for imaging the sample of cells, tissues or the likes magnified by a microscope, as line pictures by a line sensor, and for subjecting the line pictures to picture processing based on a computer, so as to promptly create the clear imaged picture of the very large region of thewhole sample (Japanese Patent Applications No. 2002-097495, No. 2002-097497, No. 2002-097498, and No. 2002-097499).

[Problems that the Invention is to Solve]

[0003] In the sample inspection of cells tissues or the likes, however, any cell cannot always be judged as a malignant cell or a cell for whichmalignance ought to be considered, by observing only a sample depth plane at a predetermined focal position, and the judgment is often impossible unless the shape, etc. of the cell at a sample depth different from the sample depth of the plane are observed. For the purpose of exactly performing the inspection of the cells, the tissues or the likes, accordingly, it becomes important to change the focal position of a microscope and to inspect the cells or the tissues in multilevel fashion.

[0004] In this regard, with inventions according to the above-mentioned applications, the clear picture can be promptly created for the very large imaging region, but the imaged picture of full size cannot be entirely displayed on a display device such as monitor because the imaged picture has the very large imaging region. Besides, in a case where a plurality of pictures at different sample depths are prepared, the quantity of picture data is very large because each picture has the very large imaging region, and it has been difficult to promptly display the picture of the different sample depth.

[0005] In case of performing the inspection of cells or the likes, the detailed remarks, etc. of an inspection department having inspected the cells or tissues are often required. Besides, as to any cell for which malignance ought to be considered, a picture of changed sample depth or magnifications need to be often imaged again. In such a case, a very exact and prompt sample inspection becomes possible if respective departments can exchange opinions and prearrange the refined conditions, etc. of the re-imaging while watching the detailed picture imaged for the whole inspection region of a sample.

[0006] In this regard, with inventions according to the above-mentioned applications, the clear picture can be promptly created for the very large imaging region, but the imaged picture of full size cannot be entirely displayed on a display device such as monitor because the picture has the very large region. When the picture is reduced, the whole region can be displayed at one time by the display device, but the imaged cells or tissues cannot be clearly seen in the reduced picture, so that the inspection and a diagnosis are impossible. Besides, when the respective departments intend to exchange opinions and make arrangements while watching display devices such as monitors, at different spots, only parts of the very large imaging region can be displayed on the display devices, and hence, a picture to be displayed might be mistaken.

[0007] It is accordingly an object of the present invention to provide a sample picture data processing method and a sample inspection system which can promptly display the picture data of a plurality of layers at different sample depths and to provide a sample inspection method and a system therefor in which, merely by transmitting conditions of small data quantity, the predetermined planar region of a picture that has an imaging region larger than a region displayable by picture display means (such as monitor) can be easily and promptly displayed at a plurality of spots.

[Means for Solving the Problems]

[0008] In order to solve the above problems, a processing method for sample picture data according to the present invention consists in a sample picture data processing method comprising the step of generating sample picture data of a plurality of layers of different sample depths from a sample through electronic imaging devices for the respective layers, and for storing the generated sample picture data; the step of designating a planar region which is to be extracted from the respective sample picture data; and the step of extracting extraction picture data corresponding to the planar region, for the respective layers from the respective sample picture data upon receiving the designation of the planar region, and for storing the extraction picture data. Besides, a sample inspection system according to the present invention consists in a sample inspection system comprising means for generating sample picture data of a plurality of layers of different sample depths from a sample through electronic imaging devices for the respective layers, and for storing the generated sample picture data; means for designating a planar region which is to be extracted from the respective sample picture data; means for extracting extraction picture data corresponding to the planar region, for said respective layers from said respective sample picture data upon receiving the designation of said planar region, and for storing the extraction picture data; and a picture processing apparatus which displays extracted pictures of said respective layers on display means in an alternative way or simultaneously in a combination of two or more of them, on the basis of said respective sample picture data and the respective extraction picture data of said respective layers. Besides, it is more preferable that, when the extraction picture is to be displayed, a plurality of selected extraction pictures are displayable in parallel or in superposition. Besides, it is also allowed that the electronic imaging devices be line sensors, and that said sample picture data consist of a set of individual line picture data imaged by the line sensors.

[0009] In order to solve the above problems, a sample inspection method according to the present invention comprises the display layer setting step of setting a first condition which designates a single layer picture that is to be displayed at a specified terminal on the basis of picture imaged for a plurality of respective layers of different sample depths from a sample; the display region setting step of setting a second condition which designates a predetermined planar region that is to be extracted from the layer picture designated by the first condition; the first picture display step of displaying the predetermined planar region extracted from the layer picture, at the specified terminal in accordance with the first and second conditions; the condition transmission step of transmitting the first and second conditions to another terminal; and the second picture display step of displaying a correspondent planar region corresponding to the predetermined planar region, at the other terminal in accordance with the first and second conditions that have been transmitted to the other terminal and on the basis of correspondent picture data that have been prestored at the other terminal in correspondence with the picture data.

[0010] Besides, the sample inspection method should preferably further comprise the index display setting step of setting a third condition which represents an index for indicating a specified part of the predetermined planar region displayed at the specified terminal; the first index display step of displaying the index on the predetermined planar region displayed at the specified terminal, in accordance with the third condition; the second condition transmission step of transmitting the third condition to the other terminal; and the second index display step of displaying a correspondent index corresponding to the index, at the other terminal in accordance with the third condition transmitted to the other terminal.

[Mode for Carrying Out the Invention]

[0011] The mode for carrying out the invention will be described with reference to the drawings in conjunction with embodiments. A sample inspection system shown in Fig. 1 is a cytodiagnostic sample inspection system which includes the terminal 605 of a picture creation department 3, the terminal 41 of an inspection department 4, and the terminal 51 of a diagnosis department 5. Each terminal is capable of transmitting and receiving data through a data transmission medium such as a telephone line or the like public line or an Internet dedicated line. Here, in the picture creation department 3, cells or tissues forming a sample are magnified and imaged by a microscope apparatus 6 so as to create a picture; in the inspection department 4, any malignant cell or any cell for which malignance ought to be considered is specified from within the picture; and in the diagnosis department 5, the specified cell is diagnosed. Besides, the terminals 605, 41, 51 include storage units 653, 42, 52, respectively, and the picture data 32a - 32c, 42a - 42c, 52a - 52c of the cells or tissues imaged every three layers of different sample depths (focused positions) are respectively stored in the storage units. The "sample depth" termed here indicates the difference of the focused position in the depthwise direction of the sample in the case where the sample is imaged by the microscope apparatus 6. That is, among the three layers mentioned above, the layer 32a is the uppermost layer which is nearest to an objective lens, the layer 32c is the lowermost layer which is remotest from the objective lens, and the layer 32b is the intermediate layer between the layer 32a and the layer 32c.

[0012] Next, the steps of creating the picture data of the cells or tissues in the picture creating department 3 will be described with reference to Figs. 2 - 7. First of all, the steps of creating the picture data will be outlined. The three positions of the cells or tissues of a sample

601 at different sample depths are respectively and simultaneously focused on line sensors 631a, 631b, 631c which are electronic imaging devices arrayed at different heights relative to the sample 601. In this embodiment, the line sensors 631a, 631b, 631c are arranged stepwise as shown in Fig. 4, thereby to make the heights different relative to the sample 6.01. Besides, pictures at the three different sample depths are read as line picture data by the three line sensors 631a, 631b, 631c. Besides, the sample 601 is horizontally moved by movement means 604 shown in Figs. 2 - 4, and the line picture data are successively stored in the storage unit 653 by the terminal 605 shown in Fig. 3. Subsequently, the picture data of the sample 601 in the three layers of the different sample depths are generated from the recorded line pictures by an arithmetic processing unit 651 in a picture processing apparatus. The steps will be described in detail below.

[0013] First, the general construction of a microscope 602 will be outlined with reference to Figs. 2 and 3. The microscope 602 which is used in the embodiment of the present invention, is an optical microscope. In the inspection of the cells, the tissues or the likes, a judgment as a malignant cell is sometimes difficult merely by watching only a focused part, and note is sometimes taken of an unfocused and obscurely micrographed part (defocused part). When the sample is imaged by the microscope 602 being the optical microscope, the unfocused information is also left as picture data, and hence, the imaging is suitable for the inspection of the cells, the tissues or the likes. The microscope 602 includes a body tube 625, an ocular lens for visual observation 623 as is attached to the body tube, a two-dimensional CCD sensor unit 627 which images some two-dimensional extent of the sample 601, and optical lenses which consist of objective lenses 621. Herein, the body tube 625 is supported on an L-shaped frame 606 through a rack-and-pinion mechanism 661 which moves this body tube up and down. Besides, in order to illuminate the sample 601 from the rear surface thereof, an optical fiber 607 which introduces light from a halogen lamp (not shown) disposed outside is connected to the lower part of the L-shaped frame 606.

[0014] Meanwhile, as shown in Fig. 4, the optical lenses are constructed of the objective lenses 621 each of which is made up of a composite lens formed of two lenses 621a, 621b, and three semicylindrical aberration compensation lenses 622a,622b, 622c which are respectively disposed in correspondence with the three line sensors 631a, 631b, 631c arranged in parallel at the different heights. As indicated by broken lines, solid lines and dot-and-dash lines in Fig. 4, the aberration compensation lenses 622a, 622b, 622c lie at positions which are shifted'the distances between the devices of the line sensors, from each other in an X-axial direction, and they are formed in such an optical configuration that layers (upper layer 601a, intermediate layer 601b, lower layer 601c) of the different sample depths are respectively focused on the line sensors 631a, 631b, 631c. Incidentally, the objective lenses 621 numbering three and having different magnifications are attached to a revolver 624, and they are manually switchable from one another.

[0015] Now, as shown in Fig. 4, the three line sensors 631a, 631b, 631c and aberration compensation lenses 622a, 622b, 622c are accommodated in a camera case 632. As shown in Fig. 2, the camera case 632 is detachably attached to the distal end of the body tube.625 of the microscope 602. Incidentally, adopted as the configuration of the attachment portion is the F-mount which is the standard mounting configuration of a single-lens reflex camera concerning a lens mounting portion. Each of the line sensors 631a , etc. is constructed in such a way that charge coupled devices one latus of each of which is 7 μm long are rectilinearly arrayed in the number of 4000. Accordingly, in a case where imaging magnifications are 100, a range whose width is 7 μm ÷ 100 = 0.07 μm and whose length is 7 μm × 4000 ÷ 100 = 0.28 mm can be imaged at one time.

[0016] The horizontal portion of the L-shaped frame 606 is overlaid with the movement means 604. The movement means 604 includes a tilting table 642 on which the sample 601 is put, and a linear motor 641 which horizontally moves this tilting table rightwards and leftwards, and frontwards and rearwards. The linear motor 641 belongs to a known technique, it is such that an armature moves on permanent magnets arrayed in the shape of a belt, and it is capable of high-speed drive, high responsiveness, and high- precision positioning. Besides, as will be explained later, the linear motor 641 is remote-controlled by a computer and moves the sample 601 to a predetermined position.

[0017] The tilting table 642 is constructed of three ultrasonic motors 642a which are arranged so as to form a regular triangle as viewed in plan, a table portion of flat shape 642d which is supported at three points by the distal ends of the vertical output shafts 642c of these ultrasonic motors, and a fixation member 642b which fixes the mutual positions of these ultrasonic motors. Herein, the distal ends of the vertical output shafts 642c abut on recesses formed in the rear surface of the table portion 642d, so as to prevent their mutual horizontal positions from shifting.

[0018] Each of the ultrasonic motors 642a belongs to a known technique, and it is such that an elastic member is disposed in touch with piezoelectric ceramics adapted to be deformed by applying a voltage, and that the elastic member is caused to generate bending vibrations by applying the voltage of ultrasonic region to the piezoelectric ceramics, thereby to rotate the output shaft. It has high responsiveness and controllability, and it has the features of low operating sound, etc. In the ultrasonic motor 642a used here, the output shaft 642c has a threaded structure, and it is rotated to move up and down. Besides, the tilting table 642 adjusts the tilt of the sample 601 and a focal distance in accordance with in-

structions from the computer.

[0019] A halogen lamp (not shown) is accommodated in a lamp portion 626. Light from the halogen lamp is bent at right angles so as to extend along the optic axis of the microscope 602, by a semitransparent mirror, whereby the sample 601 is illuminated with the light. Reflected light from the sample is intensified so as to obtain a clear picture. The lamp portion 626 forming a reflected light source is used when the sample 601 is of a substance of low light transmissivity. Besides, the optical fiber 607 for introducing the light from the halogen lamp (not shown) disposed as a transmitted light source outside the microscope apparatus is connected to the lower part of the L-shaped frame 606 so that the sample 601 can also be illuminated from the rear surface thereof. The transmitted light source is often employed as a main light source when a sample of high light transmissivity, such as the cells or the tissues, is observed. Also in this embodiment, the sample 601 is illuminated from the rear surface thereof.

[0020] Besides, the two-dimensional CCD sensor unit 627 includes therein a two-dimensional CCD sensor (not shown) which is capable of imaging some two-dimensional extent. More specifically, in the cell inspection, it is sometimes necessitated to display a picture enlarged by the microscope 602, directly on display means, and to verify a specified part, range or the like where any malignant cell exists, while the display screen of the display means is being watched. In this regard, in a case where only the line sensors 631a, etc. are disposed as imaging devices, the line picture which can be imaged at one time has a very small width. It is difficult to verify the specified part or range where the malignant cell exists, while the display screen of the narrow line picture is being observed. In contrast, when the two-dimensional CCD sensor capable of imaging some two-dimensional extent is disposed, it is easy to verify the specified part or range of the cells, the tissues or the likes while the display screen based on the two-dimensional CCD sensor is being observed. It is therefore permitted to easily verify the specified part or range within the sample 601, by disposing the two-dimensional CCD sensor.

[0021] The two-dimensional CCD sensor is such that charge coupled devices, which are used in a conventional CCD camera and one latus of each of which is 21 μm long, are arranged in plan in the number of 600 in a longitudinal direction × 600 in a lateral direction = about 350 thousand. It images the predetermined range of the sample 601 through the semitransparent mirror.

[0022] Meanwhile, a computer being commercially available or a so-called "personal computer" is used as the terminal 605, and this terminal is constructed of the arithmetic processing unit 651, display means 652, and the storage unit 653 for storing the line picture data therein. The arithmetic processing unit 651 is disposed in the picture processing apparatus. As will be explained later, it executes the setting of the imaging region of the sample 601, the movement of the movement means 604, the instruction of the execution of that imaging of the line sensors 631a, etc. which is based on a movement magnitude fed back from the encoder of this movement means, the acceptance of the line picture data imaged by these line sensors, and the synthesis of these line picture data for the creation of the general planar picture of the imaging region.

[0023] Next, there will be described the steps of creating the picture data 32a - 32c of the cells or the tissues by the constituent components stated above. As shown in Fig. 2, first of all, the sample 601 in which a cell or tissue piece to be inspected is interposed between slide glass and cover glass is set on the upper surface of the table portion 642d of the tilting table 642, and this sample is fixed by suction to the table portion 642d, or the like through vacuum means or the like so as not move. Subsequently, as shown in Fig. 7, the inspection region 611 of the sample 601 is set by an input from the input means of the personal computer.

[0024] Herein, the inspection region 611 is set for setting the start point 611a and end point 611b of the imaging of the line pictures successively imaged by the line sensors 631a, etc. as will be explained later. Incidentally, an imaged picture having some two-dimensional extent is required for the setting of the inspection region 611. Therefore, the setting is performed by displaying imaging data from the two-dimensional CCD sensor, on the display means 652 of the terminal 605, and then moving and adj usting the movement means 604 in X-and Y-directions while the display screen of this display means is being watched. Thus, the XY-coordinates of the positions 611a, 611b on a diagonal line are stored in the arithmetic processing unit 651 as information items which correspond to the movement start point and end point positions of the linear motor 641 of the movement means 604. As will be explained later, accordingly, in the case of imaging the sample by the line sensors 631a, etc. , the linear motor 641 is sequentially moved from the inner side position 611a being the first imaging position, to the horizontal direction position 611b being the last imaging position, in accordance with instructions from the arithmetic processing unit 651.

[0025] By the way, in setting the inspection region 611, the adjustments of the focal distance of the sample 601 and the tilt are simultaneously made. More specifically, in setting the inspection region 611, the two-dimensional CCD sensor is first focused on the upper layer 601a of the sample 601 at the start point position 611a while a display picture from this two-dimensional CCD sensor as indicated on the display means 652 is being watched. Subsequently, the linear motor 641 is moved in the X-axial direction, and the two-dimensional CCD sensor is focused at the right end part position of the inspection region 611. Besides, a tilt in the X-axial direction is calculated from the deviation between the focused positions, and the tilt of the tilting table 642 is adjusted. Thereafter, using similar means, the two-dimen-

sional CCD sensor is focused at the right upper part position 611b of the inspection region 611, and a tilt in a Y-axial direction is adjusted.

[0026] Here, when the microscope apparatus is so constructed that the focal position of the two-dimensional CCD sensor coincides with the focal position of the line sensor 631a for imaging the upper layer 601a of the sample 601, the line sensor 631a can be immediately focused on this upper layer 601a of the sample. Besides, the aberration compensation lenses 622a, 622b, 622c are designed so that the other line sensors 631b, 631c may be focused on the positions of their respective focal depths simultaneously with the line sensor 631a. Therefore, at the stage at which the two-dimensional CCD sensor has been focused, all of the three line sensors are focused.

[0027] Subsequently, the steps of imaging the sample 601 by the line sensors 631a, etc. will be described with reference to Figs. 7 and 8. The imaging is controlled by a program built in the arithmetic processing unit 651. First of all, the arithmetic processing unit 651 sets an inspection position of j = 0 and k = 0 by the encoder and recognizes the inspection position as coordinates of X = 0 and Y = 0. Besides, the arithmetic processing unit 651 causes the sample 601 to move to the XY-coordinate (0, 0) position by the linear motor 641. The XY-coordinate (0, 0) position is the left lower corner 611a of the inspection region 611 shown in Fig. 7, and this point becomes the start point at which the imaging is started. The point becomes the position of (a) in Fig. 8, and the line sensor 631a is arranged at the position at which it overlies the left lower corner 611a.

[0028] Now, when the start point of the imaging position has been set at the position of the left lower corner 611a of the inspection region 611, the arithmetic processing unit 651 sets a movement magnitude dx for the X-axis, and it stores in the storage unit 653, respective line pictures imaged by the line sensors 631a, 631b, 631c at the inspection position (0, 0) and starts the movement of the linear motor 641 in the X-axial direction at a constant rate ((a) - (c) in Fig. 8). The movement magnitudes of the movement means 604 are measured by the encoder, and the data thereof are sent to the arithmetic processing unit 651. Herein, when it is judged by the arithmetic processing unit 651 that the inspection region 611 has been moved one measurement width component of the line sensors 631a, etc. in the X-axial direction by the movement means 604 , the arithmetic processing unit 651 stores in the storage unit 653, line pictures from the line sensors at the second inspection position of X = 1dx and Y = 0, namely, coordinates (1dx, 0).

[0029] Besides, the arithmetic processing unit 651 adds "1" to k each time the pictures of one line are recorded. It stores the line pictures in the storage unit 653, sequentially for the range of one row having an X-axial direction length L until the linear motor 642 moves in the X-axial direction at the constant rate to bring the inspection position to the right lower corner of the inspection region 611 shown in Fig. 7 (in correspondence with the movements at (d) - (f) in Fig. 8).

[0030] Meantime, when the acceptance of the imaging of the lowermost stage of the inspection region 611, namely, Y-axis coordinate = 0 has been completed, the arithmetic processing unit 651 sets j = 1 for the encoder and moves the inspection position to the inspection position of X = L and Y = 1dy, namely, the position of XY-coordinates (L, 1dy) by the linear motor 641. This position is a position which lies on the right of the left lower corner 611a of the inspection region 611 shown in Fig. 7, by L in the X-axial direction, and which is shifted in the Y-axial direction in correspondence with the length of the line sensors 631a, etc. Besides, at the position of Y = 1dy, line pictures are accepted sequentially from the right end to the left end of the inspection region 611.

[0031] In this manner, while the scanning direction of the line sensors 631a, etc. is being altered leftward or rightward, the arithmetic processing unit 651 sequentially records line pictures in the storage unit 653 together with measured coordinates, the moment the line sensors 631a, etc. have moved into a new imaging range. Meantime, when J > n has been reached, the arithmetic processing unit 651 judges that the whole region of the inspection region 611 has been imaged, and it synthesizes the recorded line pictures and stores the planar picture data of the whole inspection region in the layers 601a, 601b, 601c of the three different sample depths as the layer picture data 32a, 32b, 32c in the storage unit 653, respectively.

[0032] By the way, in the imaging by the line sensors 631a, etc. , the arithmetic processing unit 651 affixes the XY-coordinates and the sample depths, namely, Z-axis coordinates in the above inspection region 611, to the individual imaged line picture data. More specifically, as shown in Fig. 4, the layers 601a, 601b, 601c of the different sample depths as are simultaneously imagedby the respective line sensors 631a, 631b, 631c are shifted the distances between the devices of the line sensors, from each other in the X-axial direction. Regarding the magnitude of the shift, with respect to the line picture which is imaged by the line sensor 631a, the shift magnitude is added to the X-value of the coordinates of the line picture which is imaged by the line sensor 631b, and the X-coordinate value shifted the distance between the devices is affixed. Further, the X-value of the coordinates of the line picture which is imaged by the line sensor 631c is shifted the distance between the devices still more, and the shifted value is affixed. Besides, the layers 601a, 601b, 601c are shifted the mounting heights of the line sensors from each other in a Z-axial direction. Regarding the magnitude of the shift, with respect to the line picture which is imaged by the line sensor 631a, the shift magnitude is added to the Z-value of the coordinates of the line picture which is imaged by the line sensor 631b, and the Z-coordinate value shifted the mounting height is affixed. Further, the Z-value of the coordi-

nates of the line picture which is imaged by the line sensor 631c is shifted the mounting height still more, and the shifted value is affixed. In this manner, in imaging the individual line pictures, the XYZ-coordinates of the imaging positions in the whole inspection region 611 of the sample 601 are affixed to the line picture data by the arithmetic processing unit 651 of the terminal 605.

[0033] Besides, regarding the imaging way of the line sensors 631a - 631c, all the line sensors may be always held in their imaging states as explained above. Alternatively, the imaging may well be controlled by the arithmetic processing unit 651 so that, at one end part of the sample (corresponding to (a) - (c) in Fig. 8) , only the line sensor 631c may be used for the imaging in Fig. 8 (a) , the line sensors 631c and 631b being used for the imaging in Fig. 8(b), all the line sensors being used for the imaging in Fig. 8 (c) et al. , and that, at the other end part of the sample (corresponding to (d) - (f) in Fig. 8), all the line sensors may be used for the imaging till the stage of Fig. 8(d), the line sensors 631b and 631a being used for the imaging in Fig. 8 (e) , only the line sensor 631a being used for the imaging in Fig. 8 (f). That is, when the control is performed in this manner so that the line sensor to image a position where the sample does not exist may not be used for the imaging, the imaging data of places where the sample does not exist can be removed from the picture data.

[0034] Next, there will be described a method of displaying the picture data 32a - 32c of the whole inspection region on the display means 652. A layer picture to be displayed at the terminal 605, for example, the layer picture 32a is selected. The arithmetic processing unit 651 of the terminal 605 displays the thumbnail (reduced picture) of the whole region of the selected layer picture 32a on the display means 652. Besides, when a desired planar region to display a non-reduced picture is designated on the thumbnail, the arithmetic processing unit 651 selects the layer picture data 32a from among the picture data stored in the storage unit 653 and extracts picture data corresponding to the designated planar region from among the selected layer picture data. Also, the arithmetic processing unit 651 extracts picture data corresponding to planar regions at positions corresponding to the designated planar region, from among the other layer picture data 32b, 32c. Subsequently, the arithmetic processing unit 651 brings the picture data of the respective planar regions extracted from among the corresponding layer picture data 32a - 32c, into one set, and then stores them in a picture saving memory disposed in the picture processing apparatus. Thereafter, the arithmetic processing unit 651 displays the picture of the designated planar region of the selected layer picture 32a on the display means 652.

[0035] In this manner, the arithmetic processing unit 651 extracts the respective layer picture data corresponding to the planar region displayed on the display means 652 and stores them in the picture saving memory separately. Therefore, an operator having watched the displayed layer picture wants to notice an unfocused and obscurely micrographed part and to watch the other layer pictures of sample depths focused at the positions different from the position of the displayed layer picture, the other layer pictures can be displayed on the display device 652 without expending a long time by using the picture data separately stored in the picture saving memory. Consequently, the operator can display the pictures of any designated planar region on the display means 652 by using only the terminal 605, as if he/she were observing the sample depths of the three focal positions while looking into the ocular lens 623 of the microscope 602. That is, the arithmetic processing unit 651 separately stores the respective layer picture data corresponding to the extracted planar regions, whereby visual fields virtually viewed by the microscope can be reproduced only by the terminal 605.

[0036] Incidentally, the optical layout is not restricted to the case where the aberration compensation lenses 622a, etc. are respectively disposed for the line sensors 631a, etc. as shown in Fig. 4, but line sensors 731a, 731b, 731c may well be respectively focused on layers 701a, 701b, 701c of different sample depths by an aberration compensation lens 722 having a plurality of (three in an embodiment) radii of curvature, as shown in Fig. 5. Besides, the construction of each of the line sensors 631a, etc. is not restricted to the case where the CCDs numbering 4000 are arrayed in one row, but still more CCDs may well be arrayed in several rows. In addition, regarding the size of each individual CCD which constitutes the line sensors 631a, etc., smaller CCDs can image a picture of higher resolution. In case of using CCDs of larger sizes, however, a picture of higher resolution can be imaged by enlarging the magnifications of the imaging.

[0037] Besides, apart from the manual operations stated before, the adjustments of the focal positions and tilt of the sample 601 can be easily automated in such a way that focusing means having laser beam projection means is incorporated into the microscope 602, and that the tilting table 642 is moved on the basis of instructions from the computer. Further, the number of the line sensors 631a, etc. is not restricted to three as stated before, but it can be set at two or at four or more. The inspection regions of sample depths corresponding to each number can be simultaneously imaged.

[0038] Next, a cell inspection system will be described. First, the arithmetic processing unit 651 stores the picture data 32a - 32c of the whole inspection regions in the layers 601a, 601b, 601c of the three sample depths to be stored in the storage unit 653, respectively, in the storage unit 653 of the picture creating department 3, and it also records them in a DVD which is a large-capacity record medium. Besides, such DVDs are forwarded to the inspection department 4 and the diagnosis department 5, and the picture data are respectively stored in the storage units 42, 52 through the terminals 41, 51. Thus, the same picture data 42a - 42c, 52a - 52c

of the whole inspection regions in the layers 601a, 601b, 601c of the different sample depths are also existent in the terminals 41, 51 of the inspection department 4 and the diagnosis department 5 in relation to the cells or tissues to-be-inspected.

[0039] Here, the reason why the storage units 653, 42, 52 are included in the respective departments so as to record the picture data of the whole imaging regions of the cells or tissues is that the picture data become an enormous capacity of about 1 Gbyte or more every sample. There is also considered a system wherein the picture data are recorded in a single common server or the like beforehand, and wherein the recorded data are, e. g. , accessed or downloaded from the terminals of the respective departments by utilizing data transmission media. Since, however, the picture data capacity is excessively large, an excessively long time is expended on transmission/reception with the present-day transmission speed, and the system is unsuitable for practical use.

[0040] In the inspection department 4, therefore, the picture of the predetermined planar region of a desired layer among the three layers of the cells or tissues is first displayed at the terminal 41 on the basis of the picture data 42a - 42c stored in the storage unit 42, and the existence or nonexistence of any malignant cell or any cell for which malignance ought to be considered is inspected. The picture data 42a - 42c are the picture data of an area which is larger than an area displayable by display means 41a being the first picture display means of the terminal 41. In order to display the picture data at the terminal 41, therefore, the predetermined planar region to be displayed is designated from among the picture data of the desired layer.

[0041] Besides, in the existence of any malignant cell or any cell for which malignance ought to be considered, the range thereof is specified on a display screen. Prepared as specifying methods are one in which the cell is seen is demarcated by a frame line or coloring on the display screen, and one in which an arrow or sign and/or comments is/are inserted into a displayed picture.

[0042] In a case where the inspection etc. are simultaneously performed in the plurality of departments, the inspection department 4, diagnosis department 5 and picture creating department 3 are first brought into communicable states through a data transmission medium such as a telephone line or the like public line or an Internet dedicated line. The operator of the inspection department 4 operates the terminal 41, and selects a layer picture to be displayed at the terminal 41, for example, the layer picture 42a. The terminal 41 sets sample depth information for designating the selected layer picture, as a first condition. Besides, the terminal 41 displays the thumbnail (reduced picture) of the whole set layer picture 42a on the display means 41a.

[0043] The operator selects a desired planar region to display a non-reduced picture, from within the thumbnail. The terminal 41 sets coordinate information and the like for designating the selected planar region, as a second condition. Besides, the arithmetic processing unit of the terminal 41 extracts picture data which correspond to planar regions at positions corresponding to the designated planar region, from the other layer picture data 42b, 42c. Subsequently, the arithmetic processing unit brings the picture data of the respective planar regions extracted from among the corresponding layer picture data 42a - 42c, into one set, and then stores them in a picture saving memory disposed in a picture processing apparatus. Thereafter, using the first condition and the second condition, the terminal 41 selects the layer picture data 42a from among the picture data stored in the storage unit 42 and then extracts picture data corresponding to the selected planar region, from within the layer picture data 42a, and it displays the picture of the selected planar region on the display means 41a. The first condition and the second condition have a very small data quantity unlike .the layer picture data of the selected planar region, so that a long time is not expended on communications even when the conditions are transmitted/received by the data transmission medium.

[0044] At the same time, the terminal 41 transmits the first condition and the second condition to the terminals 605, 51 of the picture creating department 3 and the diagnosis department 5 through the data transmission medium by communication means. Using the first and second conditions received, the terminals 605, 51 select the layer picture data 32a, 52a from among the corresponding picture data stored in the storage units 653, 52 and then extract picture data corresponding to the selected planar regions, from within the selected layer picture data, and they display correspondent pictures corresponding to the picture displayed at the terminal 41, on display means 652, 51a being secondpicture display means . Of course, on this occasion, in the samemanner as at the terminal 41, the respective arithmetic processing units of the terminals 605, 51 extract picture data which correspond to planar regions at positions corresponding to the designated planar region, from within the other layer picture data 32b, 32c and 52b, 52c. Besides, the respective arithmetic processing units bring the picture data of the planar regions extracted from within the layer picture data 32a - 32c and 52a - 52c, into individual sets, and they store the picture data in picture saving memories disposed in the picture processing apparatuses.

[0045] Owing to the above, the same picture is displayed at the terminal 41 of the inspection department 4, the terminal 605 of the picture creating department 3 and the terminal 51 of the diagnosis department 5 merely by transmitting/receiving the two conditions of the first and second conditions through the data transmission medium.

[0046] Besides, when the operator of the inspection department 4 indicates an index for the demarcation based on the frame line or coloring or for inserting the

arrow or sign or the comments into the displayed picture, on the picture displayed at the terminal 41, from an input device such as mouse or keyboard, the terminal 41 sets information representative of the sort, coordinates, etc. of the index, as a third condition. Likewise to the first and second conditions, the third condition has a small data quantity as compared with the layer picture data of the selected planar region, and a long time is not expended on the communications thereof. At the same time, the terminal 41 transmits the third condition to the terminal 605 of the picture creating department 3 and the terminal 51 of the diagnosis, department 5 through the data transmission medium by the transmission means. Using the third condition received, the terminals 605, 51 display indices on the display means 652, 51a. Consequently, the indices which correspond to the index displayed at the terminal 41 are displayed also on the display means 652, 51a of the terminals 605, 51.

[0047] Accordingly, it is permitted to make studies while the same planar region within the picture having the very large imaging region is being watched, in such a way that the inspection department 4, picture creating department 3 and diagnosis department 5 merely transmit/receive the small data quantities of the first - third conditions through the data transmission medium. By way of example, the labor of searching for any malignant cell is not required in the diagnosis department 5. Besides, in a case where, apart from the malignant cell or the cell for which the malignance ought to be considered as has been specified in the inspection department 4, any other cell for which malignance ought to be considered has been found out in the diagnosis department 5, or where imaging data of still higher magnifications, for example, are required, the operator of the diagnosis department 5 specifies a corresponding position on the display screen of the terminal 51 or appends the instruction of an imaging condition. Then, in the same manner as already described in relation to the terminal 41, the terminal 51 transmits the first - third conditions to the terminals 605, 41 of the inspection department 4 and picture creating department 3 through the data transmission medium, and the specified range, the imaging condition, etc. are immediately displayed. Processing can be quickly and appropriately executed in accordance with the displayed instructions.

[0048] Besides, in a case, for example, where the operator of the inspection department 4 cannot form a judgment on the malignant cell with only the focused part of a picture currently under display, and where he/she wants to watch a defocused part out of focus, with a focused layer picture of different sample depth, he/she designates the focused picture of the layer of different sample depth at the terminal 41. Then, since the picture data of the other layers corresponding to the displayed planar region are stored in the picture saving memory, the arithmetic processing unit of the terminal 41 can immediately display the different layer picture merely by altering the first condition and without the necessity of extracting the corresponding planar region from the whole imaging region anew. That is, in a case, for example, where the operator wants to change-over the display from the layer picture 42a currently under display, to the layer picture 42b, he/she selects the layer picture 42b. Then, the terminal 41 resets sample depth information for designating the selected layer picture, as the first condition, and it displays the extracted layer picture 42b of the picture saving memory on the display means 41a. Besides, the terminal 41 merely transmits only the altered first condition to the other terminals 605 , 51, whereby the same altered layer picture as at the terminal 41 is extracted from the picture savingmemories and immediately displayed at the other terminals.

[0049] In the above embodiment, studies have been made in the three departments while the same picture is being simultaneously watched. However, the present invention is not restricted to this aspect, but studies may well be similarly made in only two departments or in four or more departments while the same picture is being watched. Since, in this manner, information and opinions can be exchanged through the data transmission medium, it is permitted to efficiently perform a very exact sample inspection as if the members of the departments met together. Besides, the present invention is not limited only to the cells or the tissues, but it can be utilized for the sample inspection of blood, bacteria, or the like. In addition, the above embodiment is so constructed that the extracted picture of each layer is displayed on the display means 652 in an alternative way, but the combination of a plurality of extracted pictures of the respective layers may well be simultaneously displayed on the display means 652 without being restricted to the construction. By way of example, extracted pictures of two or more sample depths may well be disposed in superposition, or two or more extracted pictures may well be displayed on the display means 652 in parallel. In this case, the two or more pictures can be displayed on the display means in parallel by making each planar region half the size of the screen or smaller. In this way, the inspection is facilitated more owing to easier multilevel recognition because the two or more pictures are displayed on the display means 652. Besides, the number of the line sensors of the microscope apparatus is not restricted to three, but a single line sensor or four or more line sensors may well be employed.

[Advantages of the Invention]

[0050] The picture data of a plurality of layers of different sample depths can be promptly displayed on display means. Moreover, when a plurality of pictures are displayed in parallel or in superposition, it is facilitated to recognize cells or the likes in multilevel fashion. Moreover, the predetermined planar region of a picture having a very large imaging region can be easily and promptly displayed at a plurality of spots merely by transmitting the conditions of small data quantities.

[Brief Description of the Drawings]

[Fig. 1]

[0051] Fig. 1 is a general constructional view of an inspection system.

[Fig. 2]

[0052] Fig. 2 is a constructional view of a microscope apparatus.

[Fig. 3]

[0053] Fig. 3 is another constructional view of a microscope apparatus.

[Fig. 4]

[0054] Fig. 4 is a layout diagram of optical lenses.

[Fig. 5]

[0055] Fig. 5 is another layout diagram of optical lenses.

[Fig. 6]

[0056] Fig. 6 is an enlarged front view of line sensors and aberration compensation lenses.

[Fig. 7]

[0057] Fig. 7 is an explanatory diagram of the imaging steps of line pictures.

[Fig. 8]

[0058] Fig. 8 is an explanatory diagram concerning the imaging of the line sensors.

[Description of Reference Numerals and Signs]

[0059]

2	Data transmission medium
3	Picture creation department
32a - 32c	Layer picture data
4	Inspection department
41	Terminal
41a	Display means
42	Storage unit
42a - 42c	Layer picture data
5	Diagnosis department
51	Terminal
51a	Display means
52	Storage unit
52a - 52c	Layer picture data
601	Sample
602	Microscope
605	Terminal
631	Line sensor (Electronic imaging device)
651	Arithmetic processing unit (Picture processing apparatus)
652	Display means
653	Storage unit

Claims

1. A sample picture data processing method comprising:

the step of generating sample picture data of a plurality of layers of different sample depths from a sample through electronic imaging devices for the respective layers, and for storing the generated sample picture data;
the step of designating a planar region which is to be extracted from the respective sample picture data; and
the step of extracting extraction picture data corresponding to the planar region, for said respective layers from said respective sample picture data upon receiving the designation of said planar region, and for storingthe extraction picture data.

2. A sample picture data processing method according to claim 1, wherein the sample is a cytodiagnostic sample.

3. A sample inspection system comprising:

means for generating sample picture data of a plurality of layers of different sample depths from a sample through electronic imaging devices for the respective layers, and for storing the generated sample picture data;
means for designating a planar region which is to be extracted from the respective sample picture data;
means for extracting extraction picture data corresponding to the planar region, for said respective layers from said respective sample picture data upon receiving the designation of said planar region, and for storing the extraction picture data; and
a picture processing apparatus which displays extracted pictures of said respective layers on display means in an alternative way or simultaneously in a combination of two or more of them, on the basis of the respective extraction picture data of said respective layers.

4. A sample inspection system according to claim 3,

wherein the sample is a cytodiagnostic sample..

5. A sample inspection system according to claim 3 or 4, wherein, when the sample picture is to be displayed, a plurality of selected extraction pictures are displayable in parallel or in superposition.

6. A sample inspection system according to any of claims 3 - 5, wherein the electronic imaging devices are line sensors, and said sample picture data consist of a set of individual line picture data imaged by the line sensors.

7. A sample inspection method **characterized by** comprising:

the display layer setting step of setting a first condition which designates a single layer picture that is to be displayed at a specified terminal on the basis of picture data imaged for a plurality of respective layers of different sample depths from a sample;
the display region setting step of setting a second condition which designates a predetermined planar region that is to be extracted from the layer picture designated by the first condition;
the first picture display step of displaying the predetermined planar region extracted from said layer picture, at the specified terminal in accordance with the first and second conditions;
the condition transmission step of transmitting said first and second conditions to another terminal; and
the second picture display step of displaying a correspondent planar region corresponding to said predetermined planar region, at the other terminal in accordance with said first and second conditions that have been transmitted to said other terminal and on the basis of correspondent picture data that have been prestored at said other terminal in correspondence with the picture data.

8. A sample inspection method according to claim 7, **characterized by** comprising the index display setting step of setting a third condition which represents an index for indicating a specified part of said predetermined planar region displayed at said specified terminal; the first index display step of displaying the index on said planar region displayed at said specified terminal, in accordance with the third condition; the second condition transmission step of transmitting said third condition to said other terminal; and the second index display step of displaying a correspondent index corresponding to said index, at said other terminal in accordance with said third condition transmitted to said other terminal.

9. A sample inspection system **characterized by** comprising:

display layer setting means for setting a first condition which designates a single layer picture that is to be displayed at a specified terminal on the basis of picture data imaged for a plurality of respective layers of different sample depths from. a sample;
display region settingmeans for setting a second condition which designates a predetermined planar region that is to be extracted from the layer picture designated by the first condition;
first picture display means for displaying the predetermined planar region extracted from said layer picture, at the specified terminal in accordance with the first and second conditions;
condition transmission means for transmitting said first and second conditions to another terminal; and
second picture display means for displaying a correspondent planar region corresponding to said predetermined planar region, at the other terminal in accordance with said first and second conditions that have been transmitted to said other terminal and on the basis of correspondent picture data that have been prestored at said other terminal in correspondence with the picture data.

10. A sample inspection system according to claim 9, **characterized by** comprising index display setting means for setting a third condition which represents an index for indicating a specified part of said predetermined planar region displayed at said specified terminal; first index display means for displaying the index on said predetermined planar region displayed at said specified terminal, in accordance with the third condition; second condition transmission means, for transmitting said third condition to said other terminal; and second index display means for displaying a correspondent index corresponding to said index, at said other terminal in accordance with said third condition transmitted to said other terminal.

FIG.1

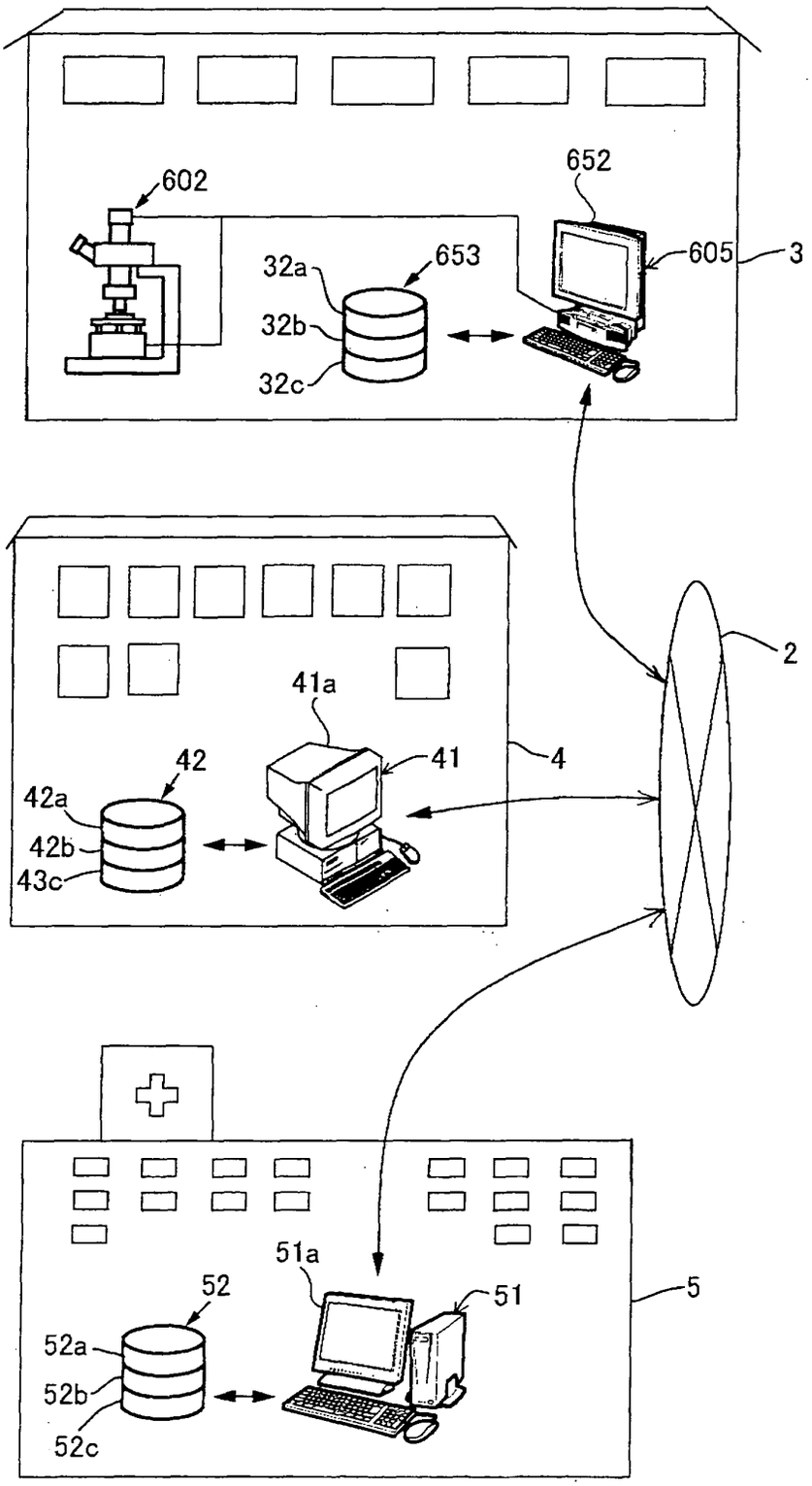

602
652
605
3
32a
653
32b
32c
2
41a
41
4
42
42a
42b
43c
51a
52
51
5
52a
52b
52c

FIG.2

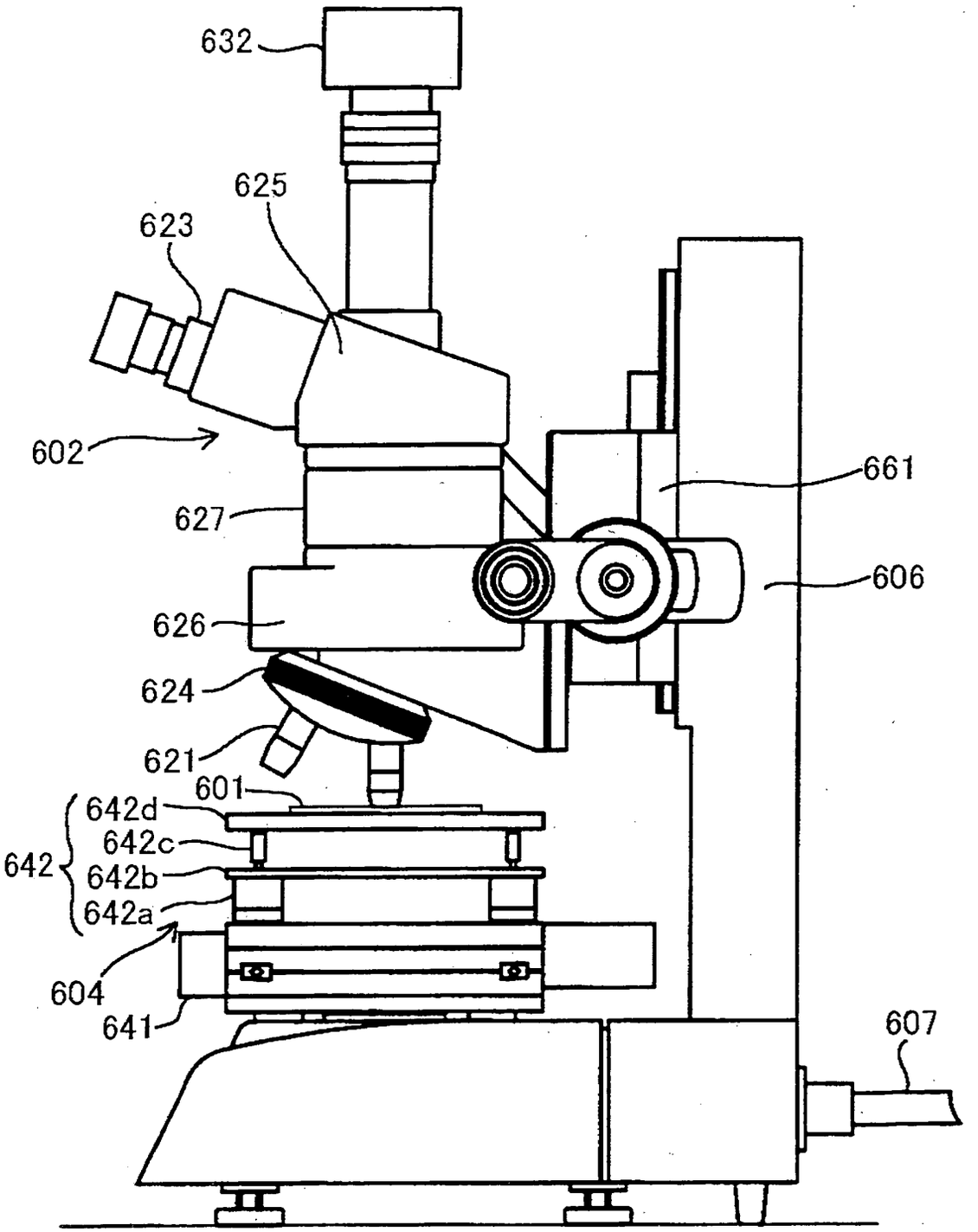

632
625
623
602
661
627
606
626
624
621
601
642d
642c
642
642b
642a
604
641
607

FIG.3

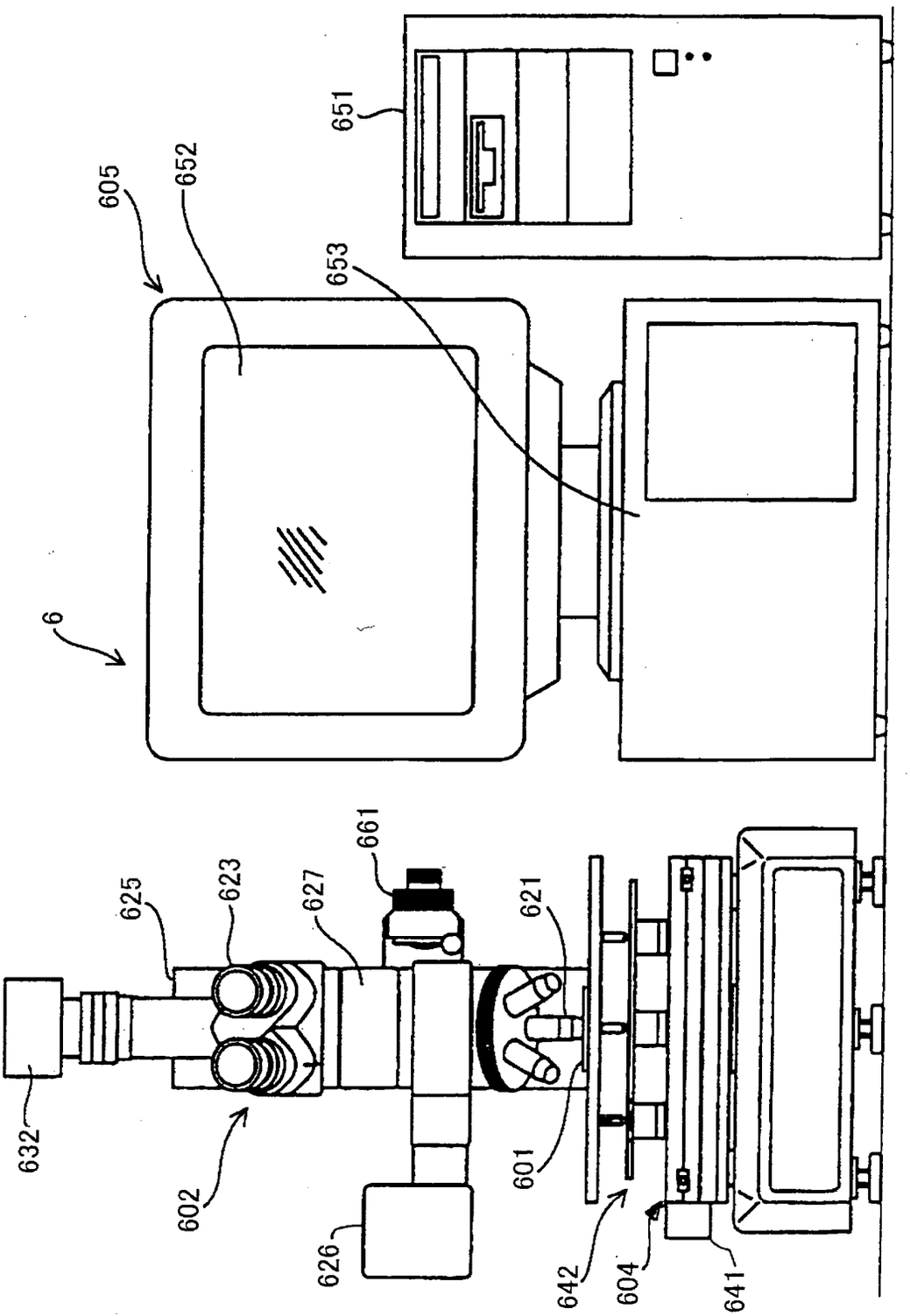


FIG.4

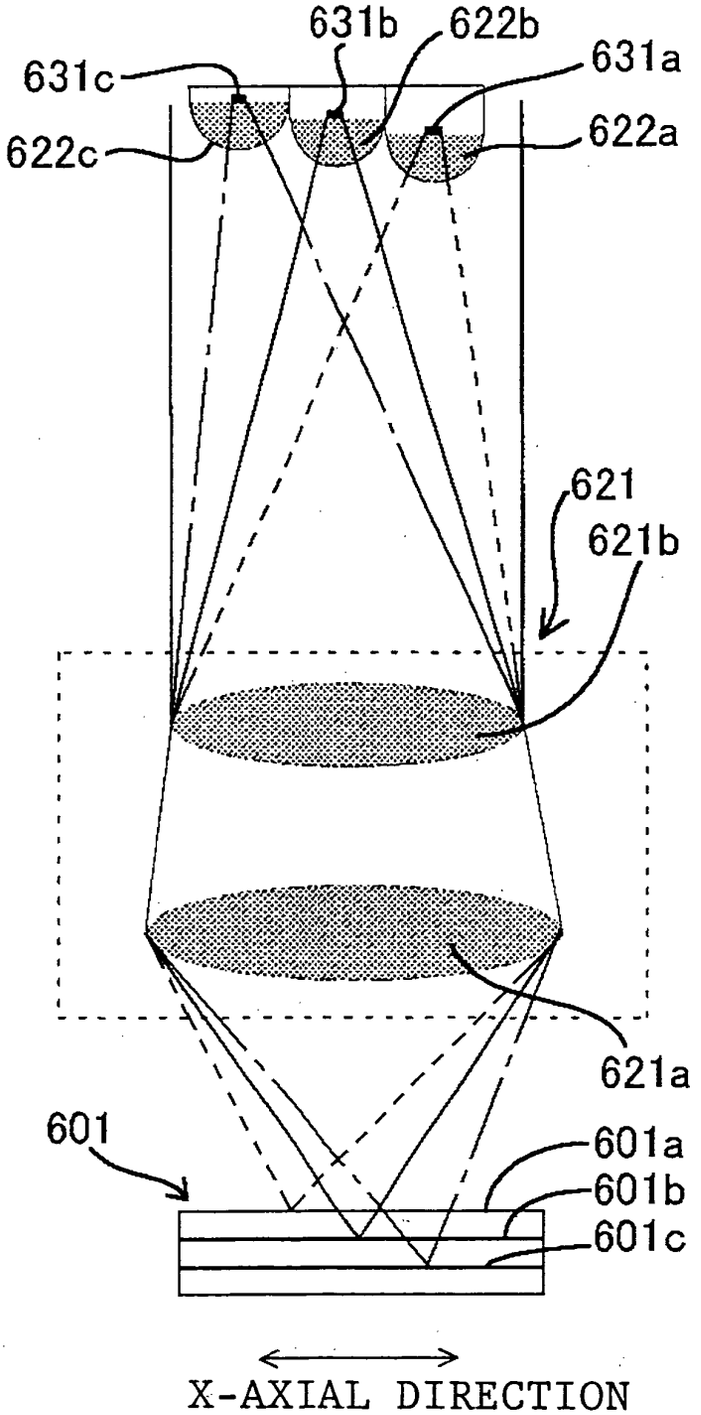
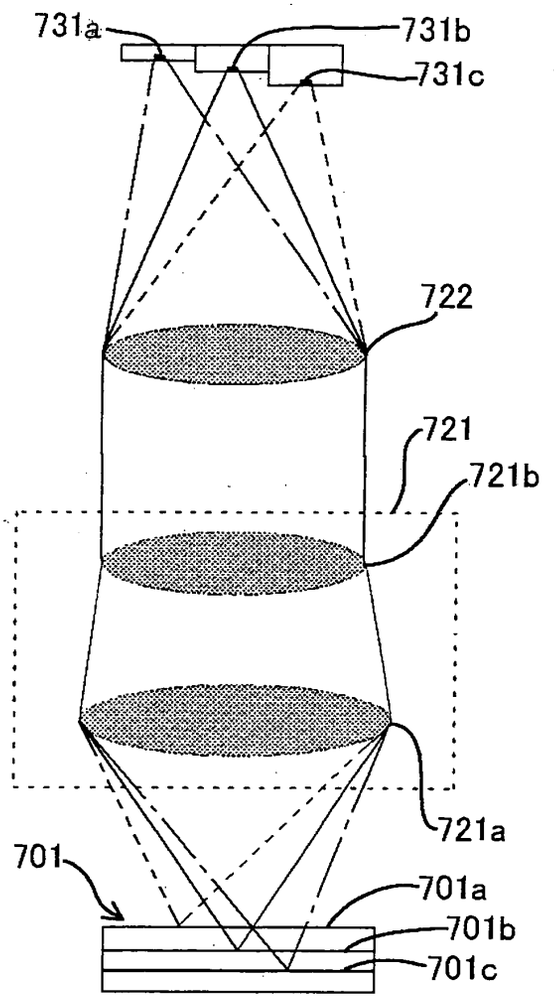

631b
622b
631c
631a
622c
622a
621
621b
621a
601
601a
601b
601c
X-AXIAL DIRECTION

FIG.5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731b
731c
722
721
721b
721a
701
701a
701b
701c

FIG.6

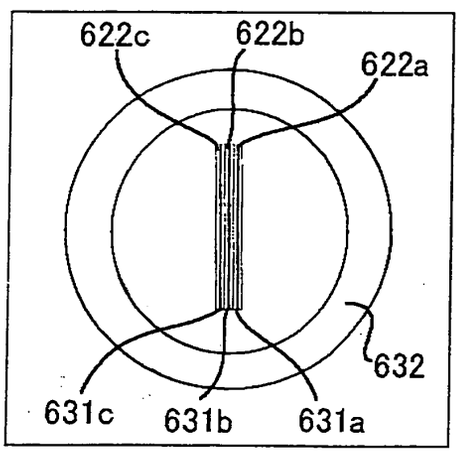

622c
622b
622a
632
631c
631b
631a

FIG.7

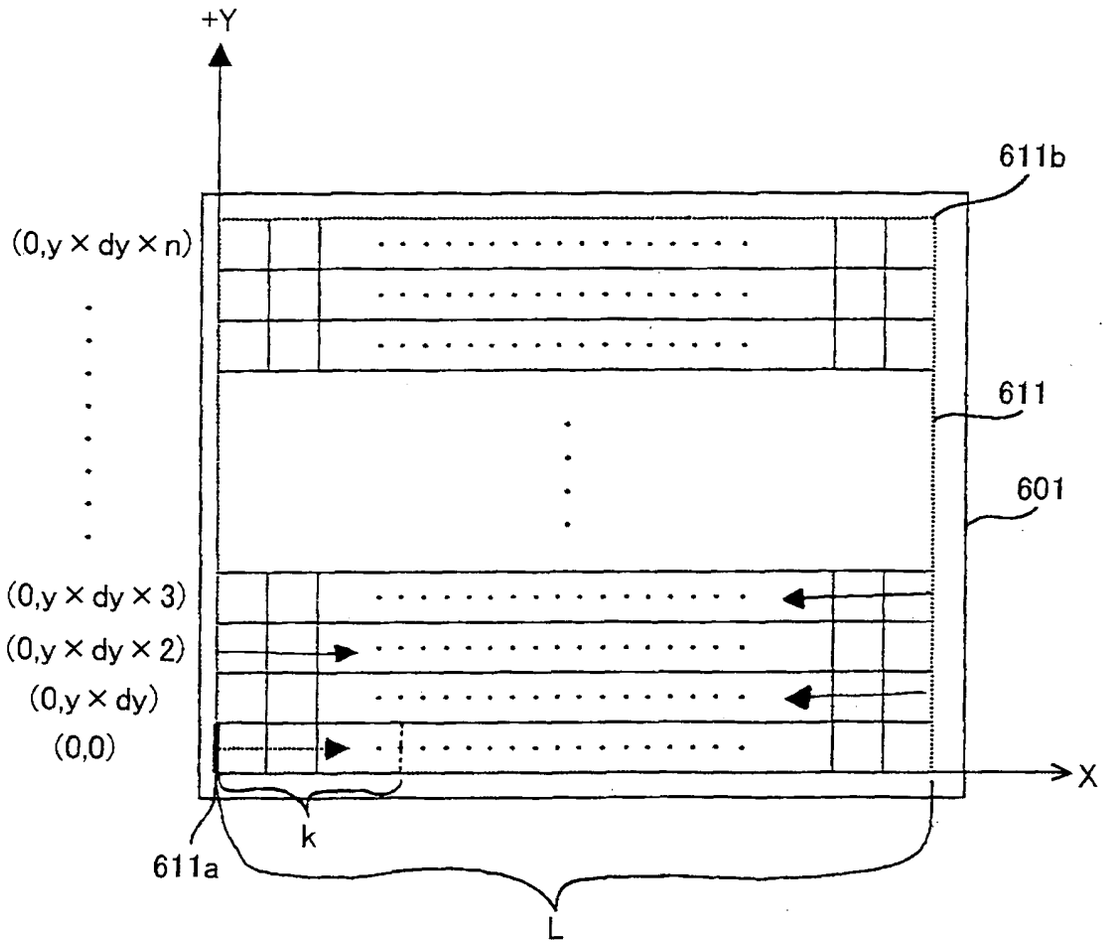
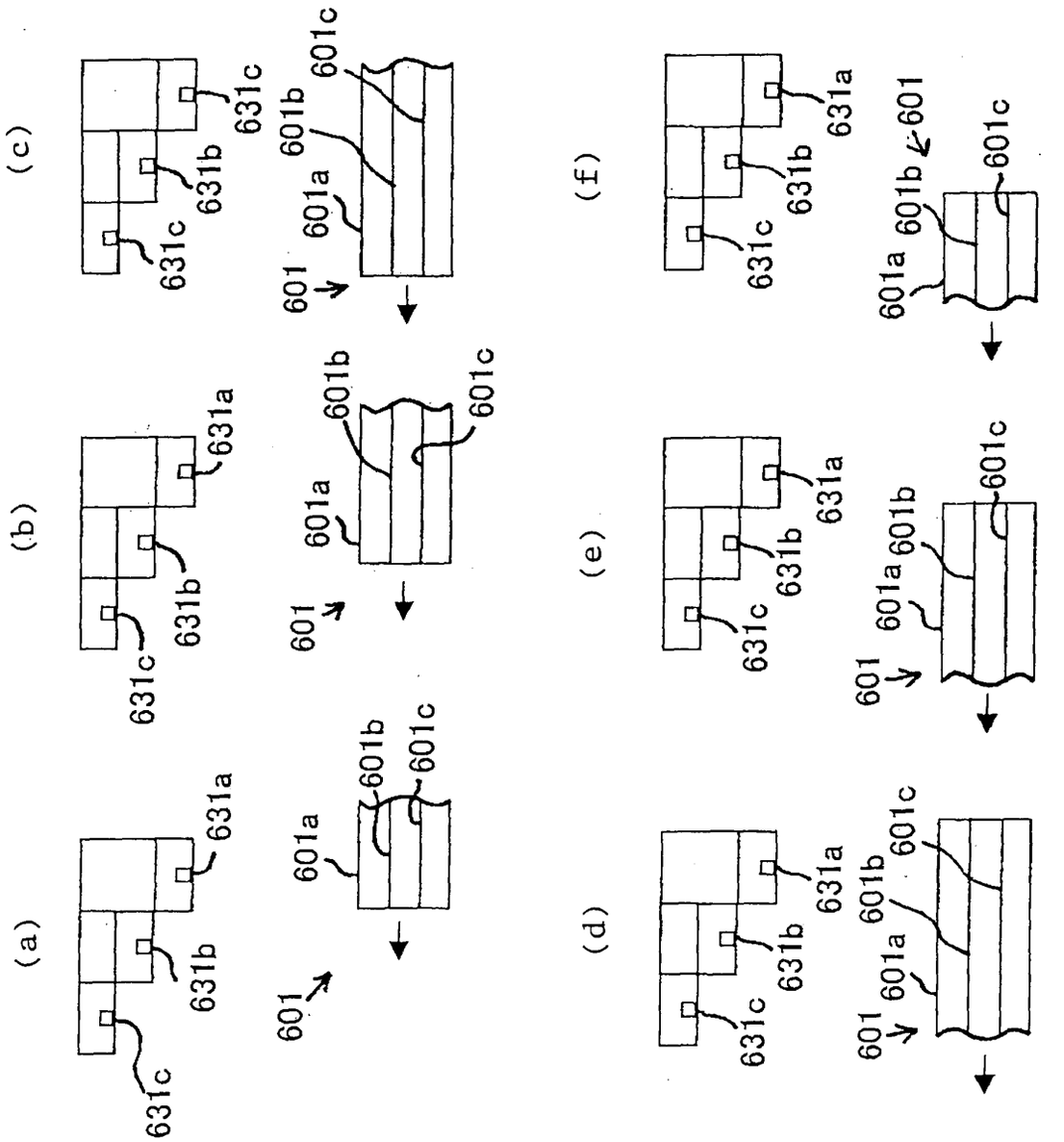


FIG.8


(a)
631c
631b
631a
601
601a
601b
601c
(b)
631c
631b
631a
601
601a
601b
601c
(c)
631c
631b
631a
601
601a
601b
601c
(d)
631c
631b
631a
601
601a
601b
601c
(e)
631c
631b
631a
601
601a
601b
601c
(f)
631c
631b
631a
601
601a
601b
601c