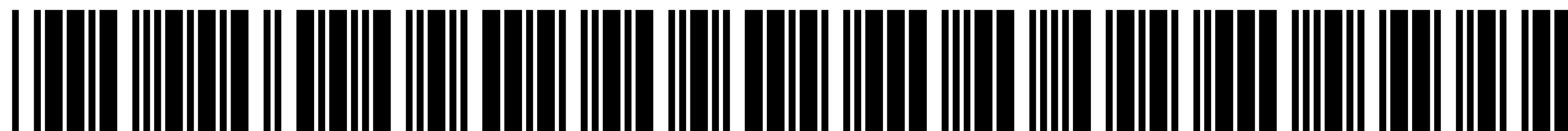


(19) **United States**

(12) **Patent Application Publication**

Okita

(10) **Pub. No.: US 2012/0133913 A1**

(43) **Pub. Date: May 31, 2012**

(54) **ADJUSTMENT METHOD, SUBSTRATE PROCESSING METHOD, SUBSTRATE PROCESSING APPARATUS, EXPOSURE APPARATUS, INSPECTION APPARATUS, MEASUREMENT AND/OR INSPECTION SYSTEM, PROCESSING APPARATUS, COMPUTER SYSTEM, PROGRAM AND INFORMATION RECORDING MEDIUM**

(75) Inventor: **Shinichi Okita**, Nishitokyo-shi (JP)

(73) Assignee: **Nikon Corporation**, Tokyo (JP)

(21) Appl. No.: **13/367,671**

(22) Filed: **Feb. 7, 2012**

Related U.S. Application Data

(62) Division of application No. 11/706,377, filed on Feb. 15, 2007, now Pat. No. 8,134,681.

(60) Provisional application No. 60/872,504, filed on Dec. 4, 2006.

(30) **Foreign Application Priority Data**

Feb. 17, 2006 (JP) 2006-041219

Publication Classification

(51) **Int. Cl.**
G03B 27/52 (2006.01)

(52) **U.S. Cl.** **355/30**

(57) **ABSTRACT**

When a host issues an analysis order that specifically instructs the analytical contents to an analytical apparatus (step **401**), the analytical apparatus collects two types of measurement and/or inspection results from a measurement and/or inspection instrument (steps **403** to **409**), and in step **411**, the analytical apparatus analyzes the measurement and/or inspection results and optimizes processing conditions of a series of processes related to wafer W. In step **411**, data related to a processing state of a processing apparatus is acquired from the processing apparatus as needed. In step **413**, the measurement and/or inspection results and the optimization results are accumulated in a database, and the optimization results are transmitted to various processing apparatuses (including the measurement and/or inspection instrument). After that, the analytical apparatus sends a processing end notice to the host (step **417**).

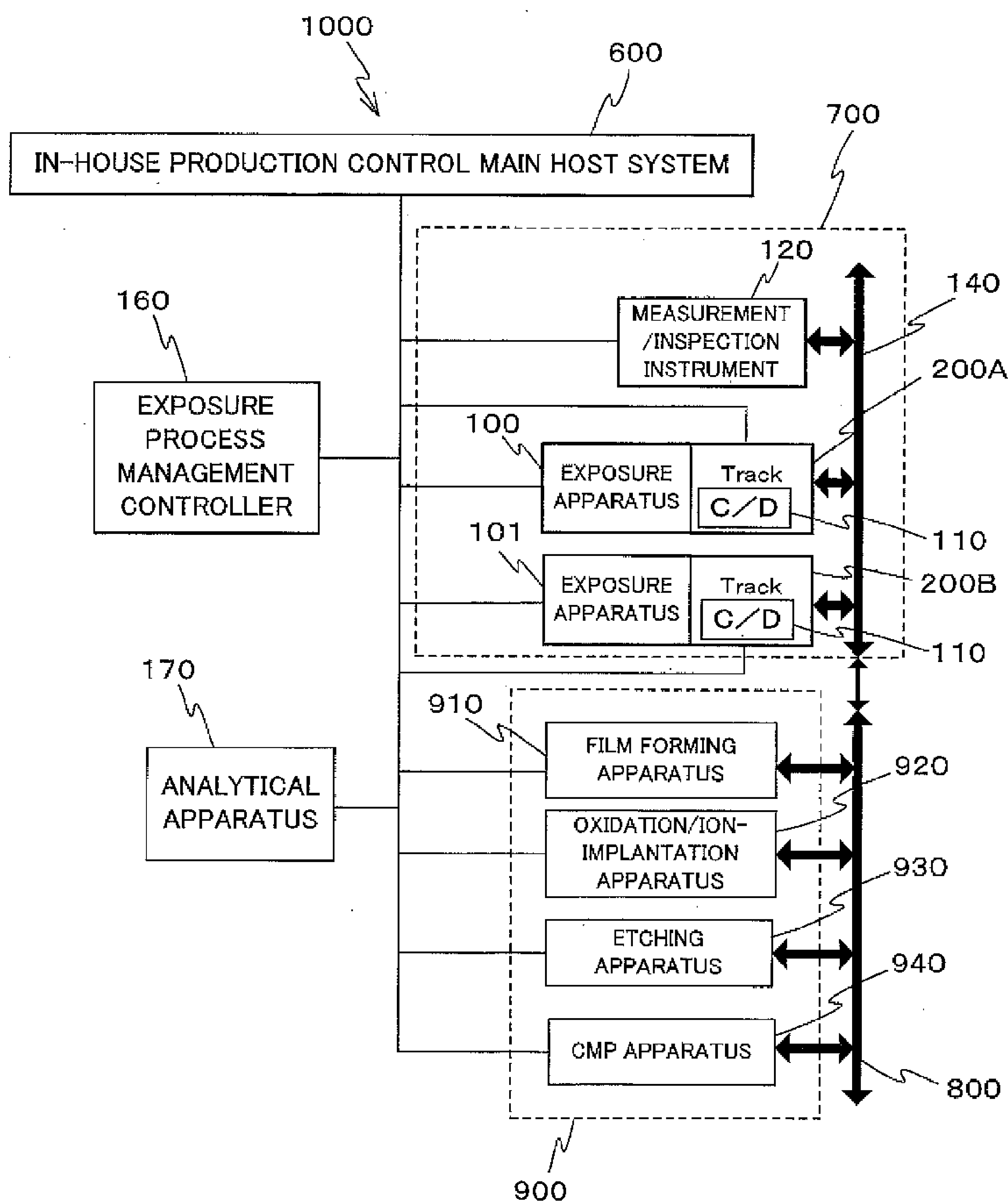


Fig. 1

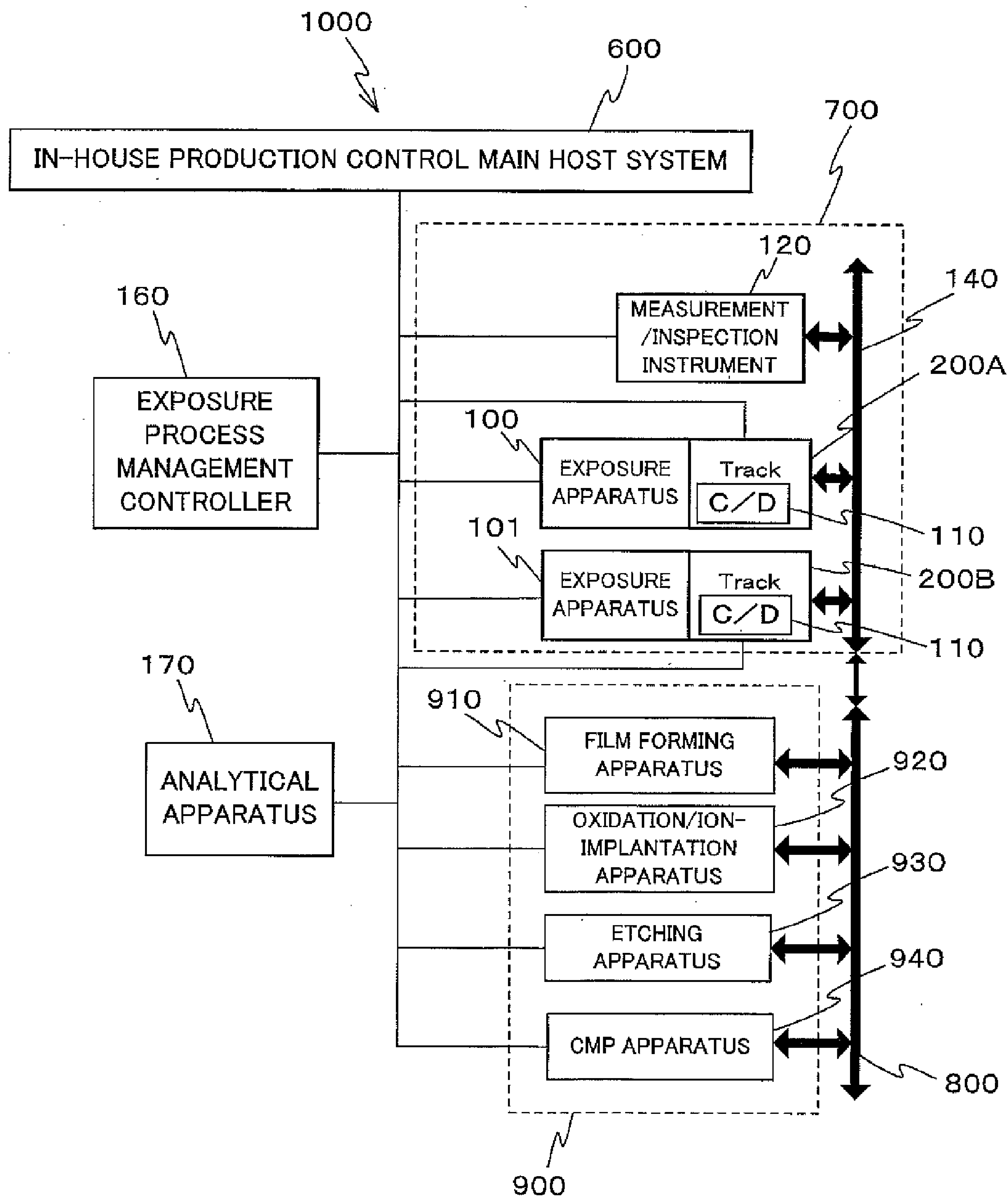


Fig. 2

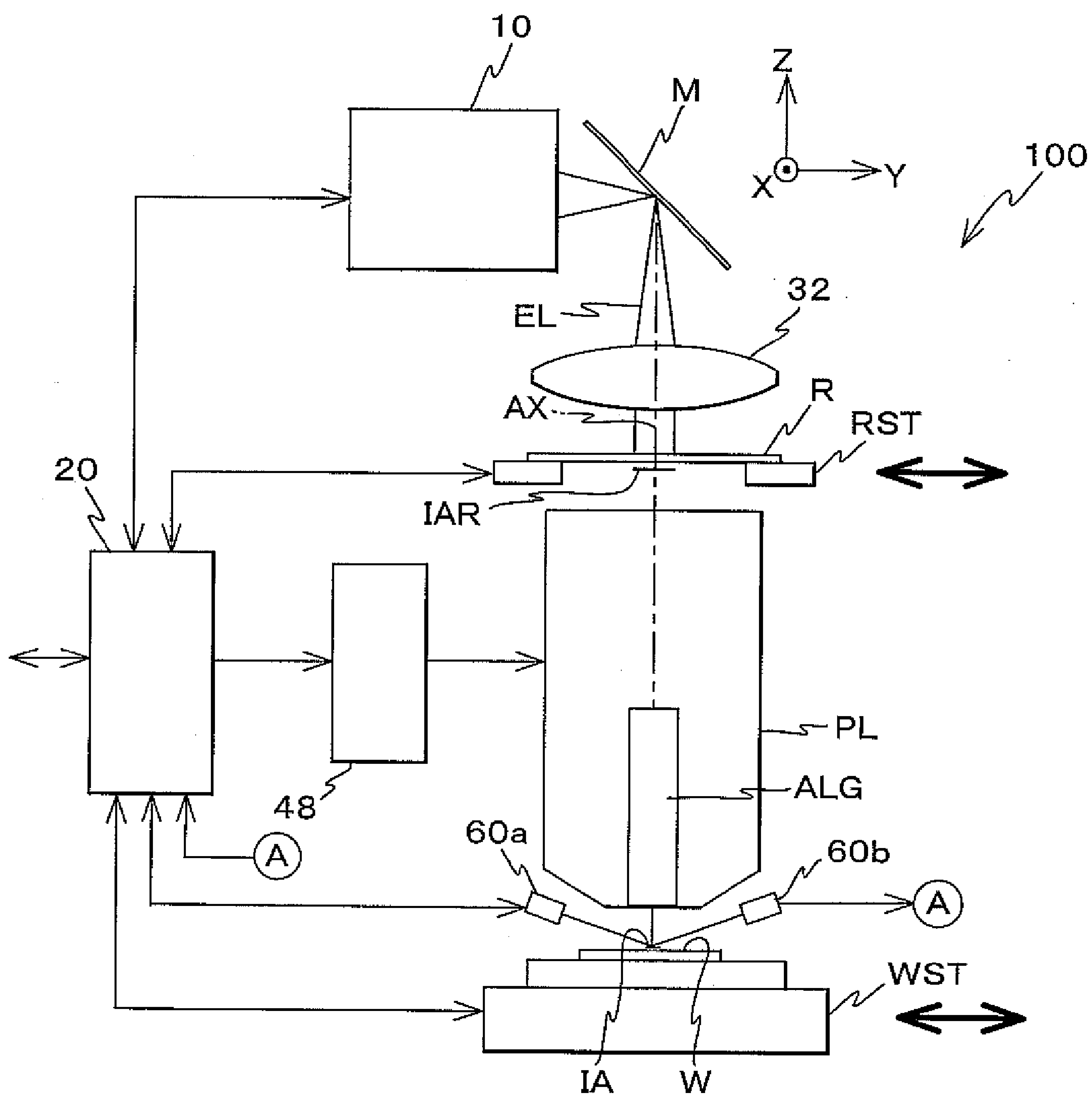


Fig. 3A

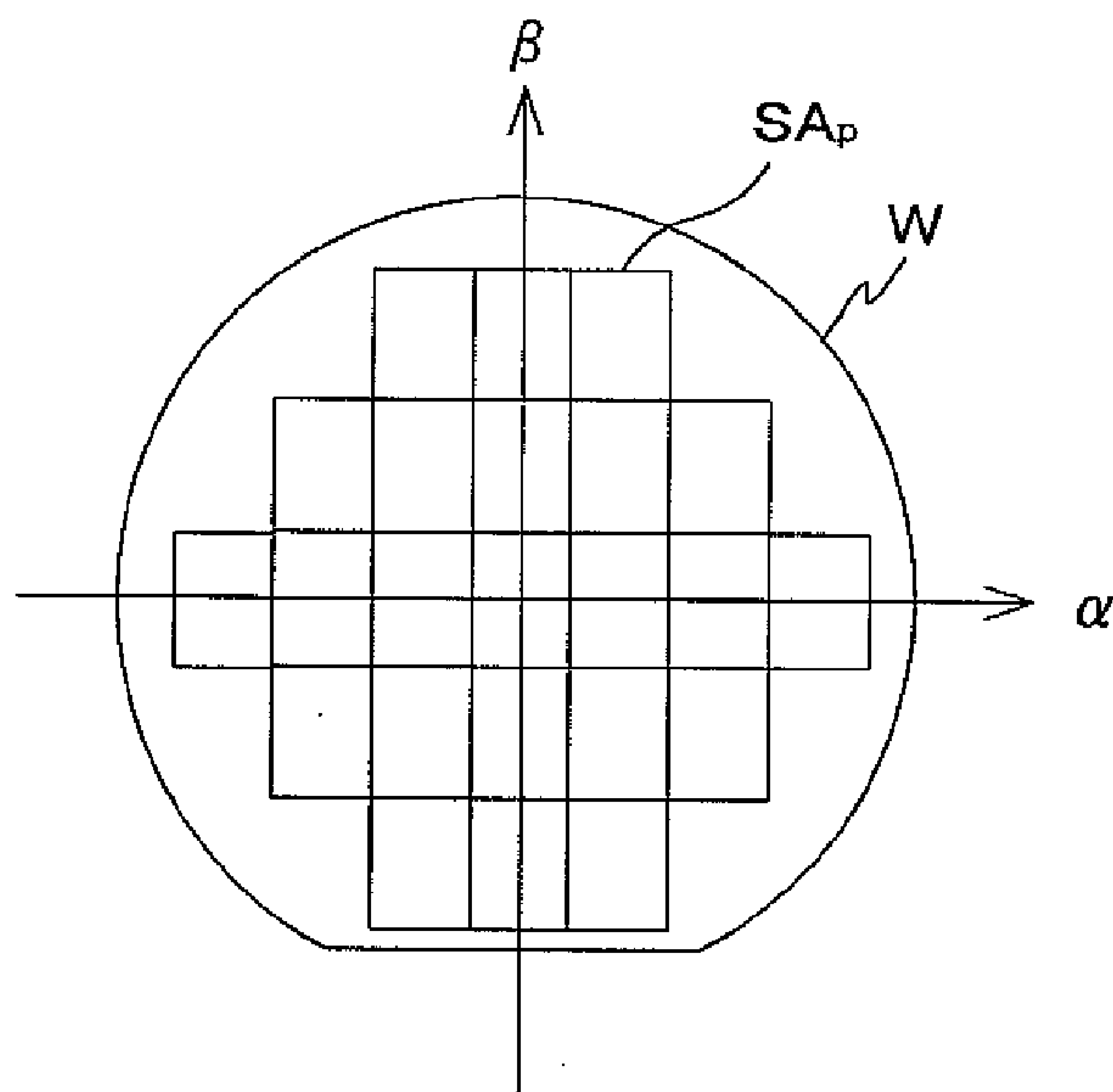


Fig. 3B

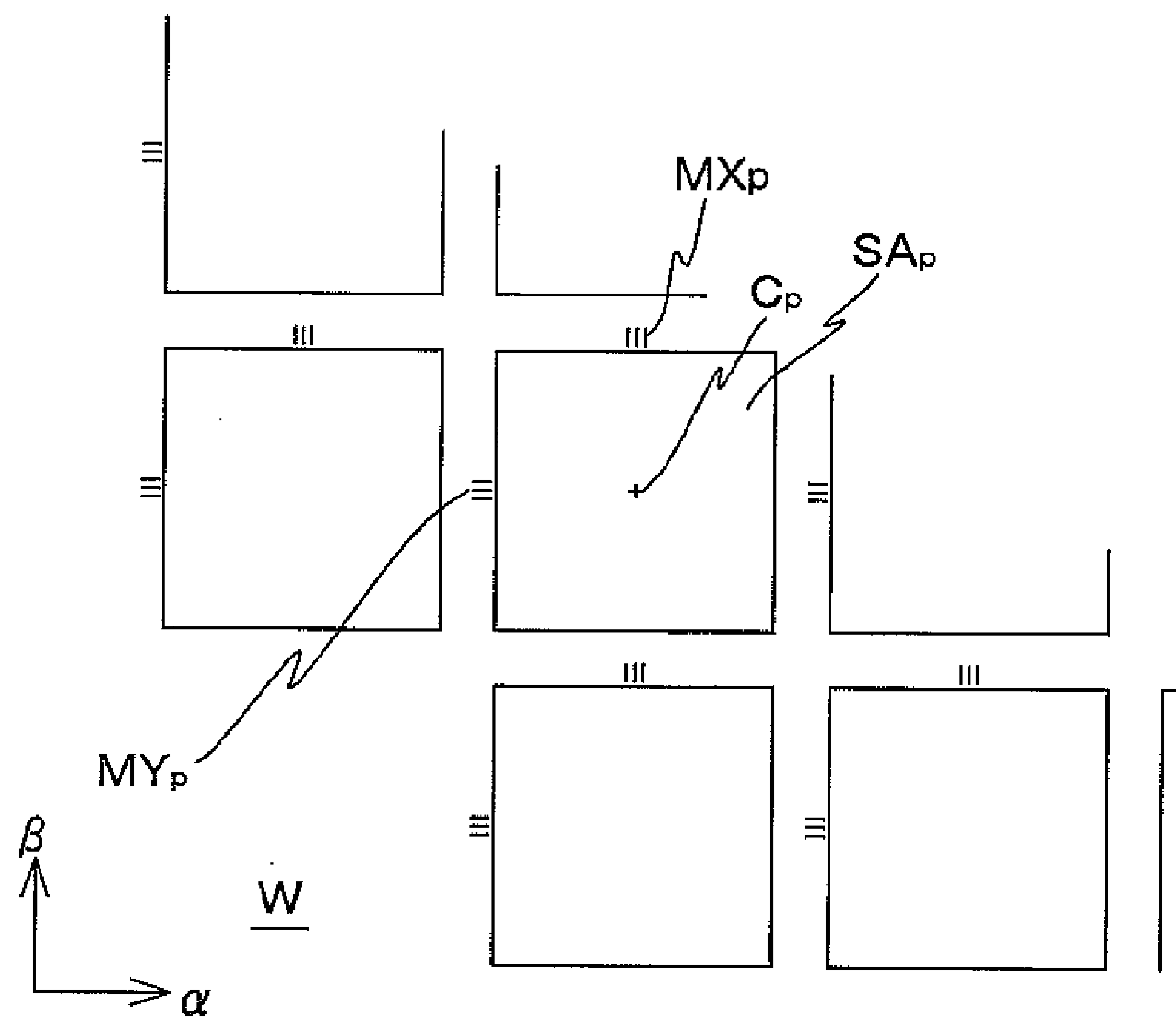
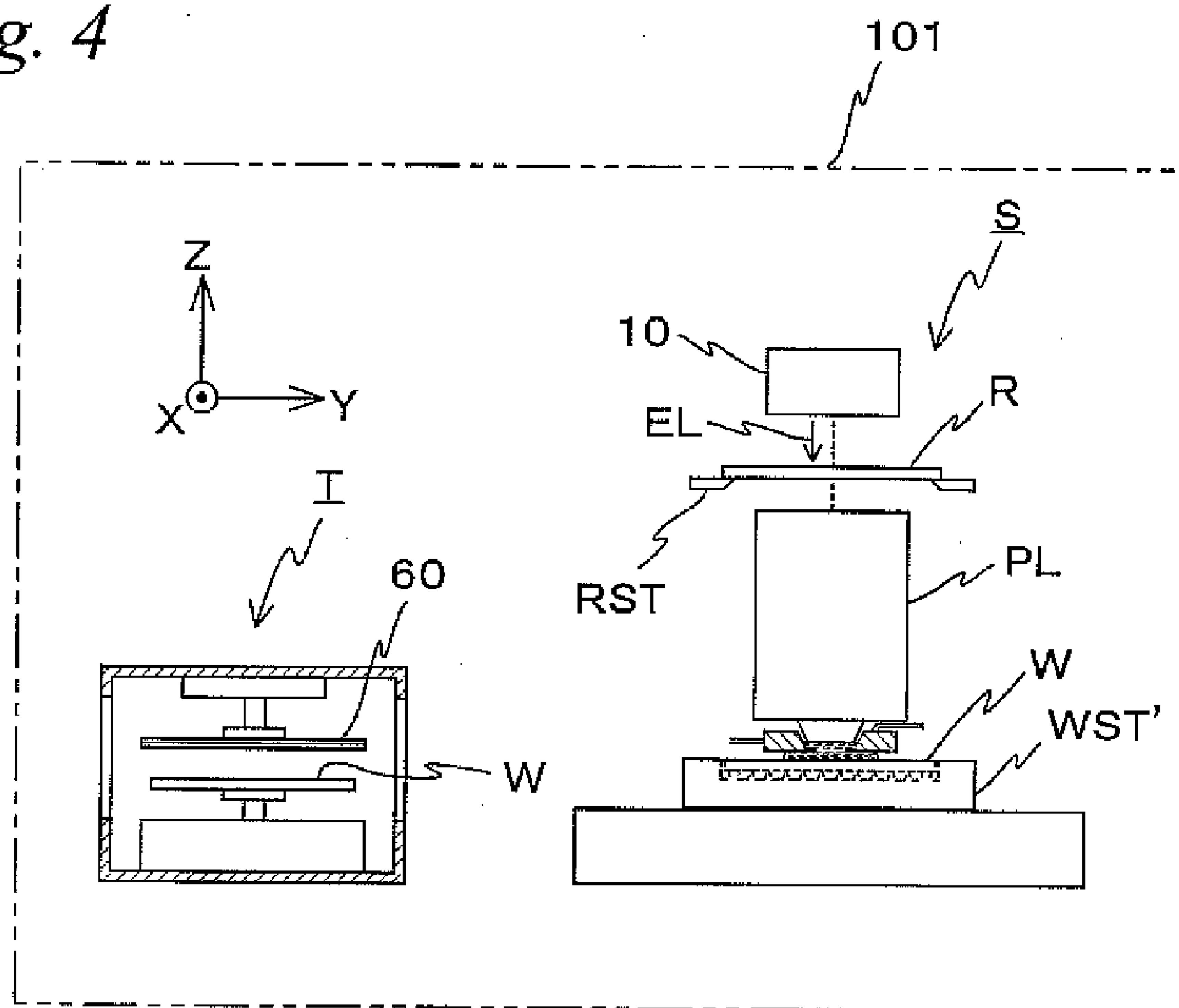


Fig. 4



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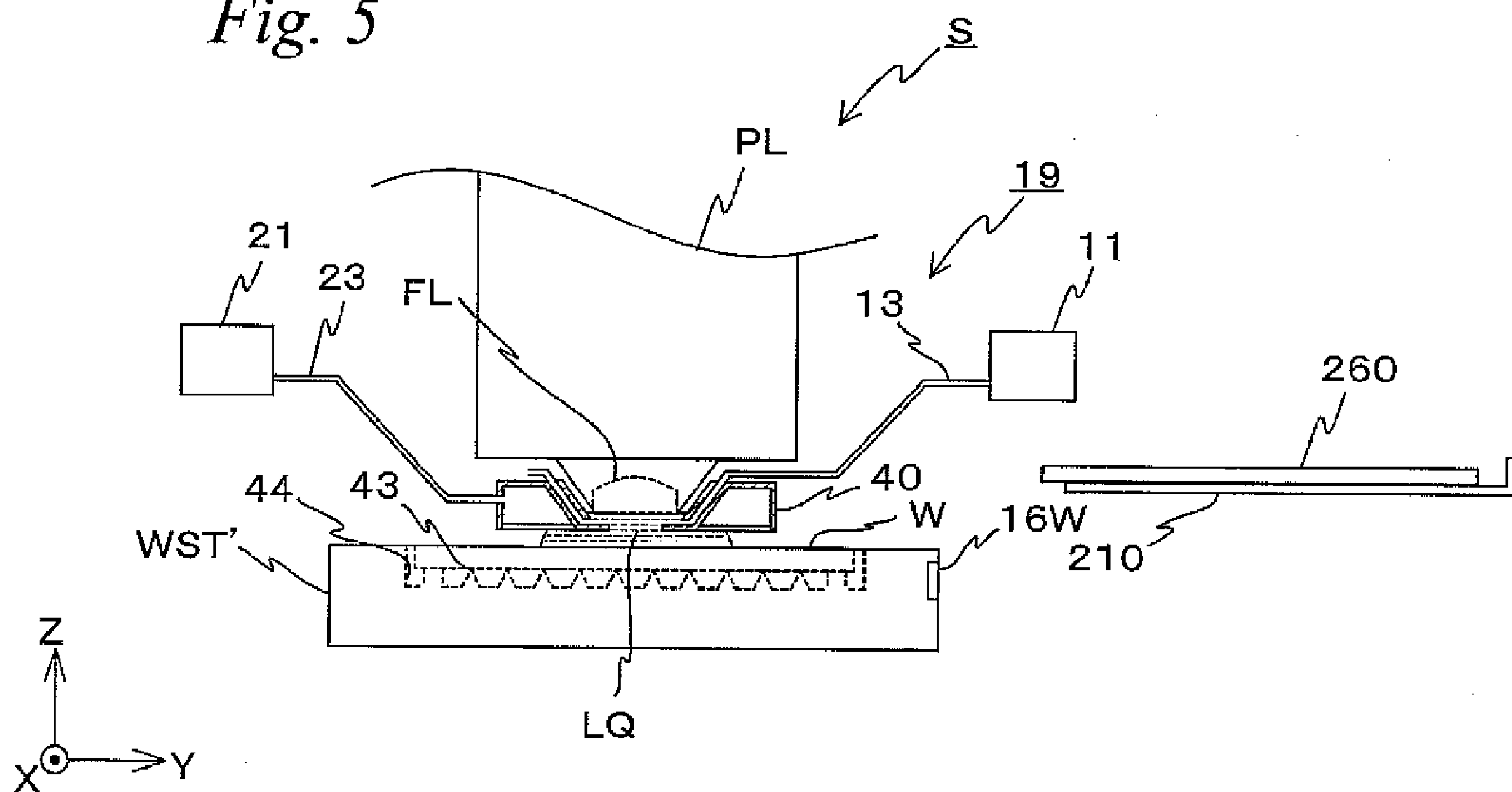

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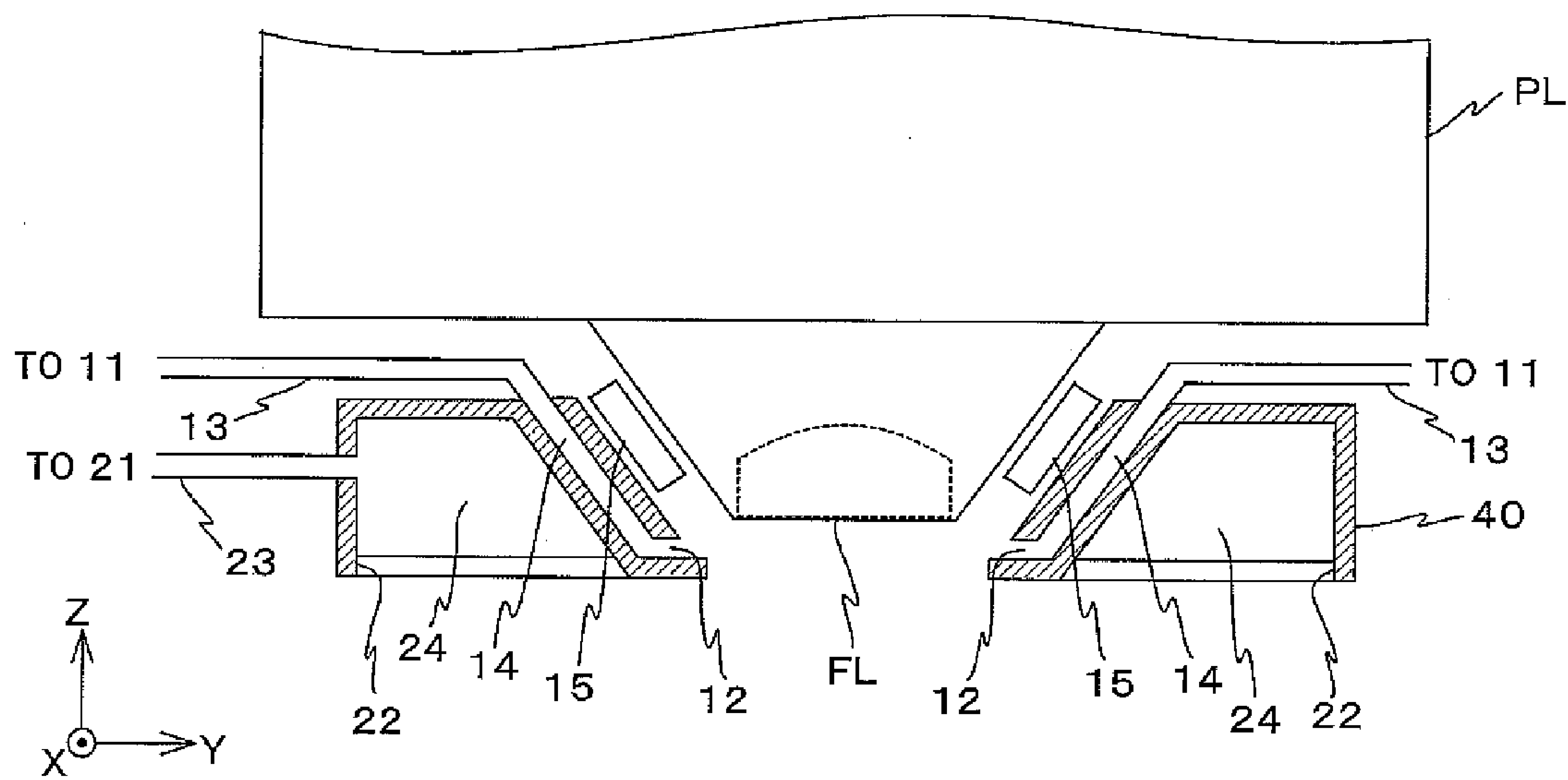


Fig. 7A

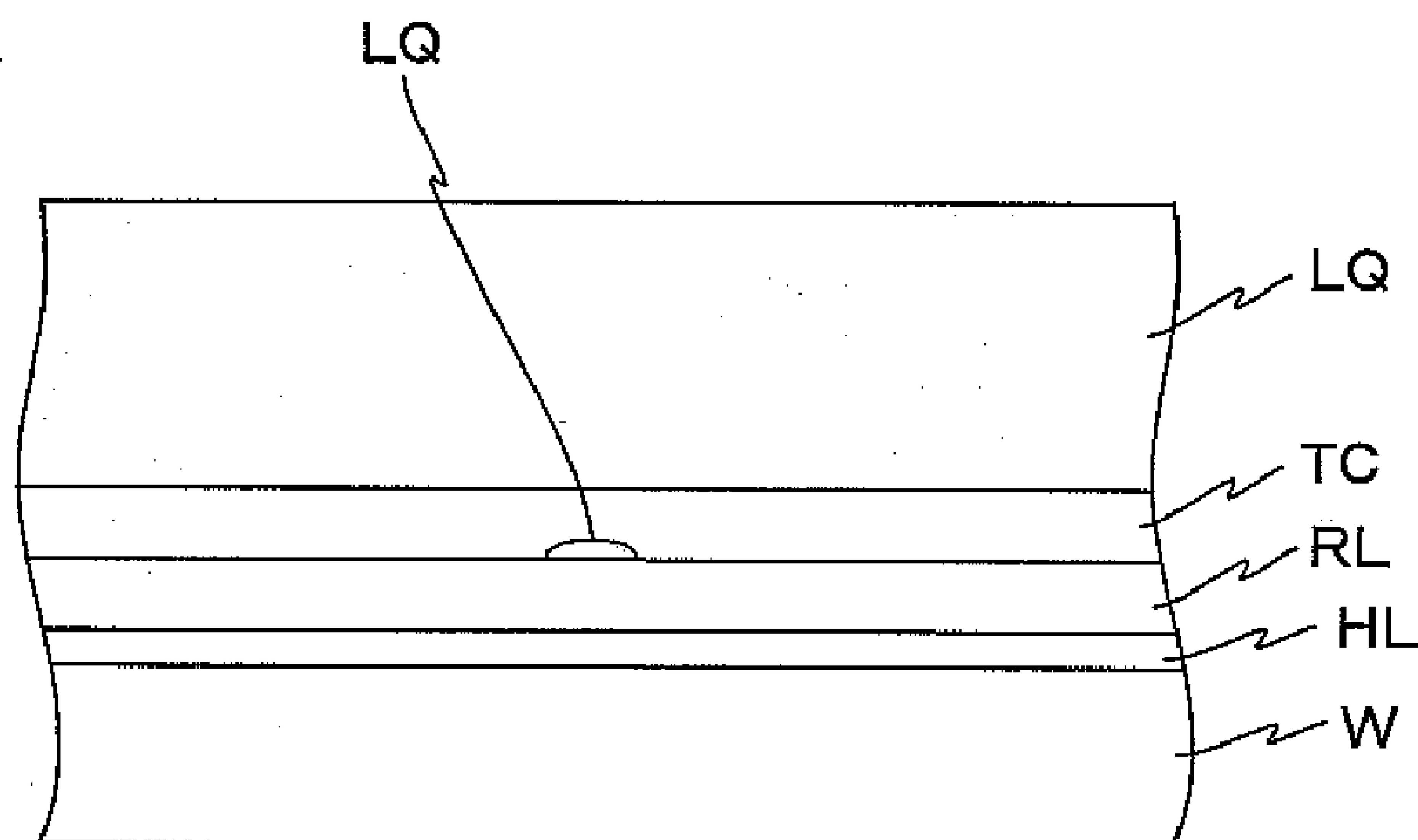


Fig. 7B

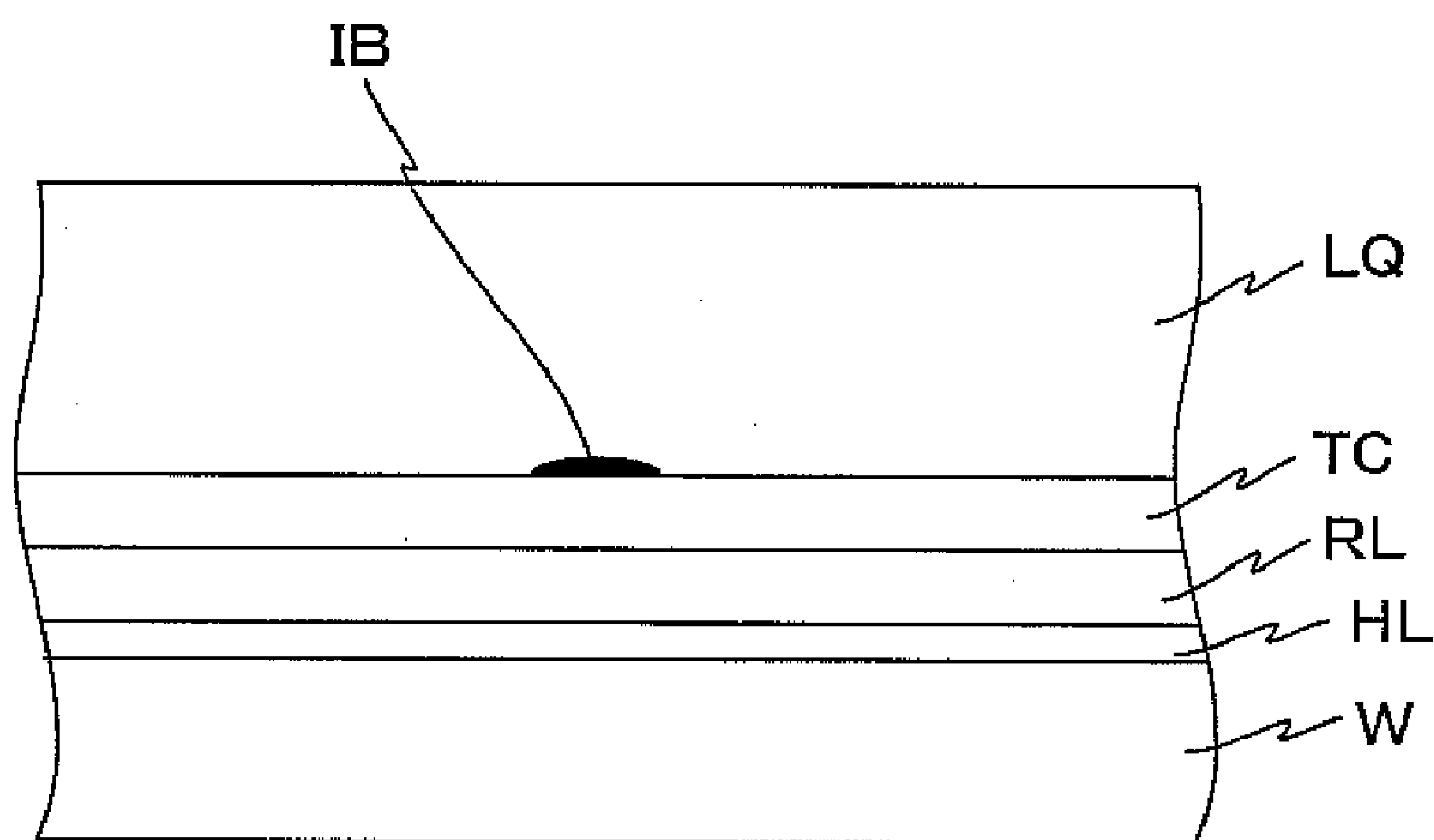


Fig. 7C

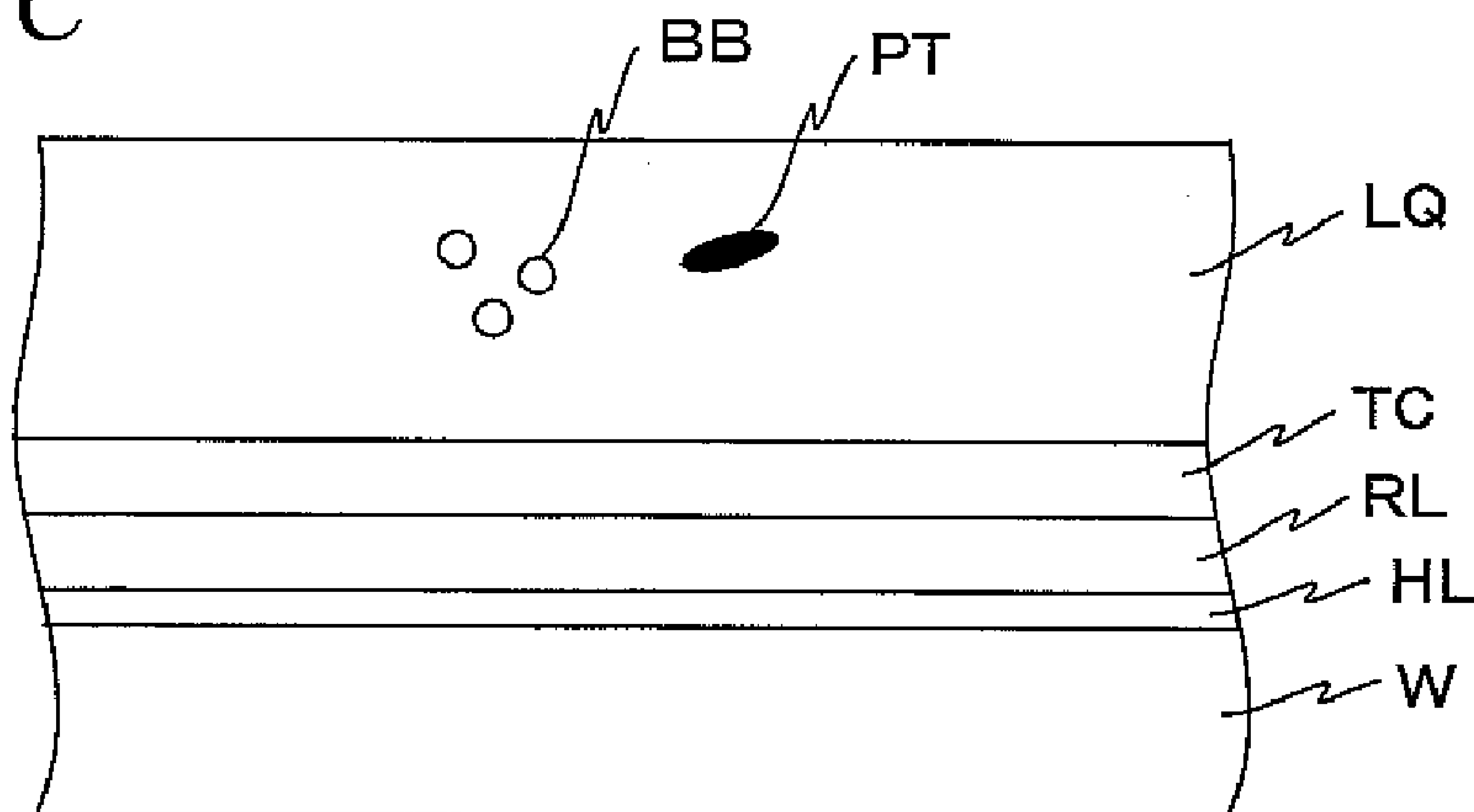


Fig. 8A

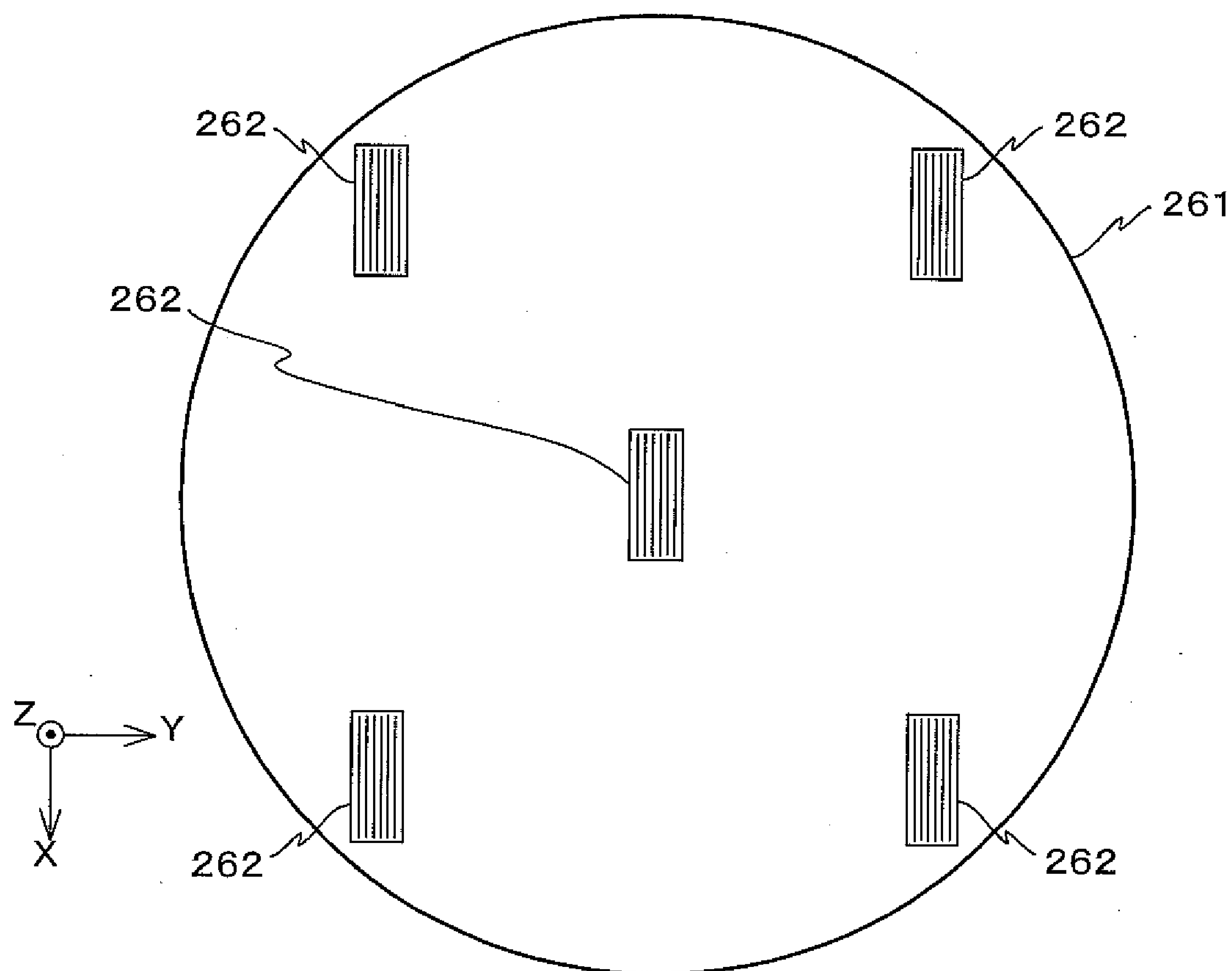


Fig. 8B

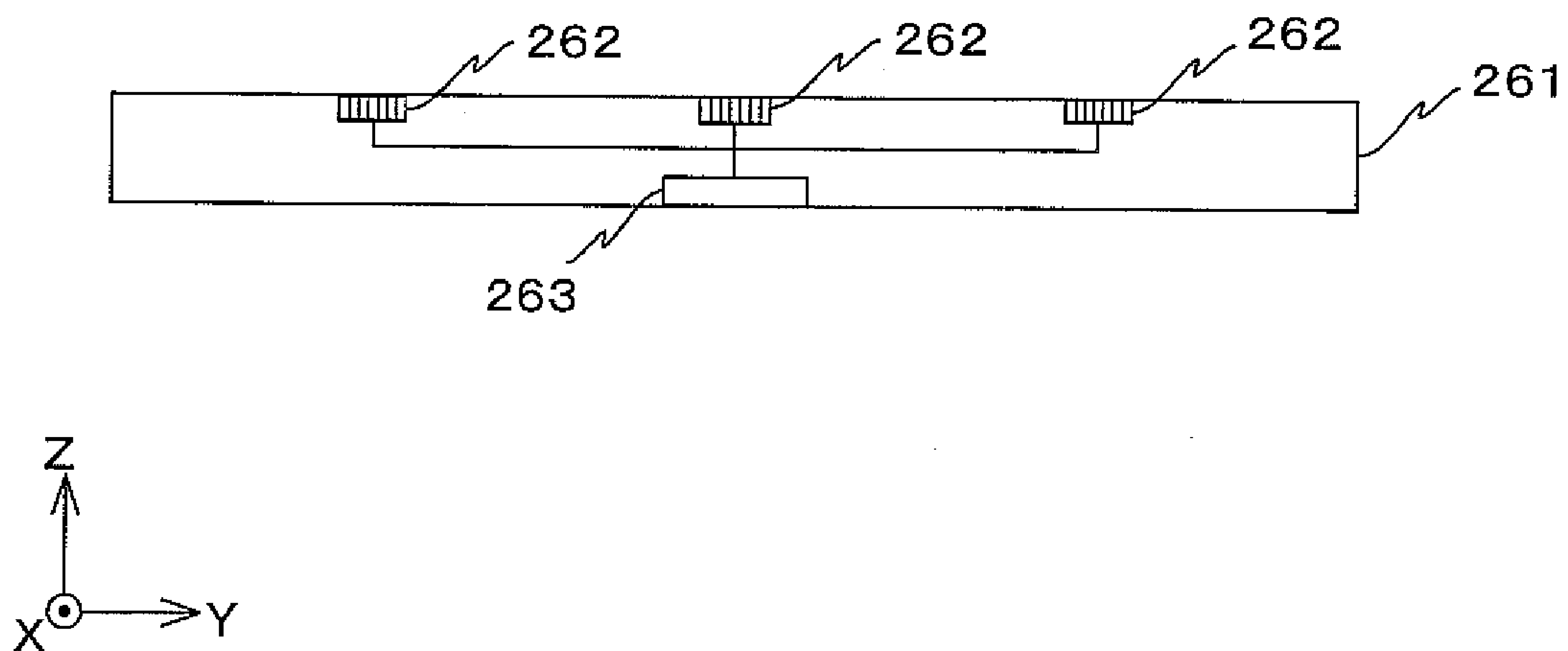
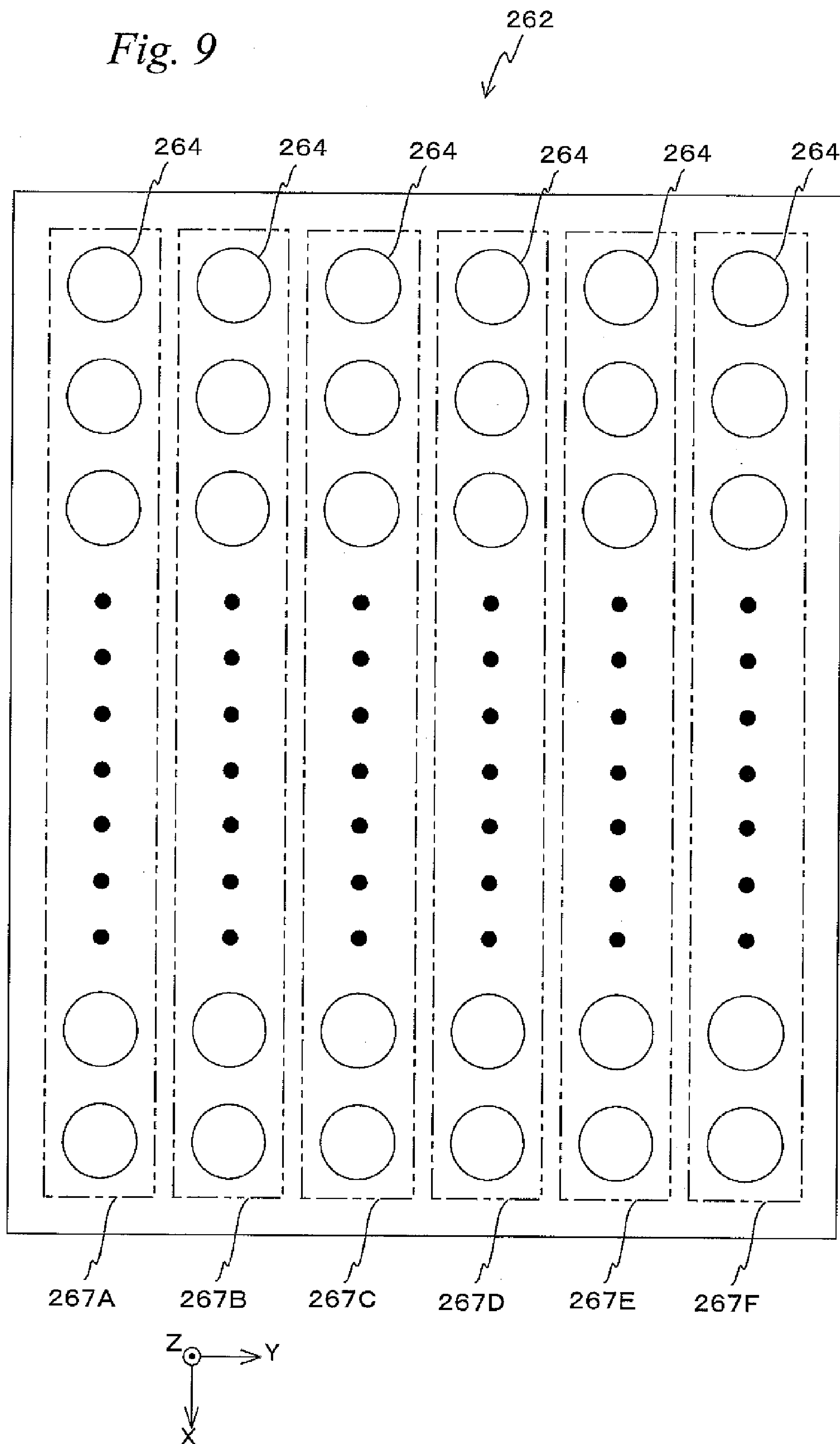


Fig. 9



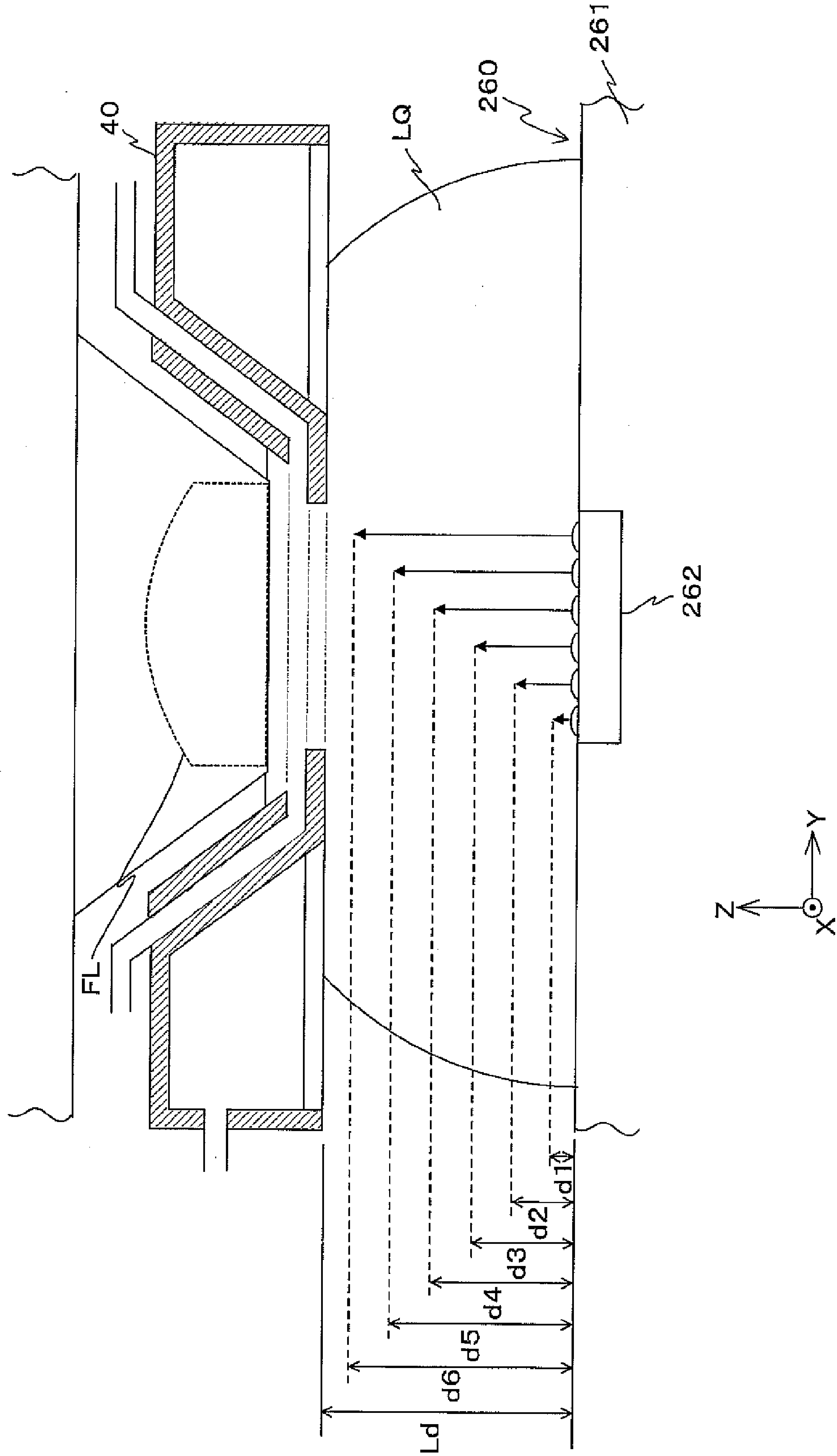


Fig. 10
40
LQ
260
261
262
FL
d1
d2
d3
d4
d5
d6
Ld
Z
Y
X

Fig. 11

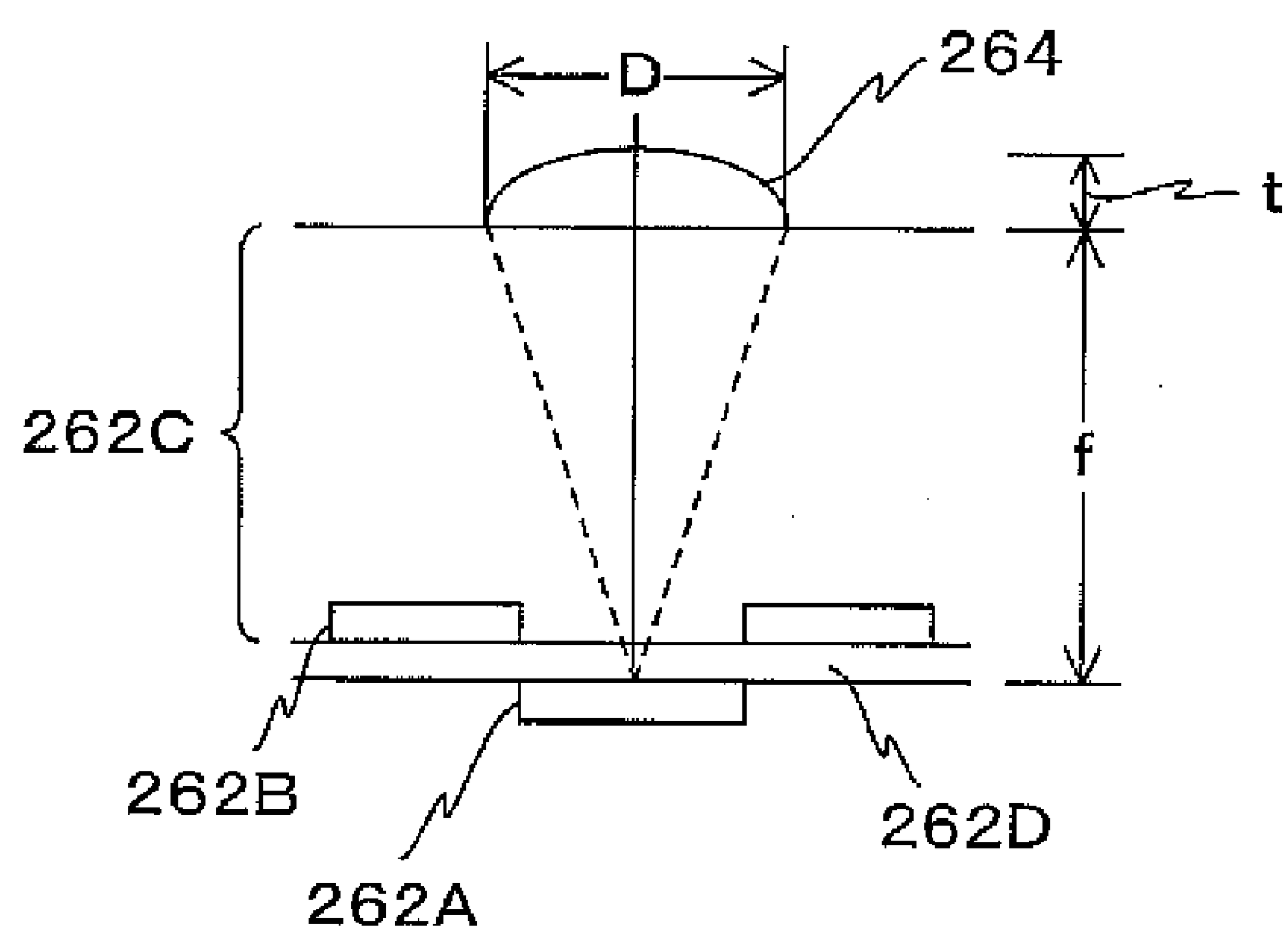
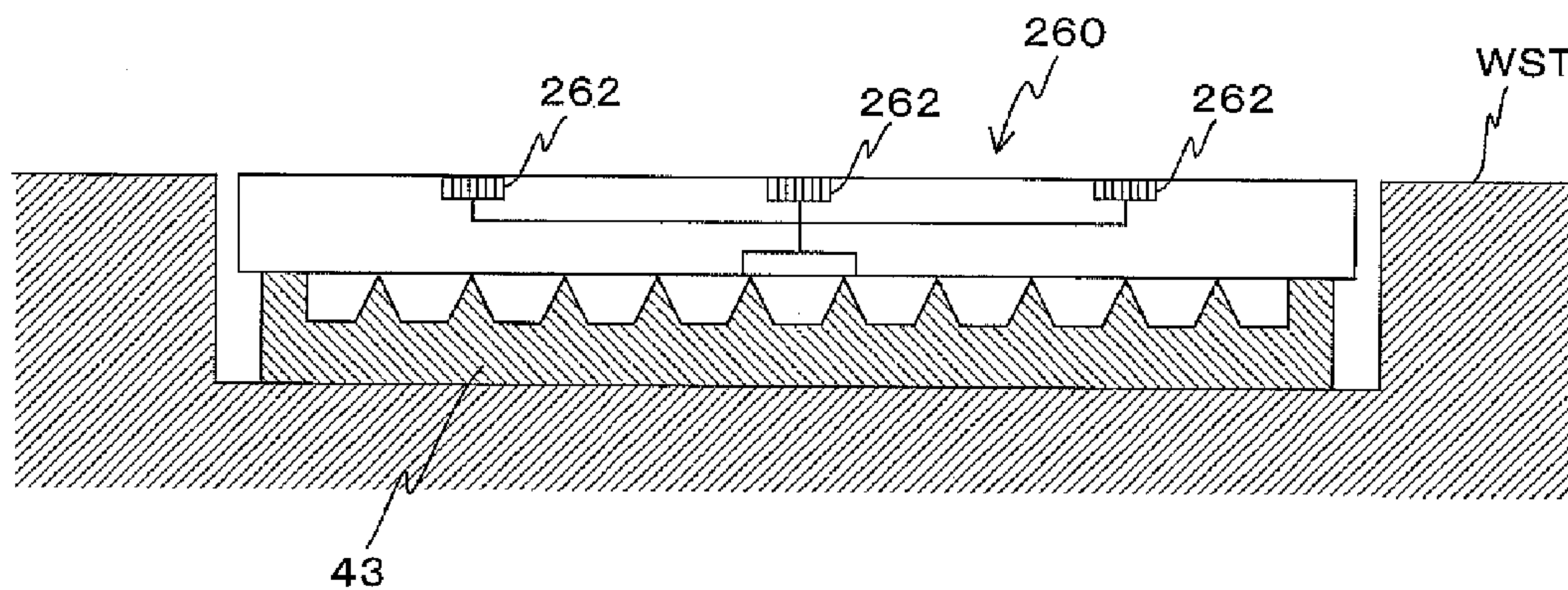


Fig. 12



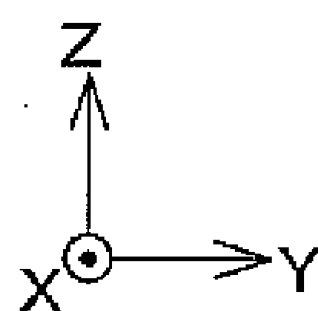


Fig. 13

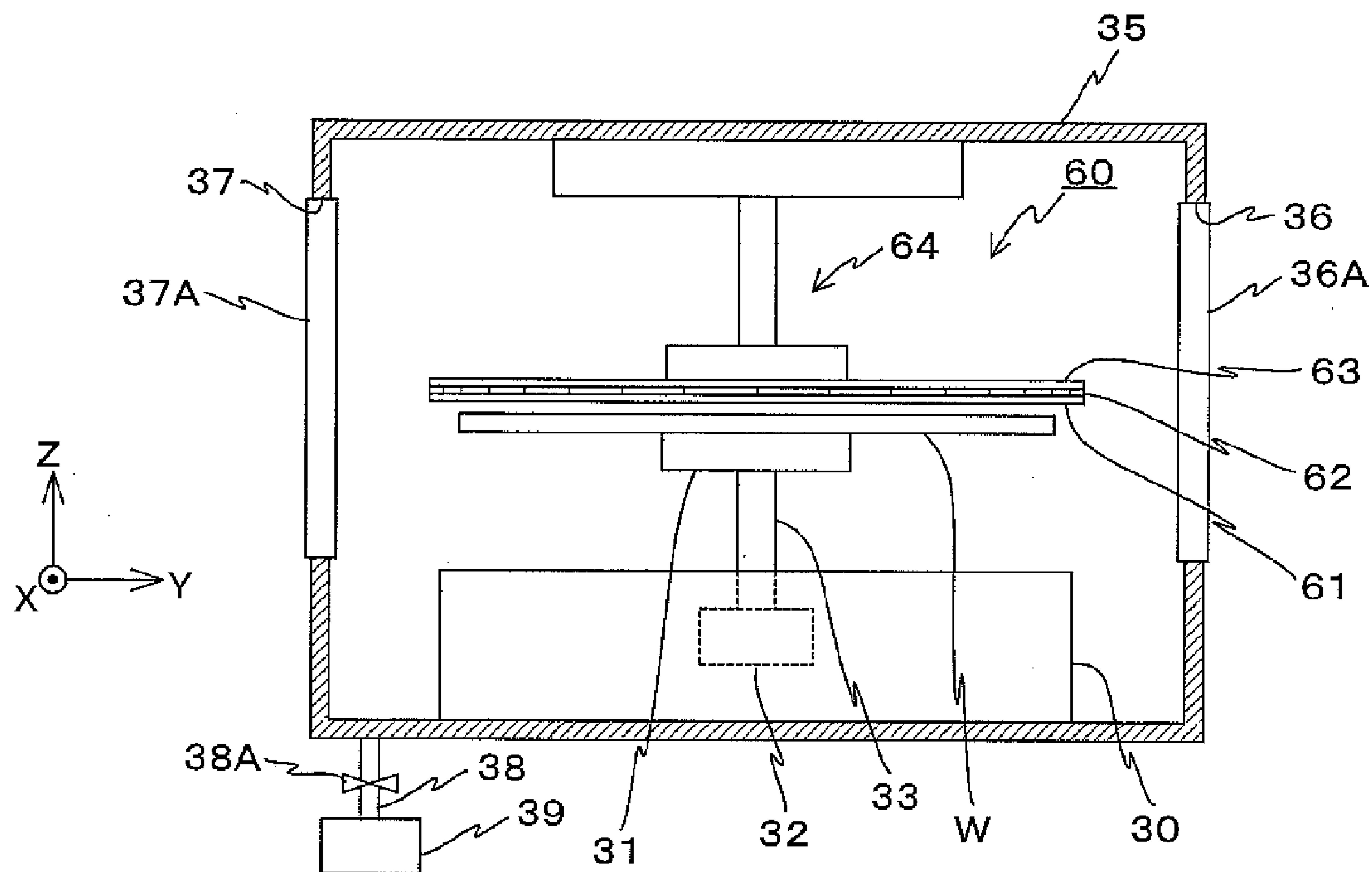
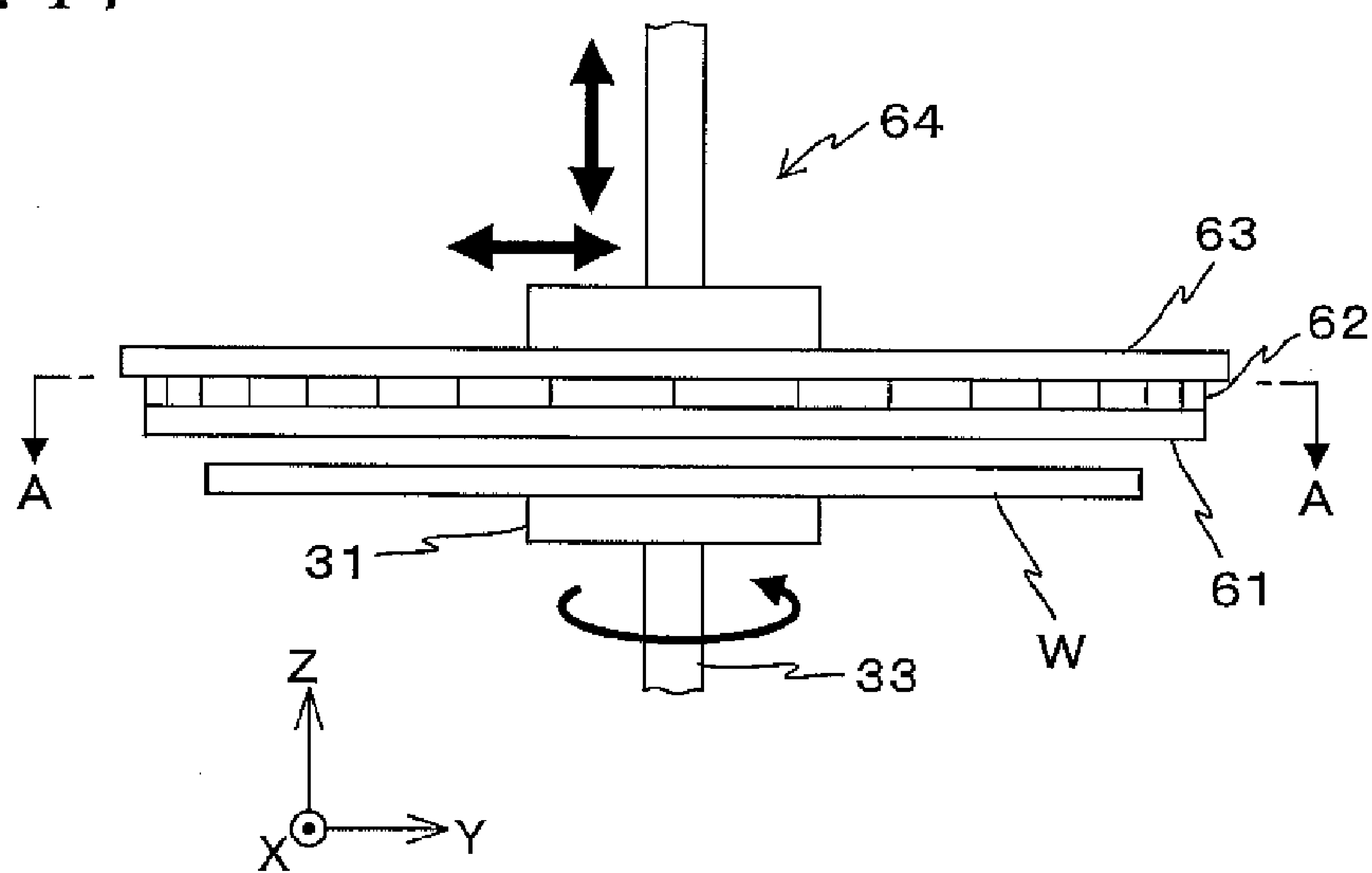


Fig. 14



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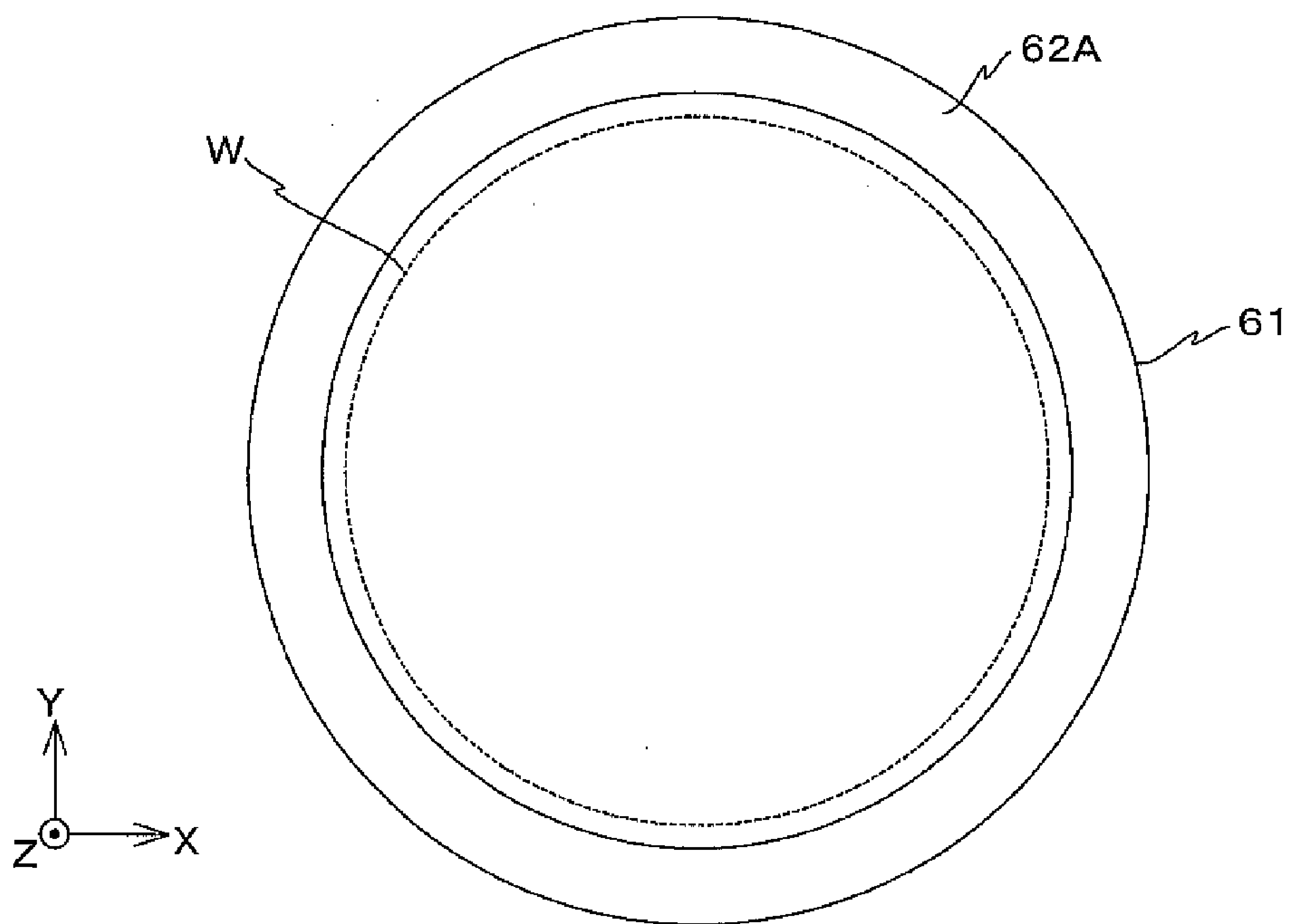

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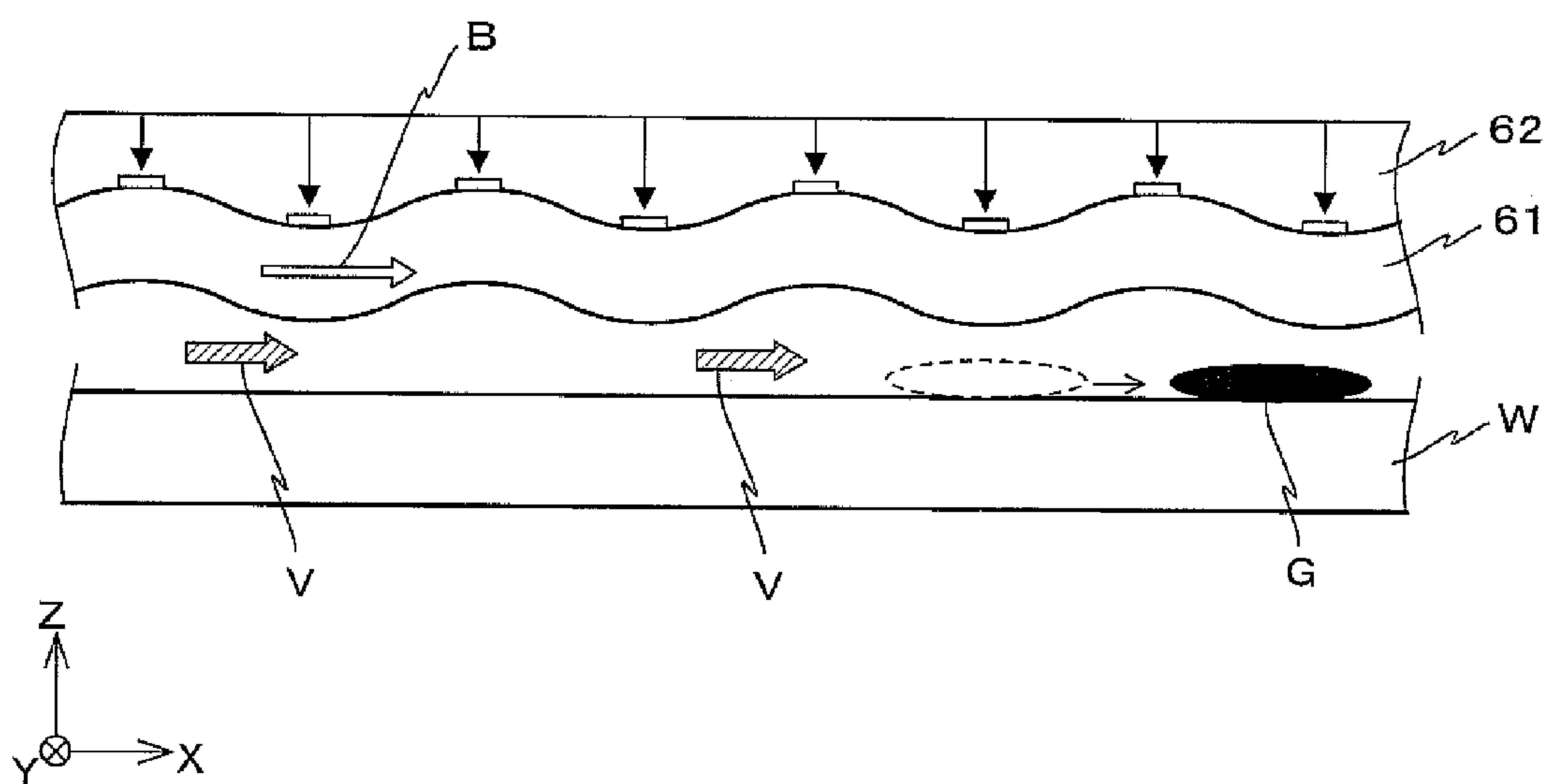
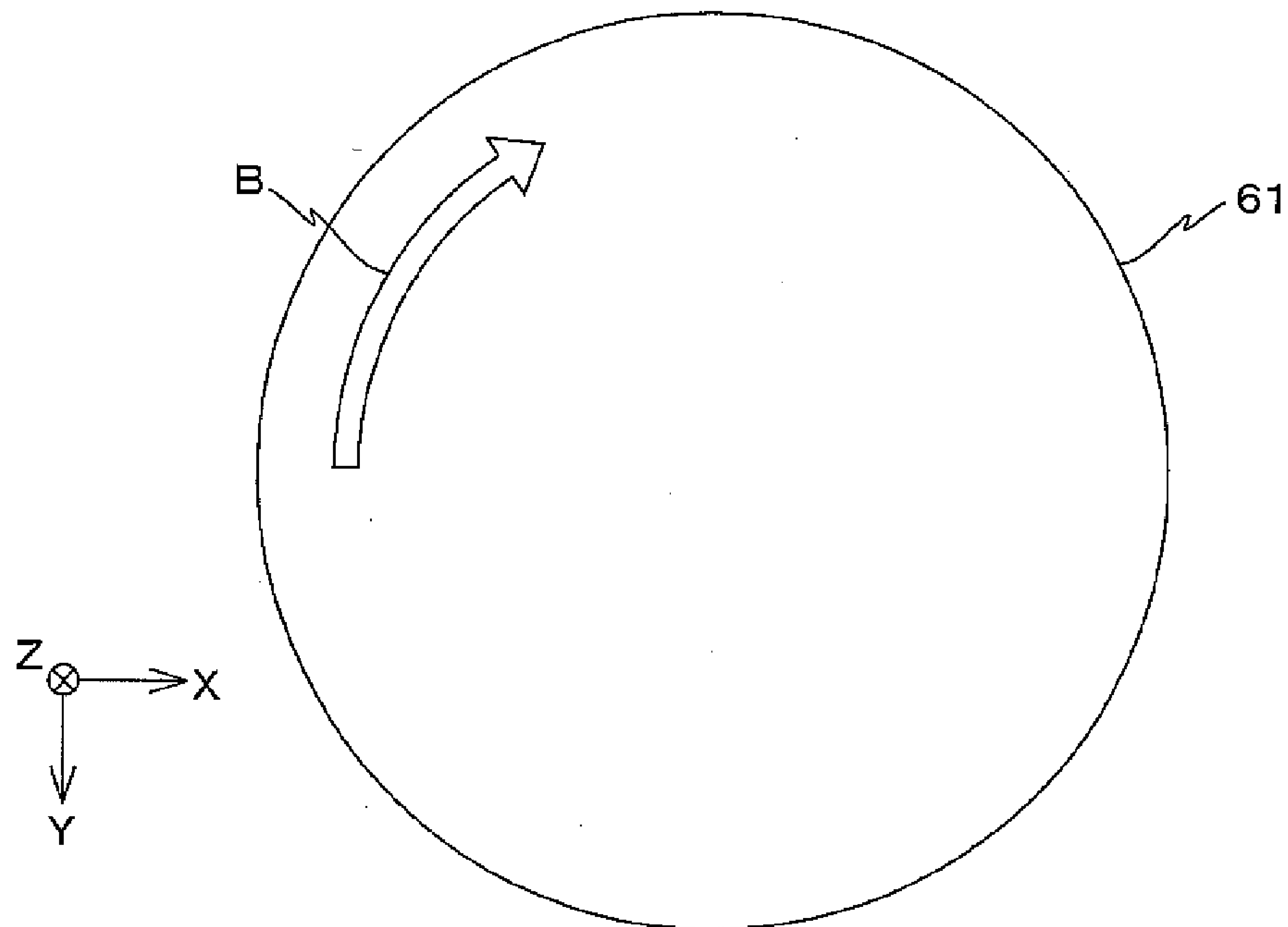


Fig. 17



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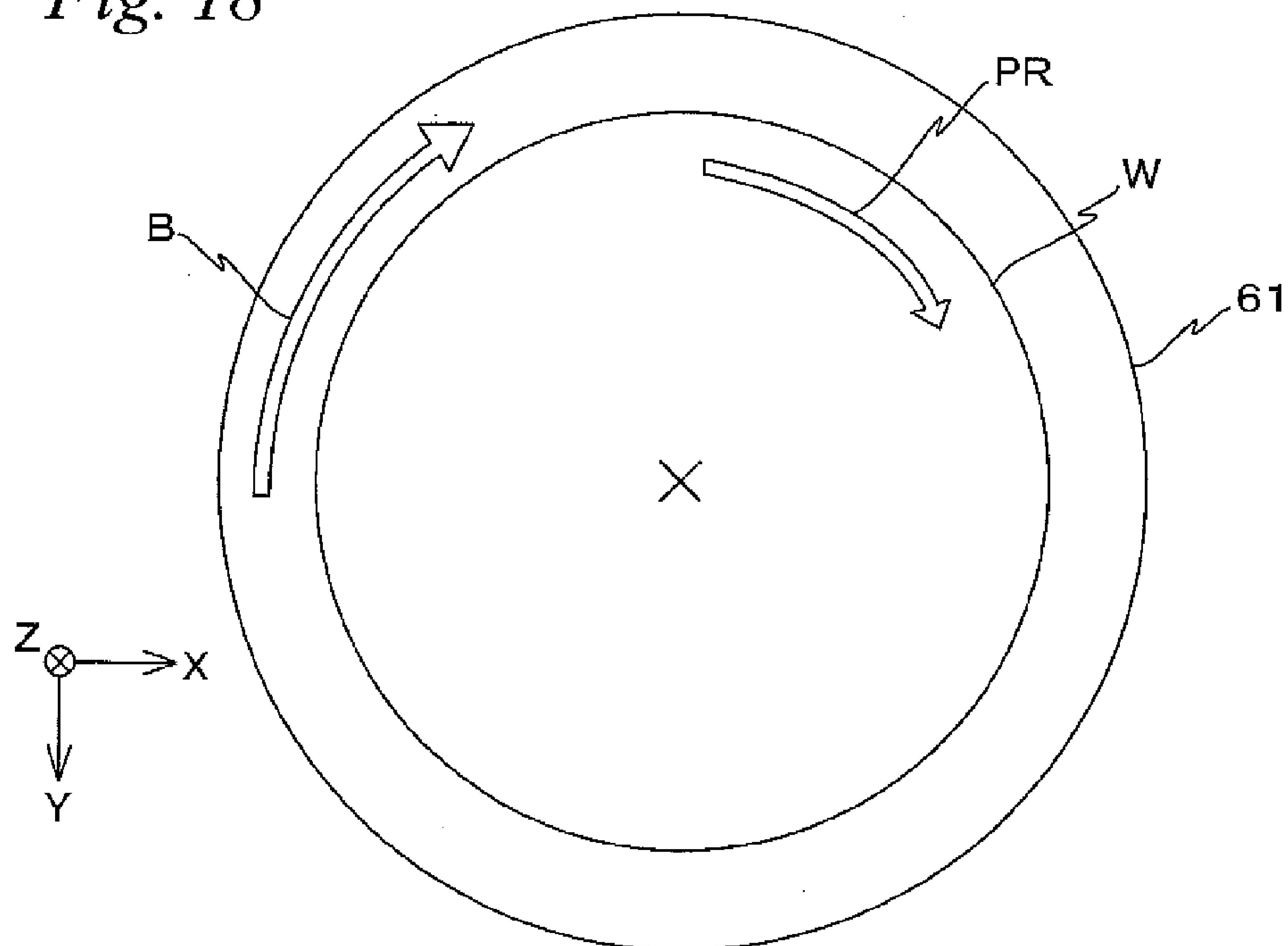


Fig. 19

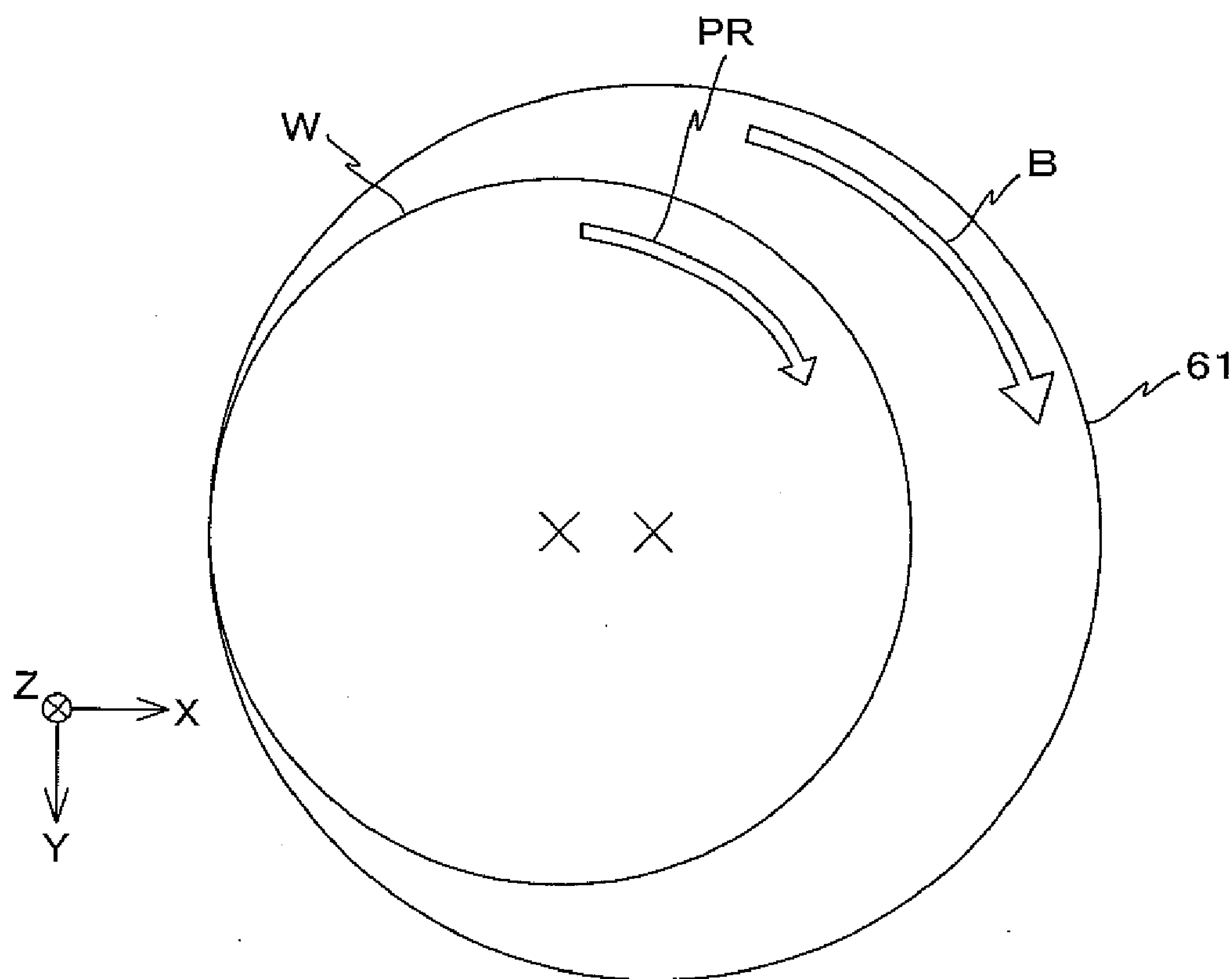


Fig. 20A

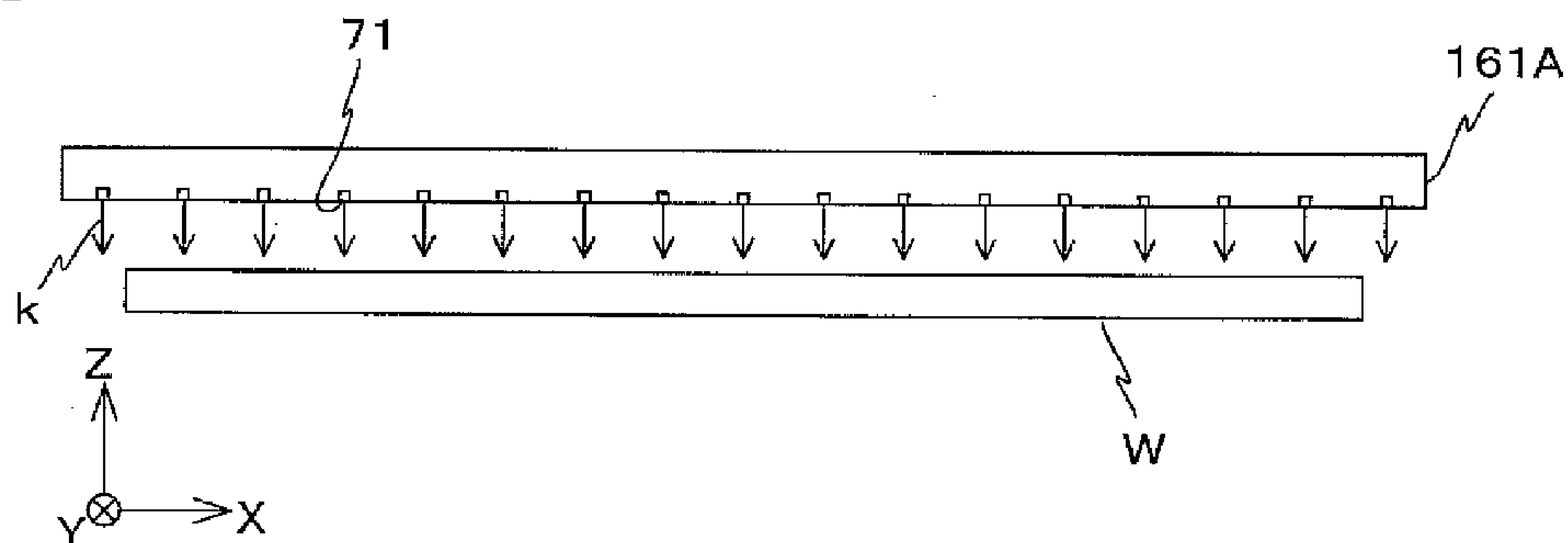


Fig. 20B

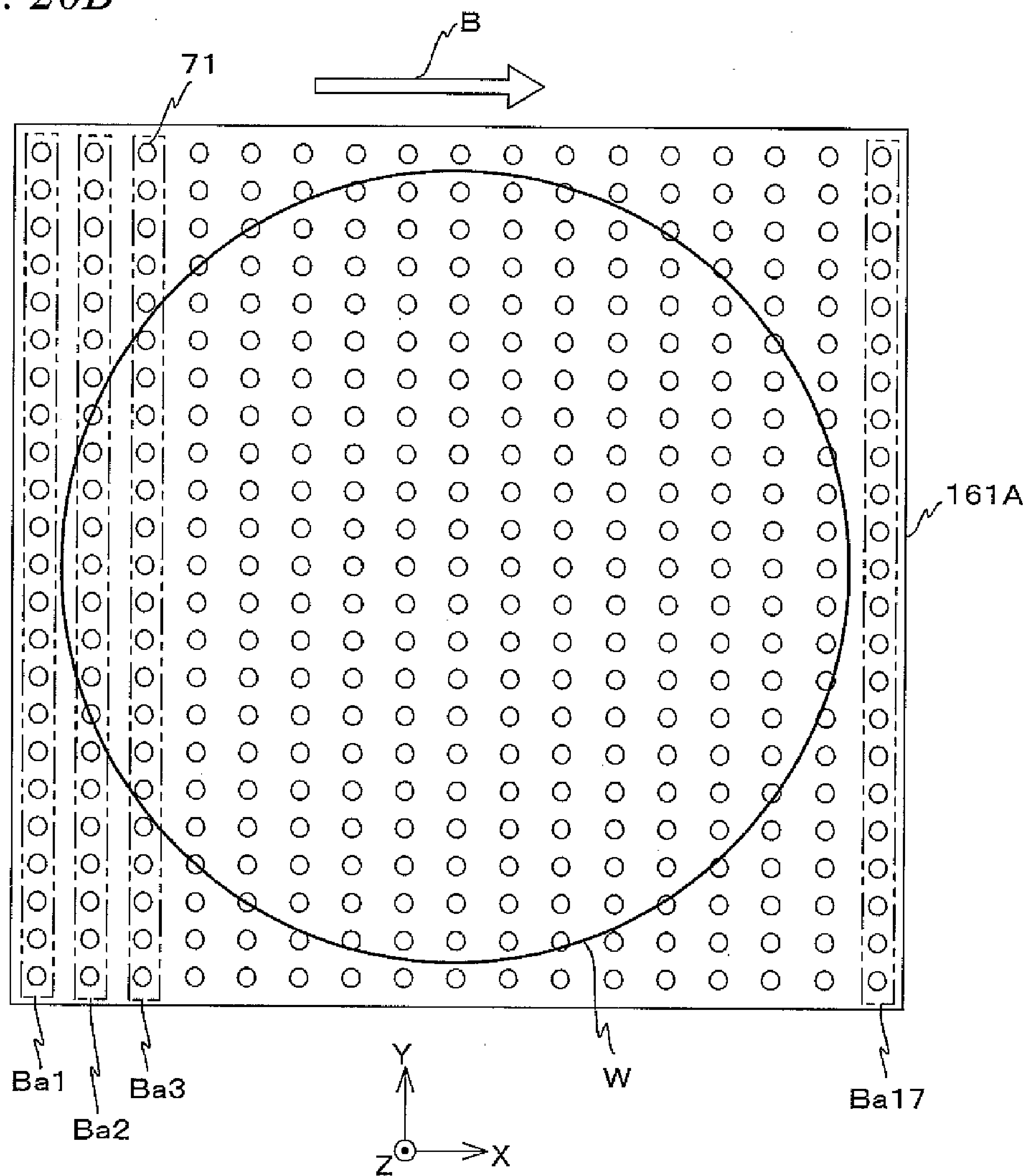


Fig. 21A

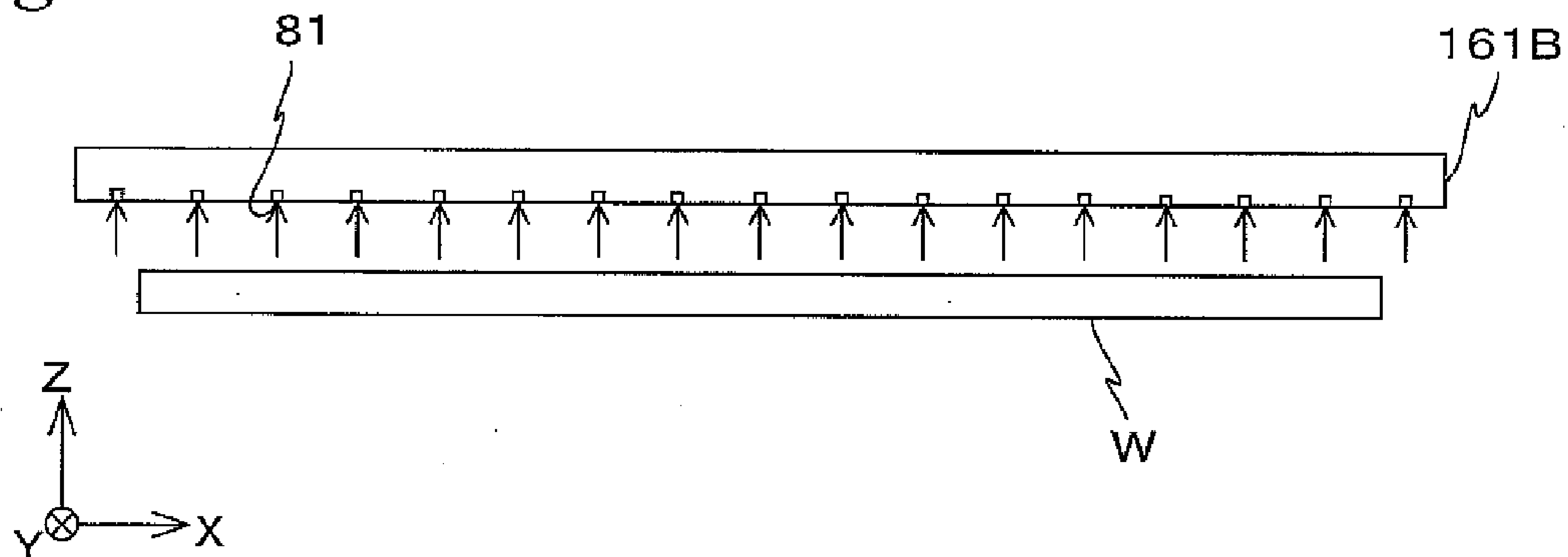
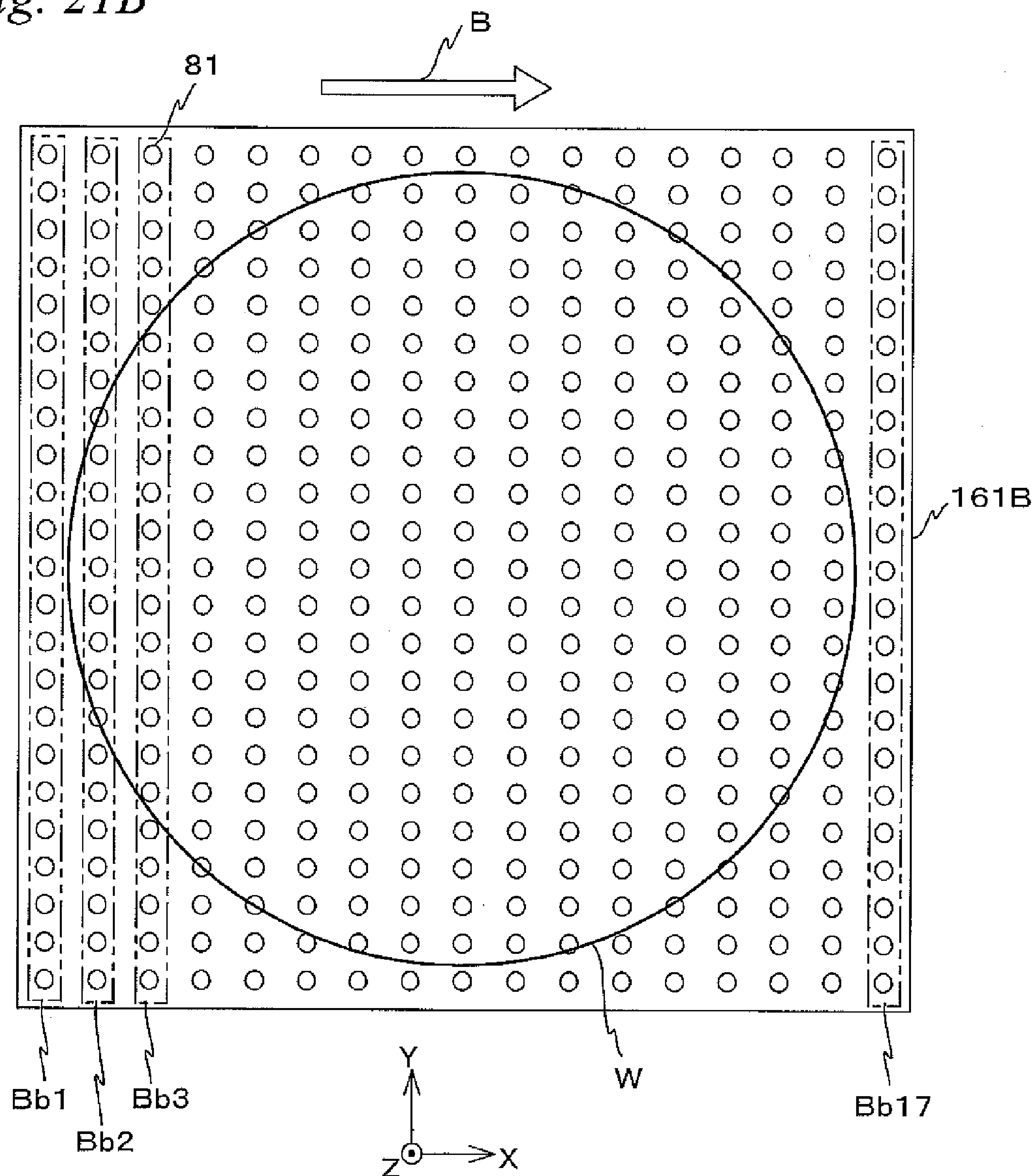


Fig. 21B



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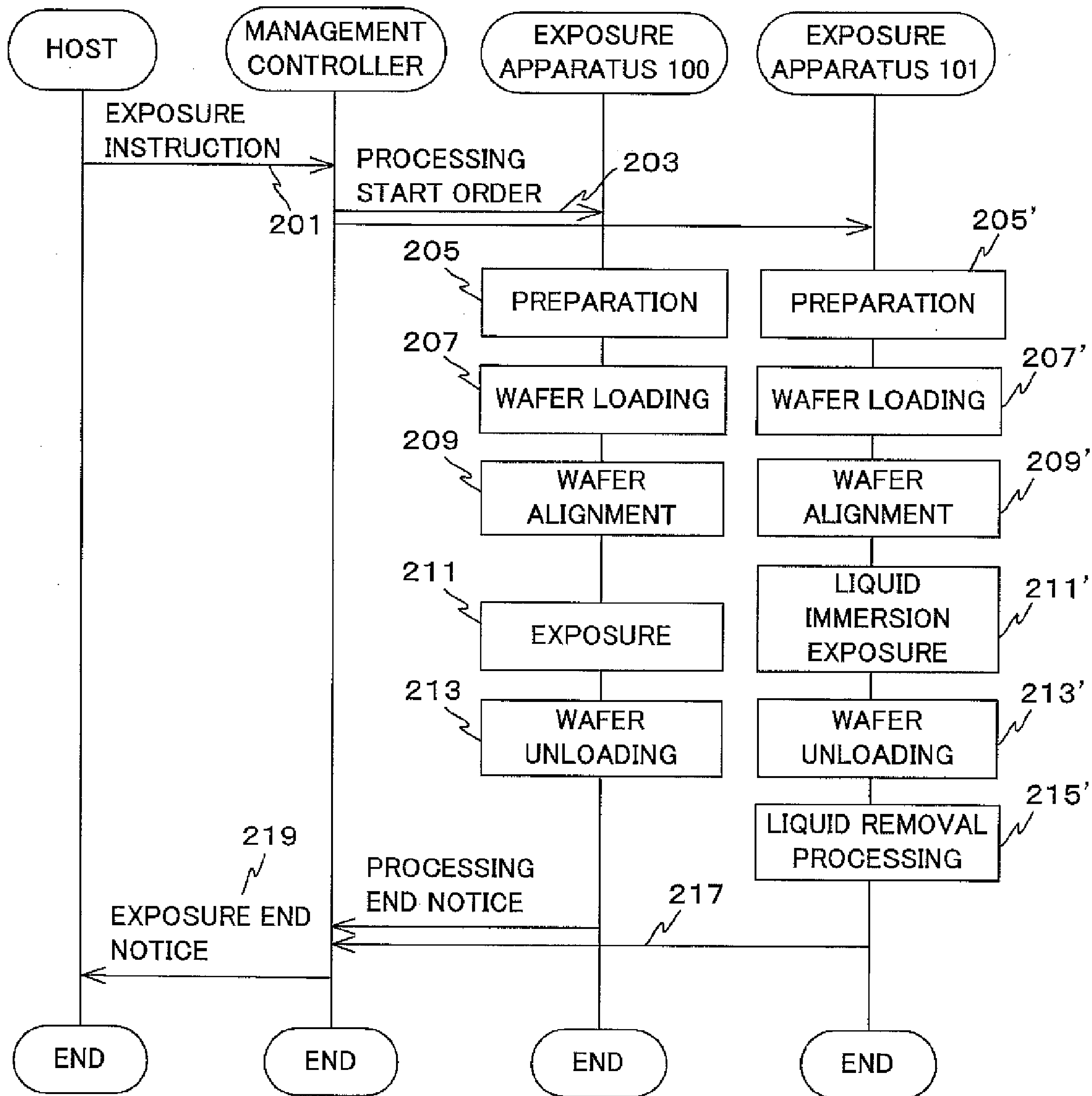

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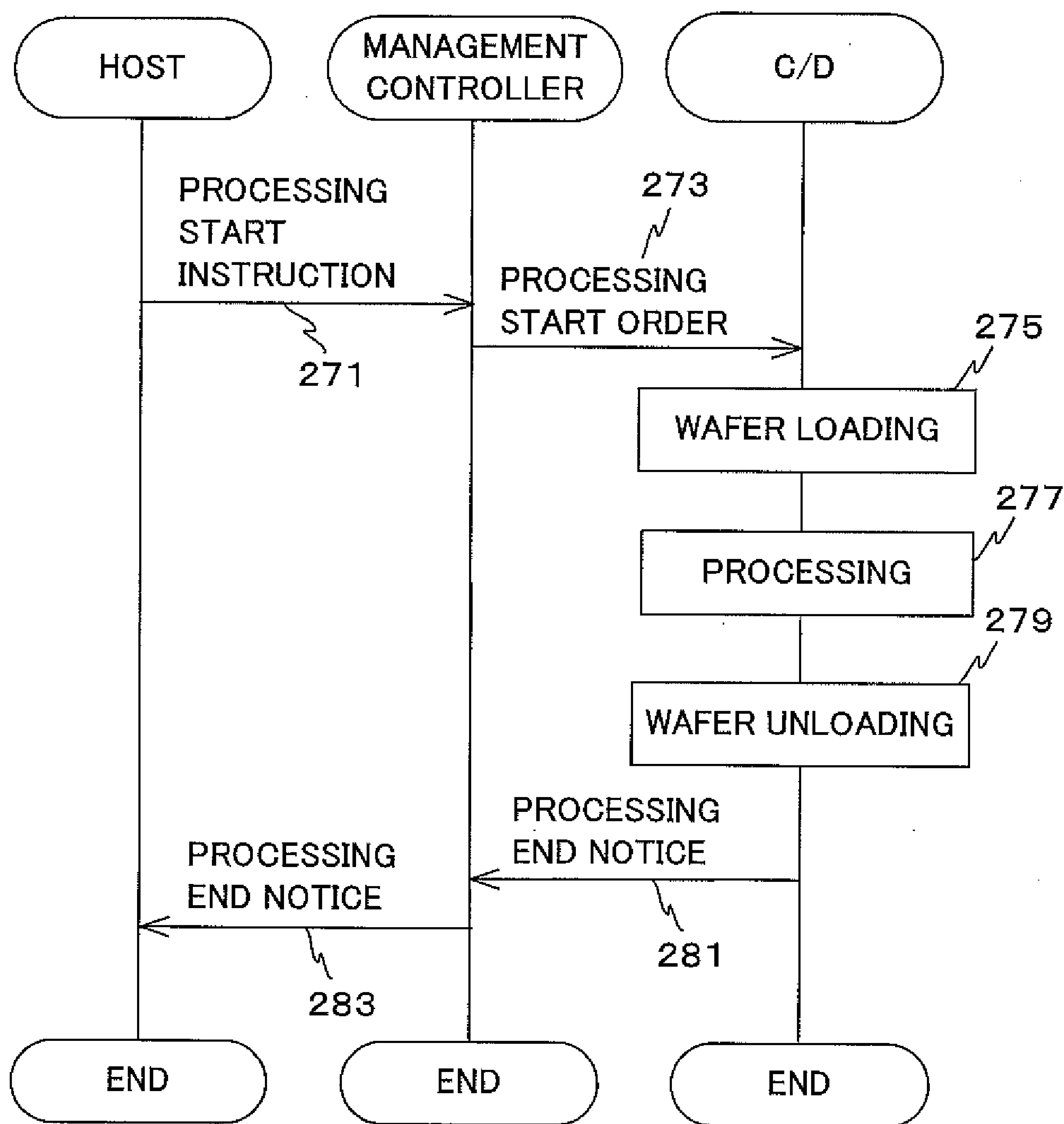
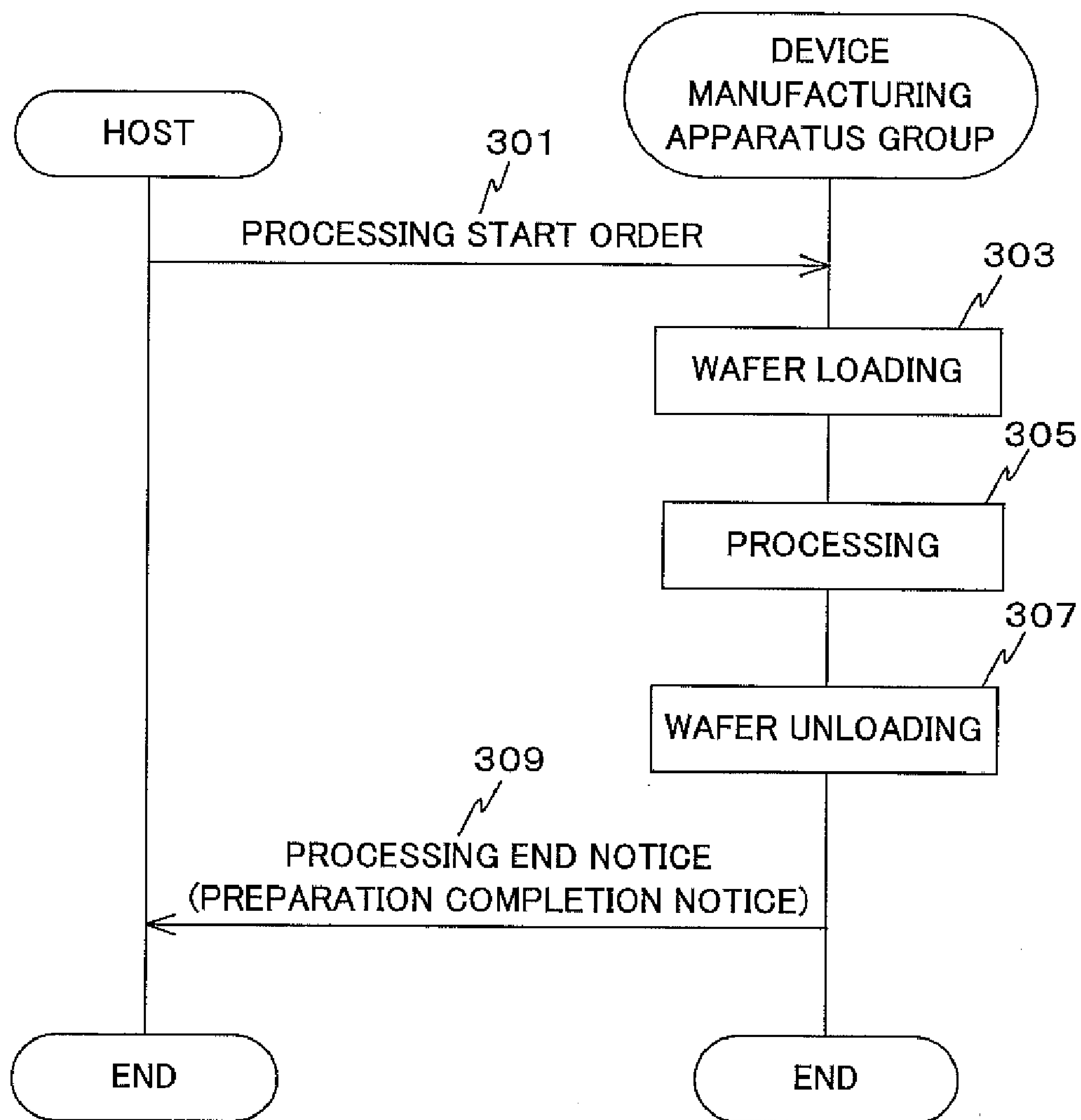


Fig. 24



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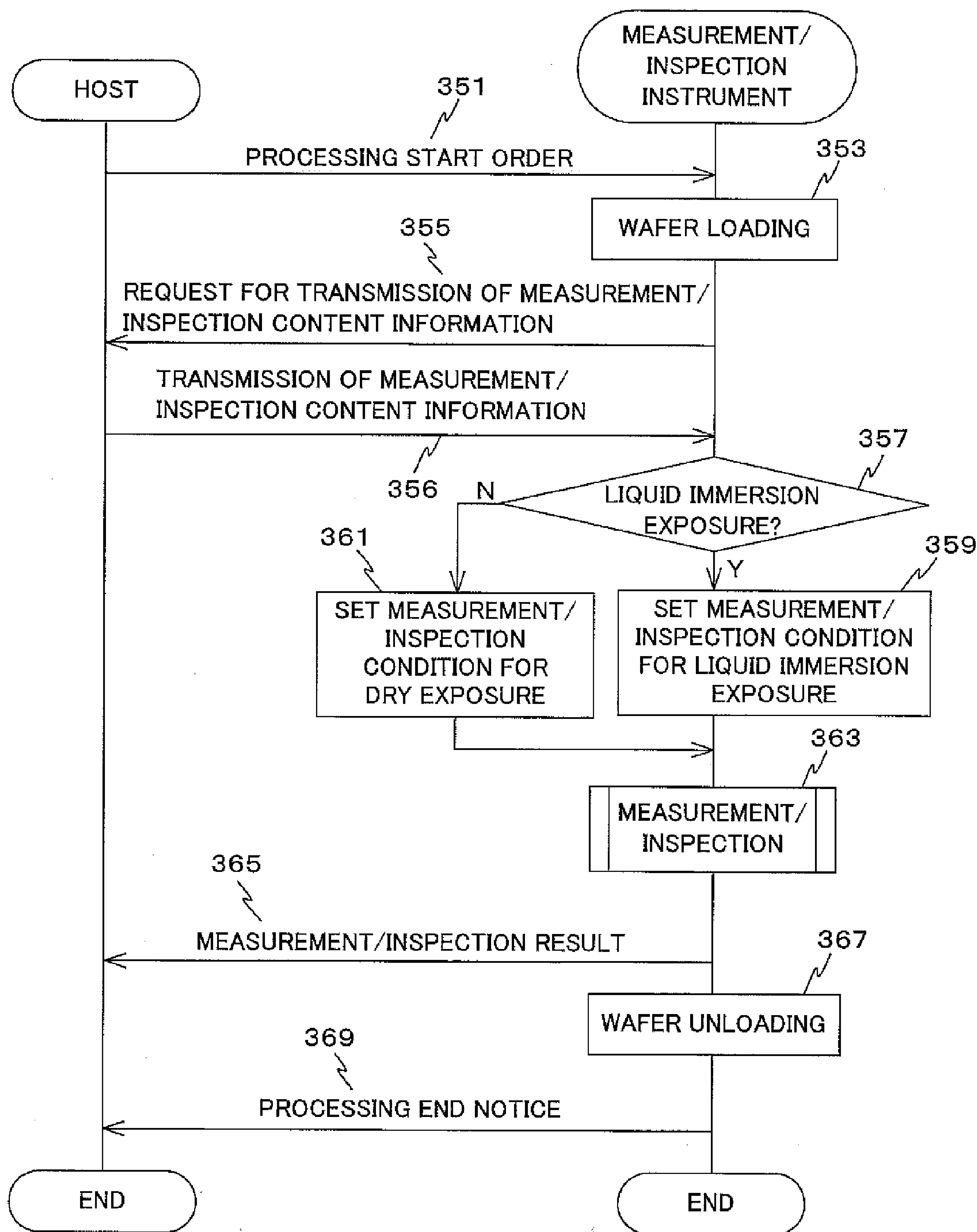


Fig. 26A

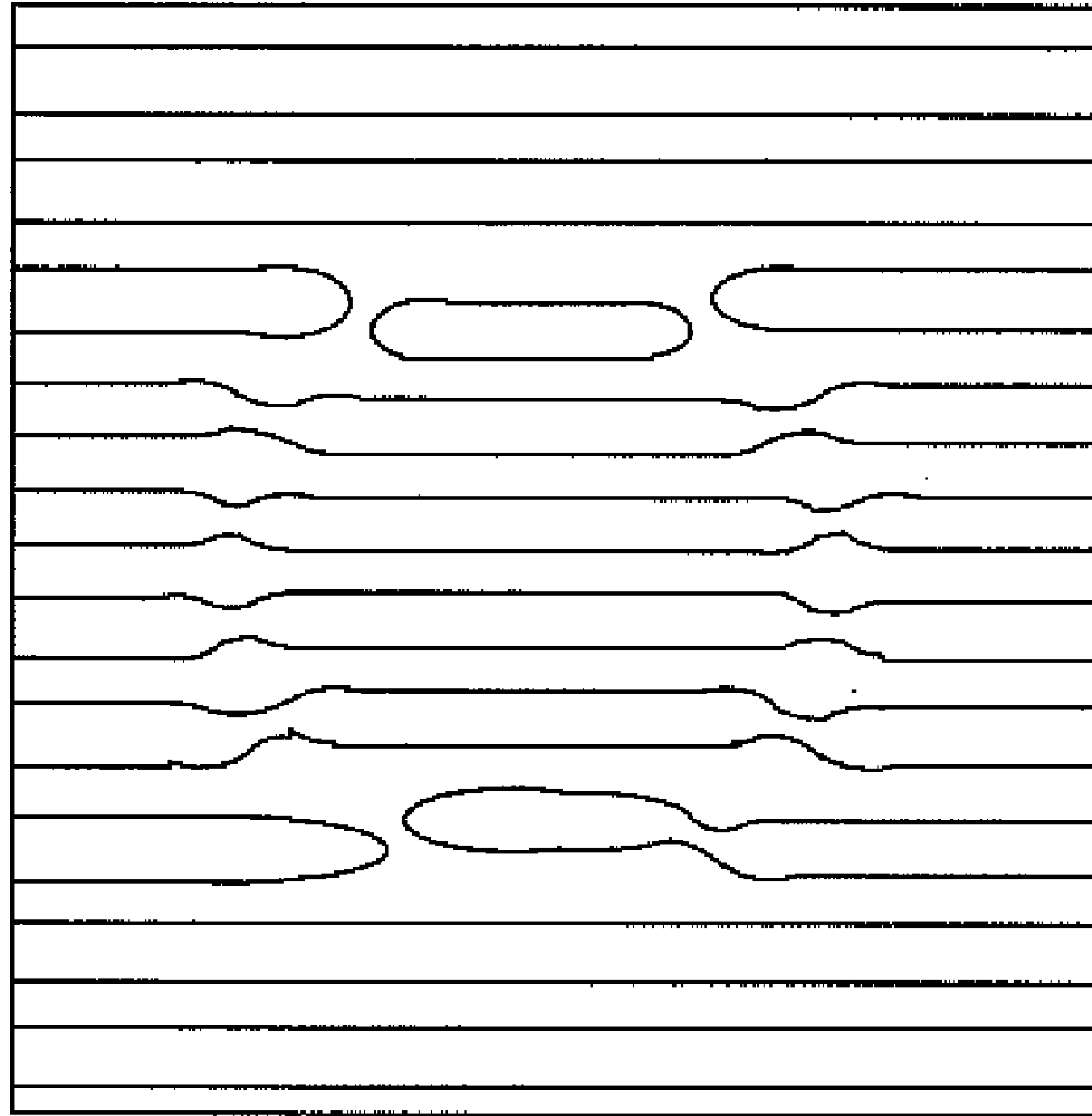


Fig. 26B

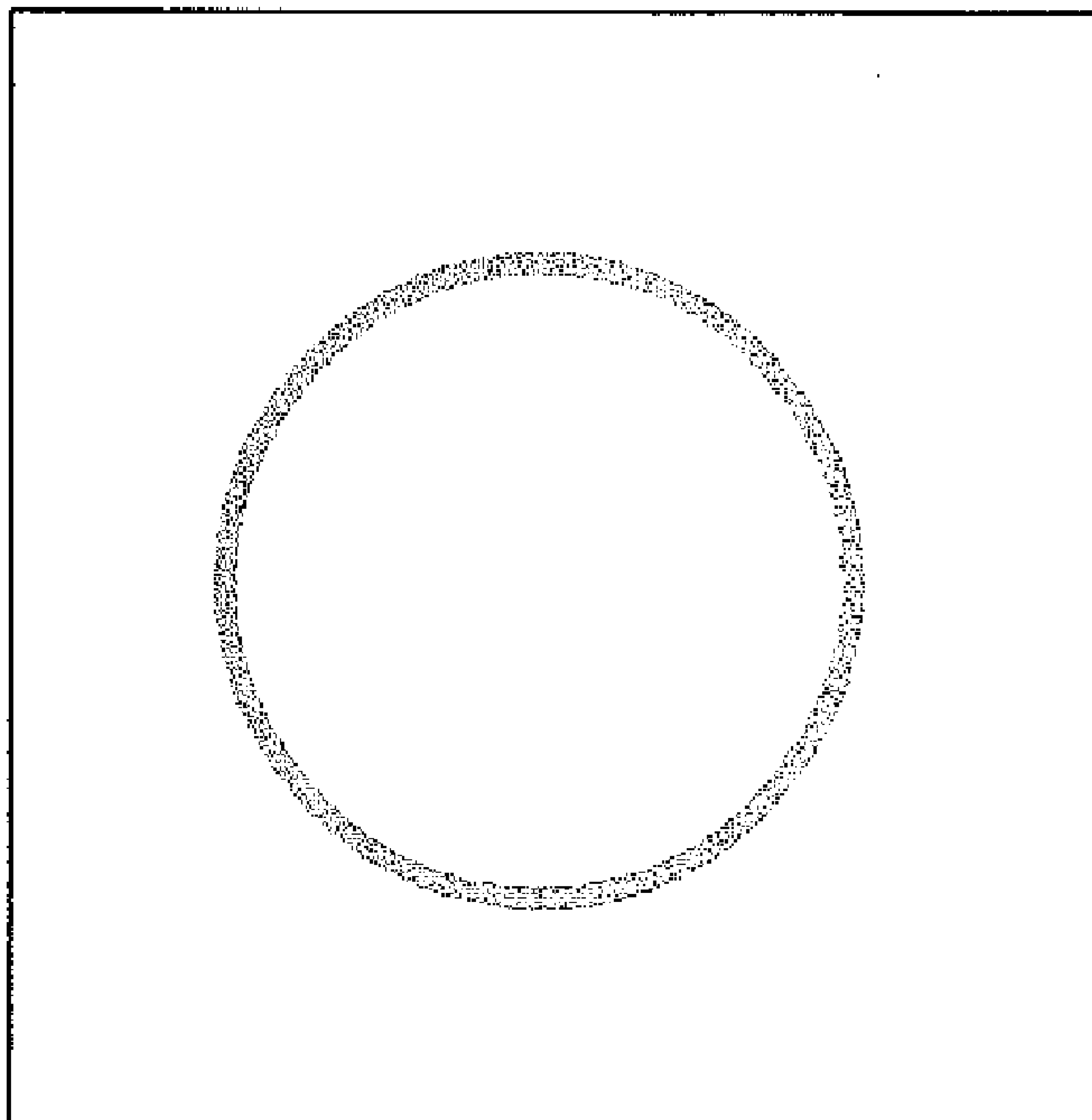


Fig. 27

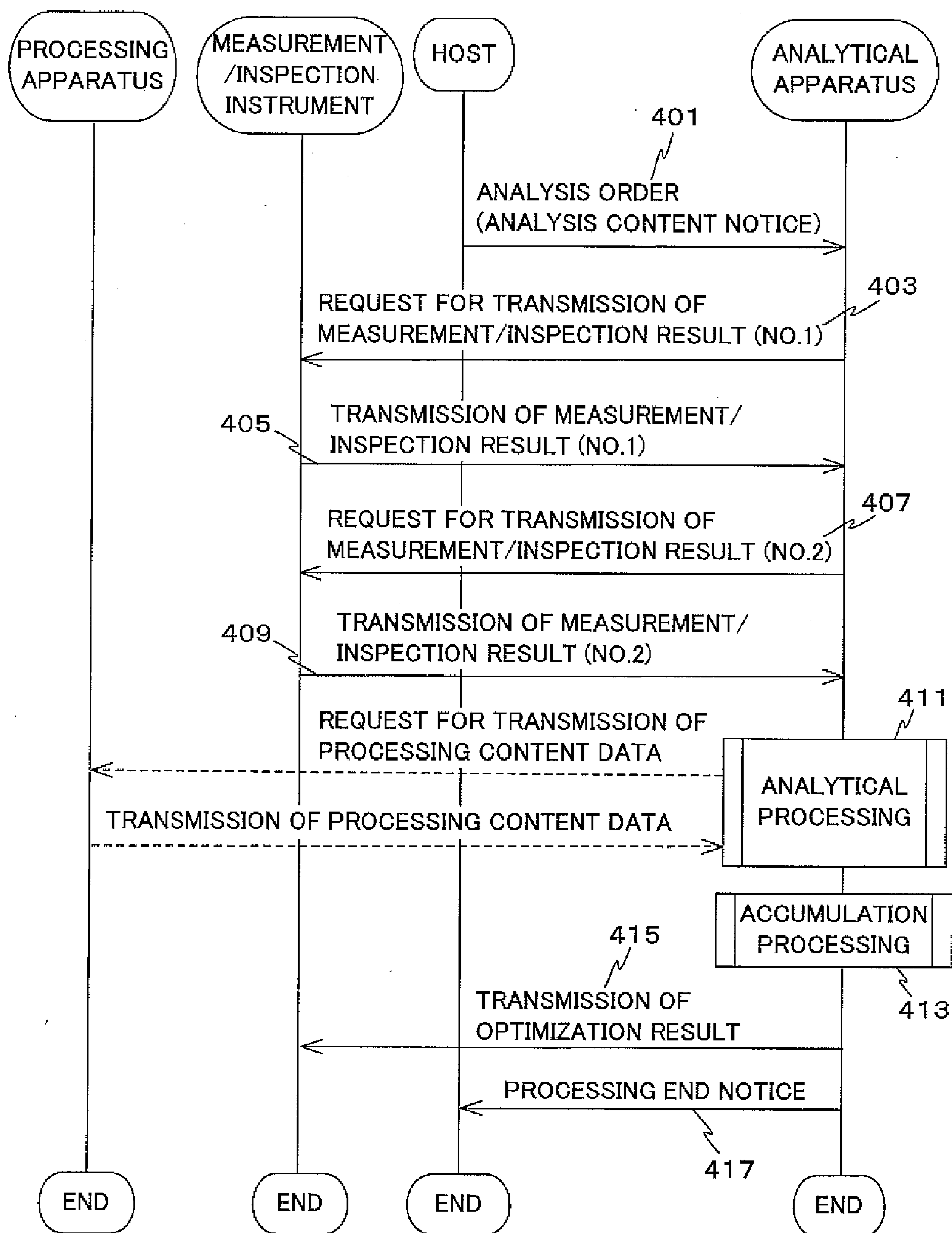


Fig. 28

MAIN ITEM	SUBITEM (ESSENTIAL)	SUBITEM (FOR LIQUID IMMERSION EXPOSURE)	SUBITEM (SELECTION)
FILM FORMATION /RESIST COATING PROCESSING & WAFER MEASUREMENT/ INSPECTION PROCESSING (A)	ANTIREFLECTION FILM COATING		
			ANTIREFLECTION FILM THICKNESS MEASUREMENT
			ANTIREFLECTION FILM APPEARANCE INSPECTION
	RESIST COATING		
			RESIST FILM THICKNESS MEASUREMENT
			RESIST FILM APPEARANCE INSPECTION
		TOPCOAT FILM COATING	
			TOPCOAT FILM THICKNESS MEASUREMENT
			TOPCOAT FILM APPEARANCE INSPECTION
WAFER MEASUREMENT/ INSPECTION PROCESSING (B)			ALIGNMENT PRE-MEASUREMENT
			FOCUS PRE-MEASUREMENT
			APPEARANCE INSPECTION
EXPOSURE PROCESSING	ALIGNMENT		
	EXPOSURE		
			LIQUID IMMERSION MONITORING
		LIQUID REMOVAL	
WAFER MEASUREMENT/ INSPECTION PROCESSING (C)			APPEARANCE INSPECTION
PEB PROCESSING			
WAFER MEASUREMENT/ INSPECTION PROCESSING (D)			APPEARANCE INSPECTION
DEVELOPMENT PROCESSING			
WAFER MEASUREMENT/ INSPECTION PROCESSING (E)			PATTERN DEFECT INSPECTION
			PATTERN LINE WIDTH MEASUREMENT
			OVERLAY ERROR MEASUREMENT
ETCHING PROCESSING			
WAFER MEASUREMENT/ INSPECTION PROCESSING (F)			PATTERN DEFECT INSPECTION
			PATTERN LINE WIDTH MEASUREMENT
			OVERLAY ERROR MEASUREMENT
IMPURITY DIFFUSION PROCESSING/ WIRING PROCESSING			
PROBING PROCESSING			
REPAIR PROCESSING			
DICING PROCESSING			
PACKAGING PROCESSING			
BONDING PROCESSING			

Fig. 29A

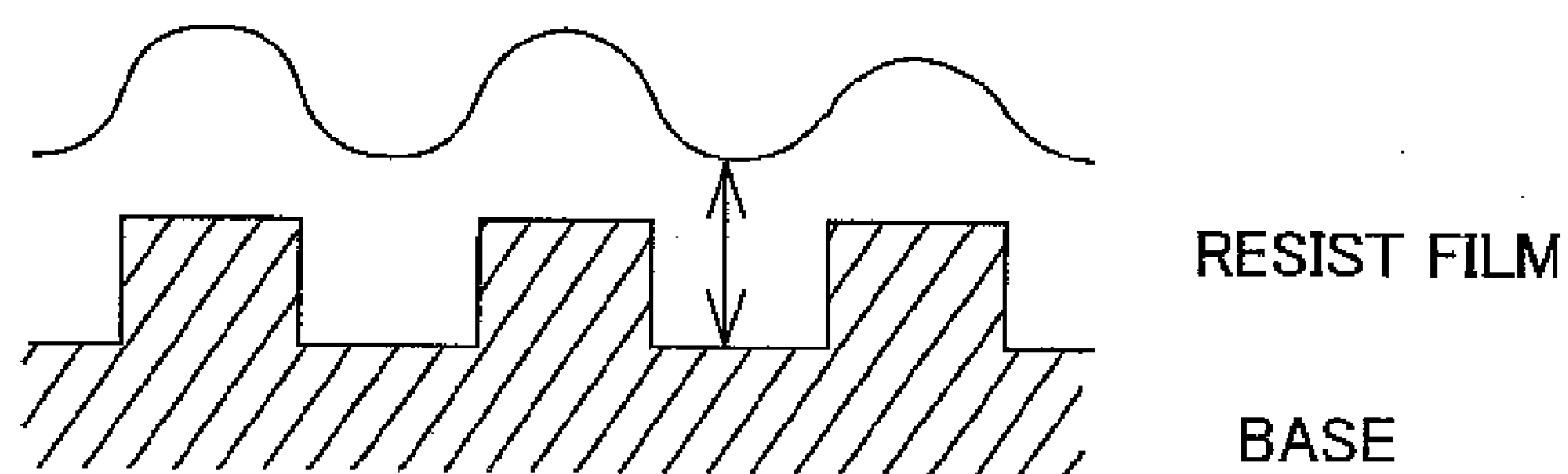


Fig. 29B

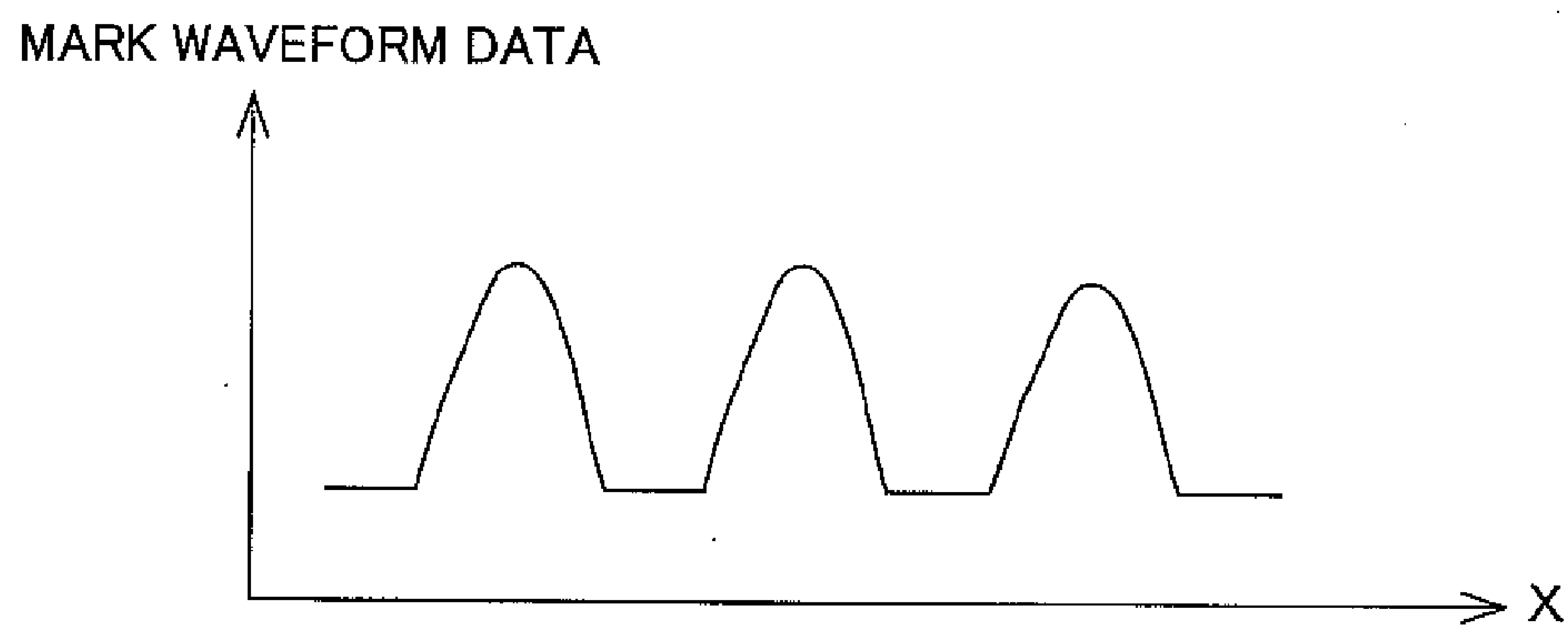


Fig. 29C

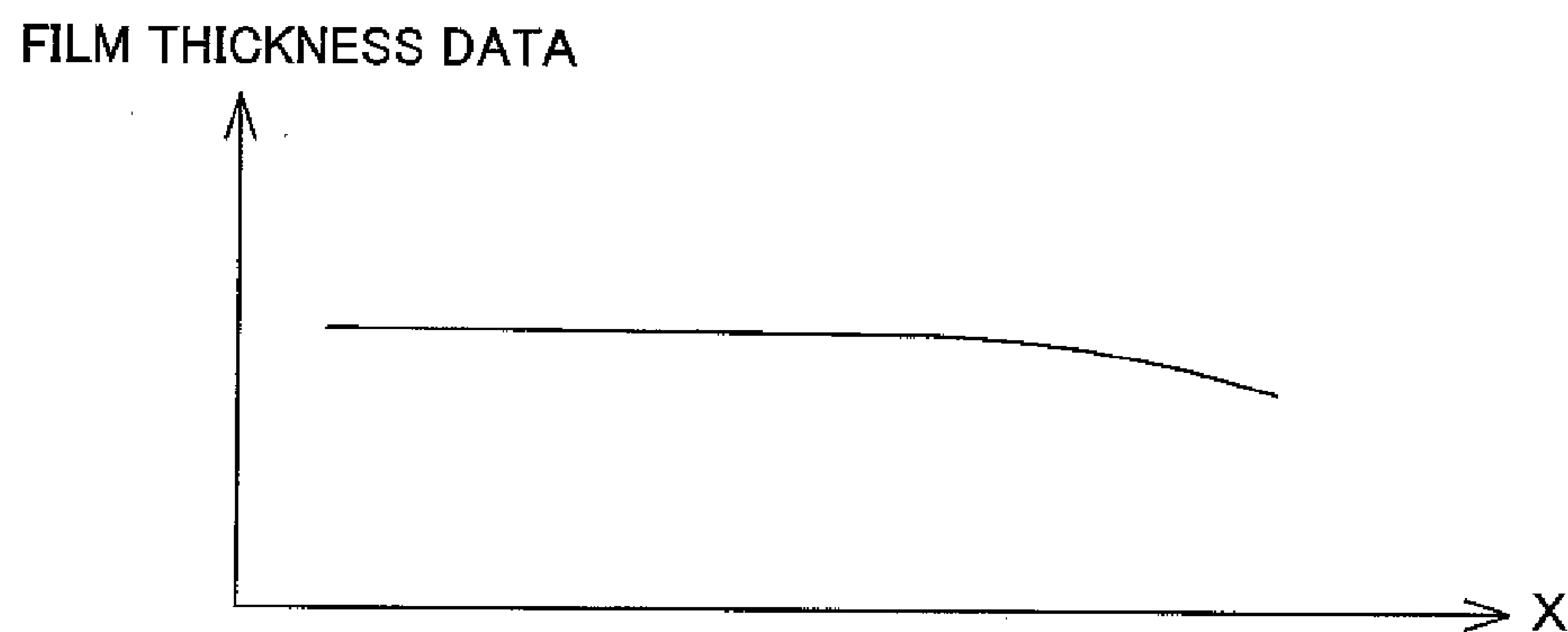


Fig. 30

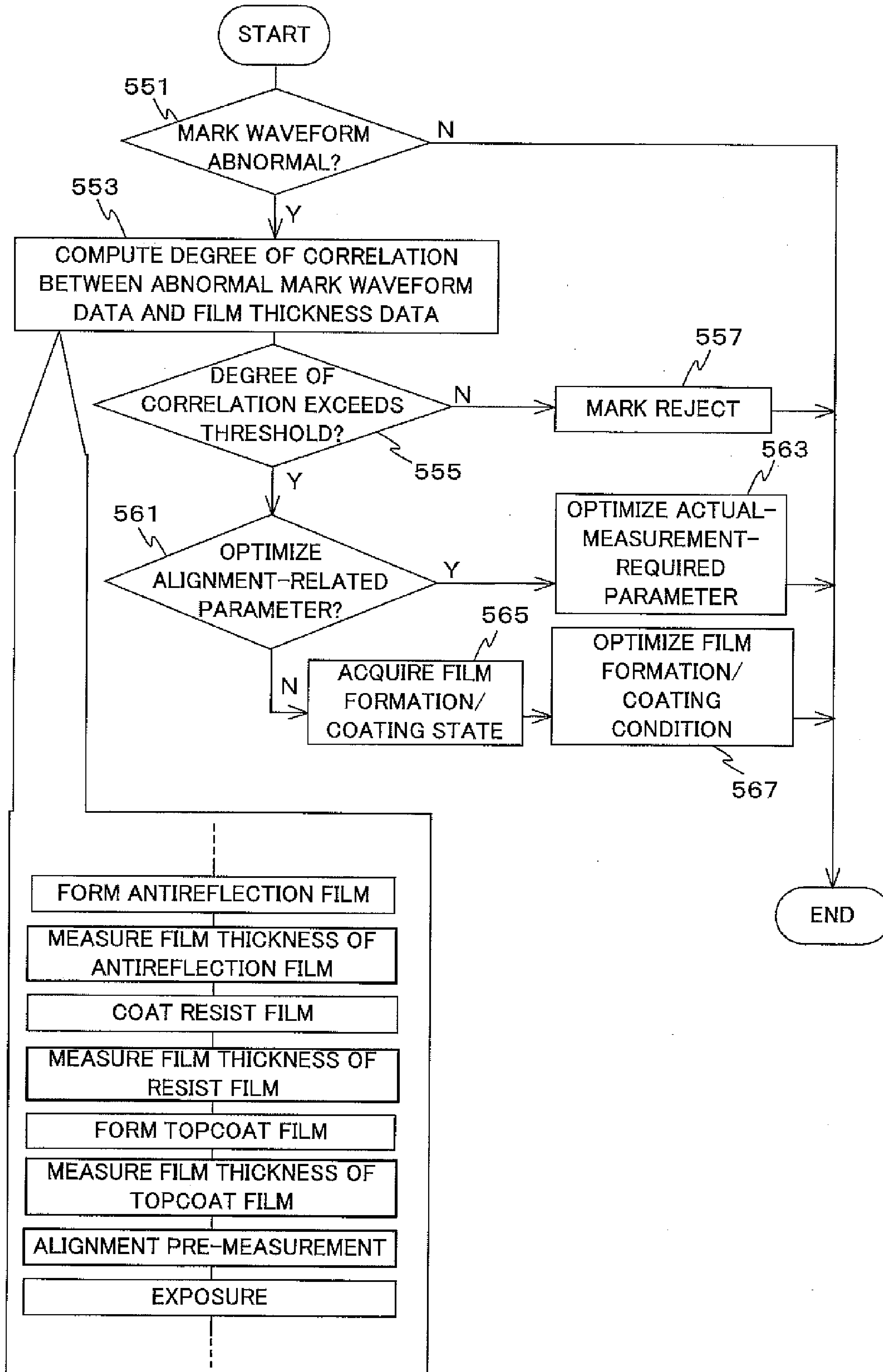


Fig. 31A

Fig. 31B

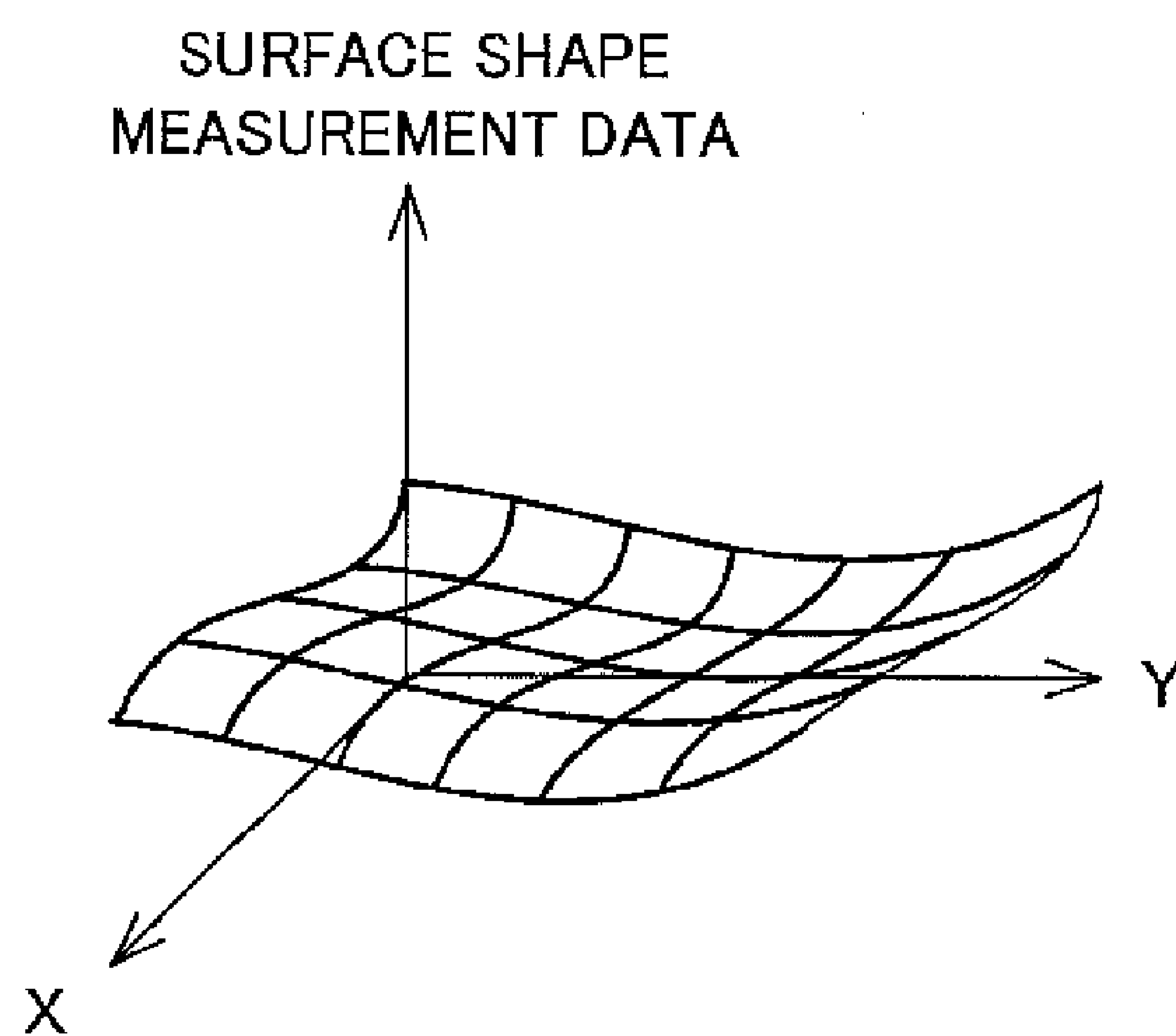


Fig. 31C

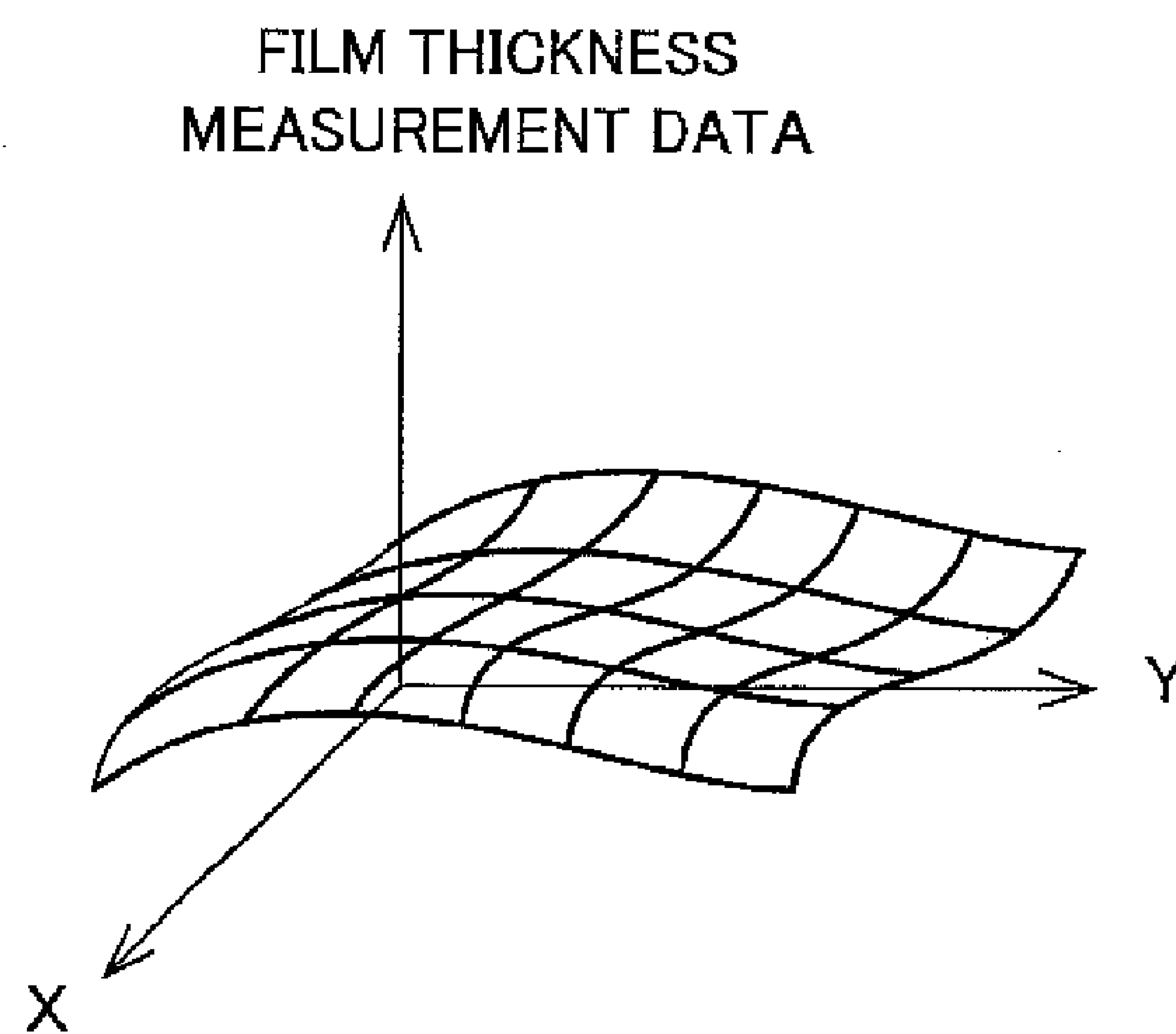


Fig. 32

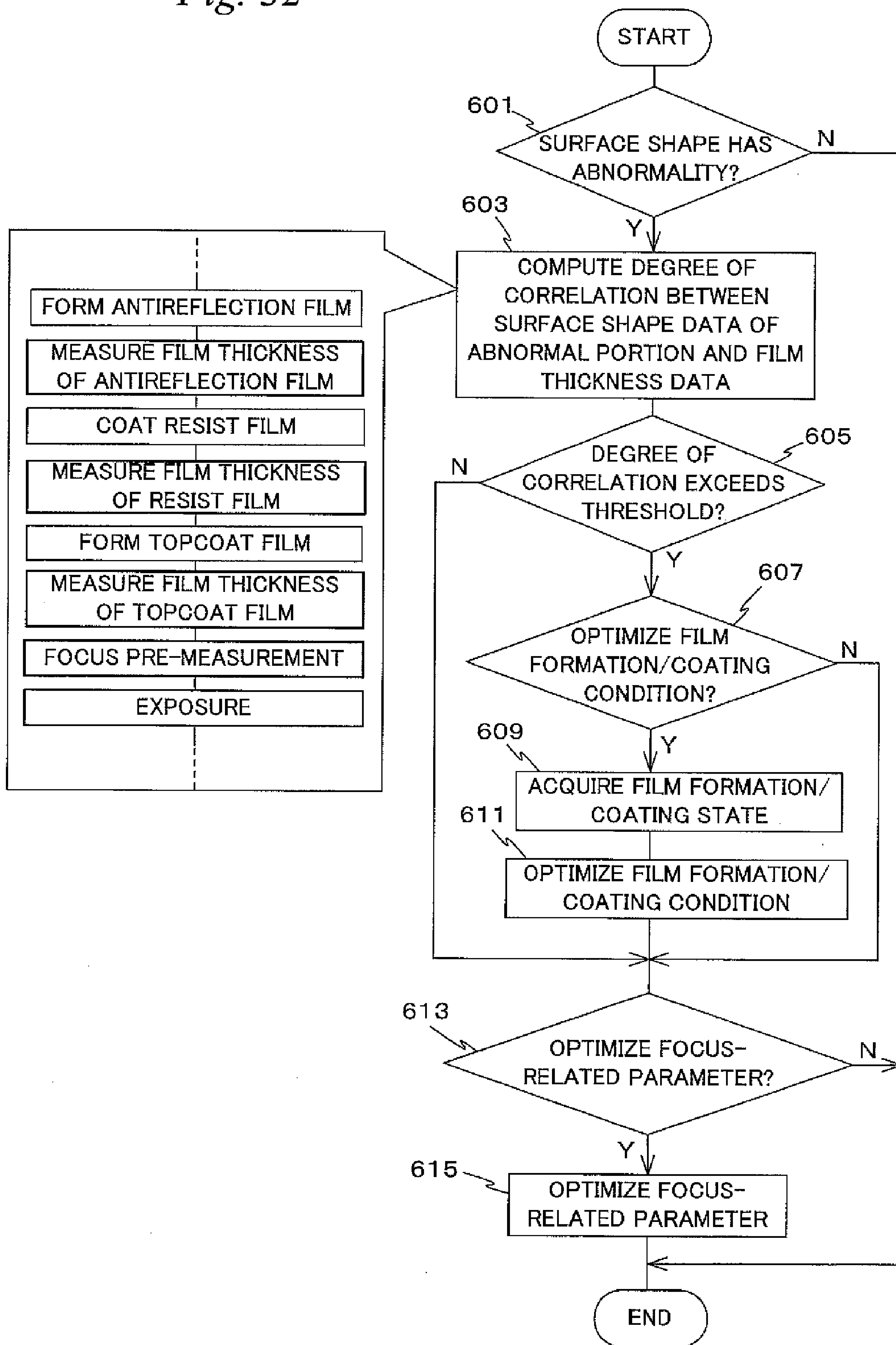


Fig. 33A

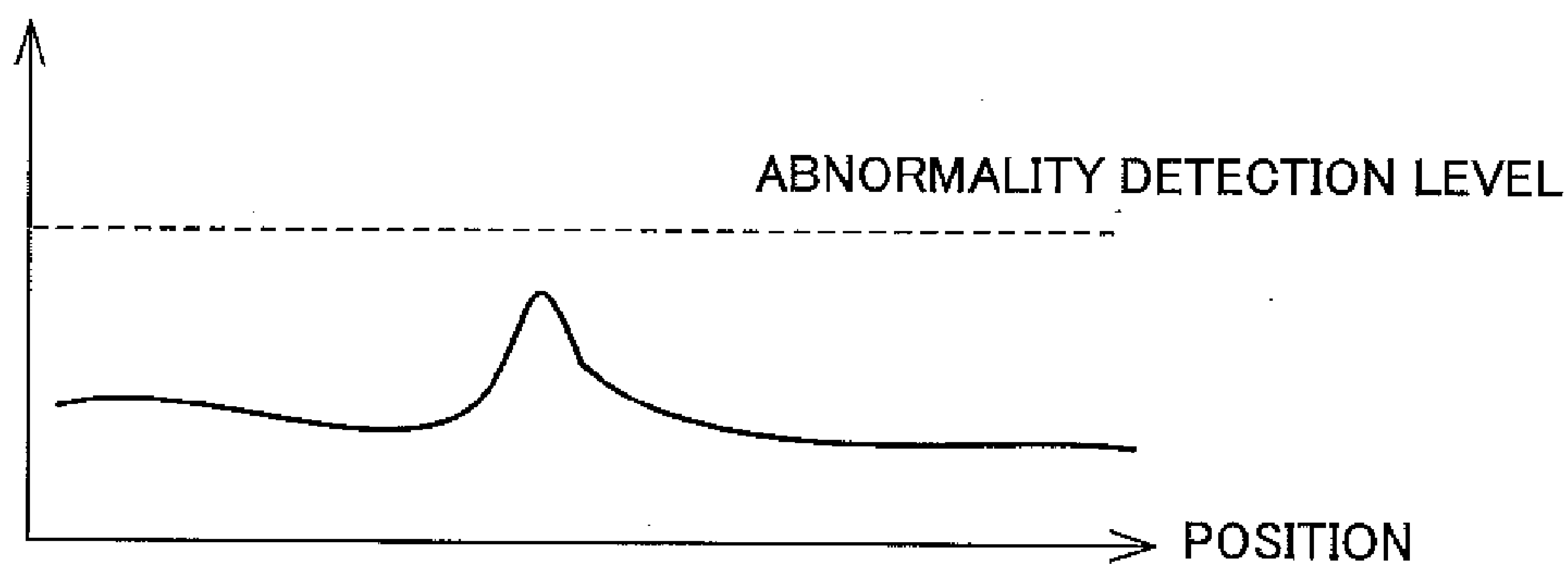


Fig. 33B

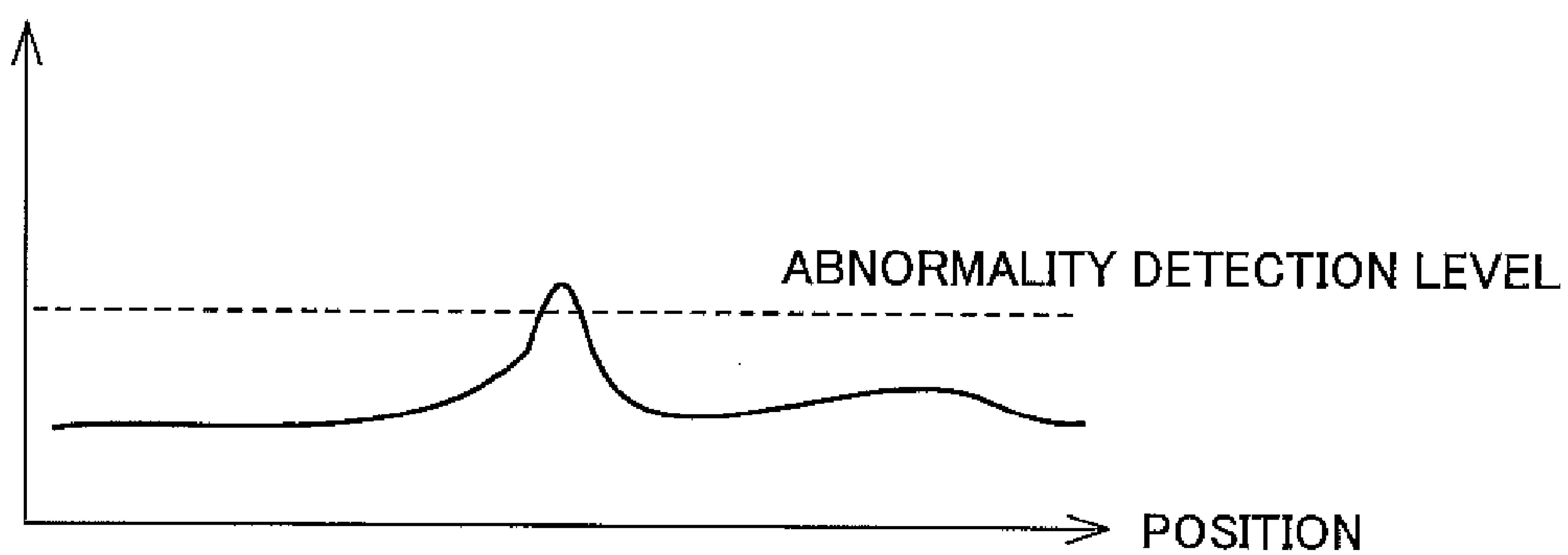


Fig. 34

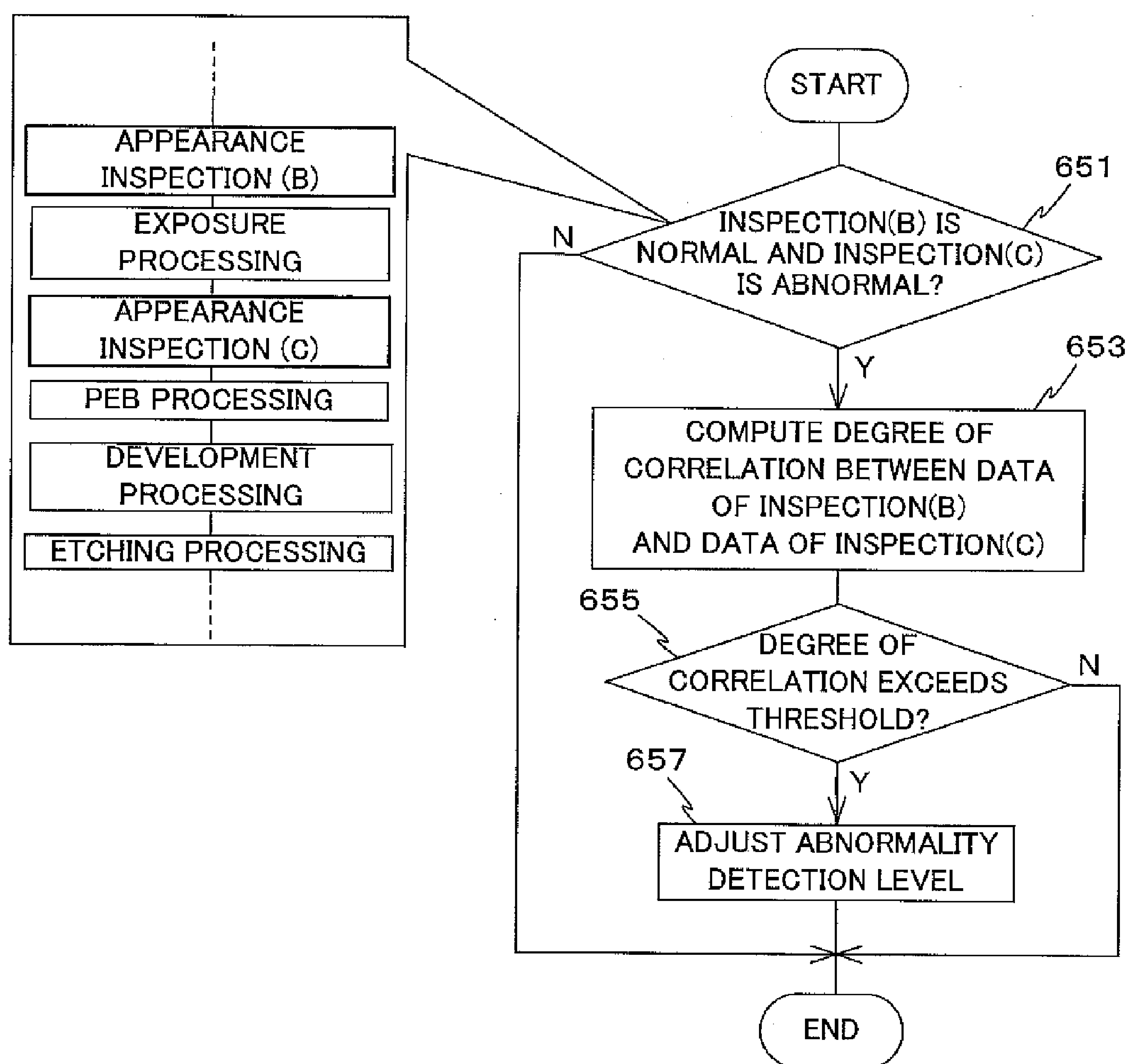


Fig. 35

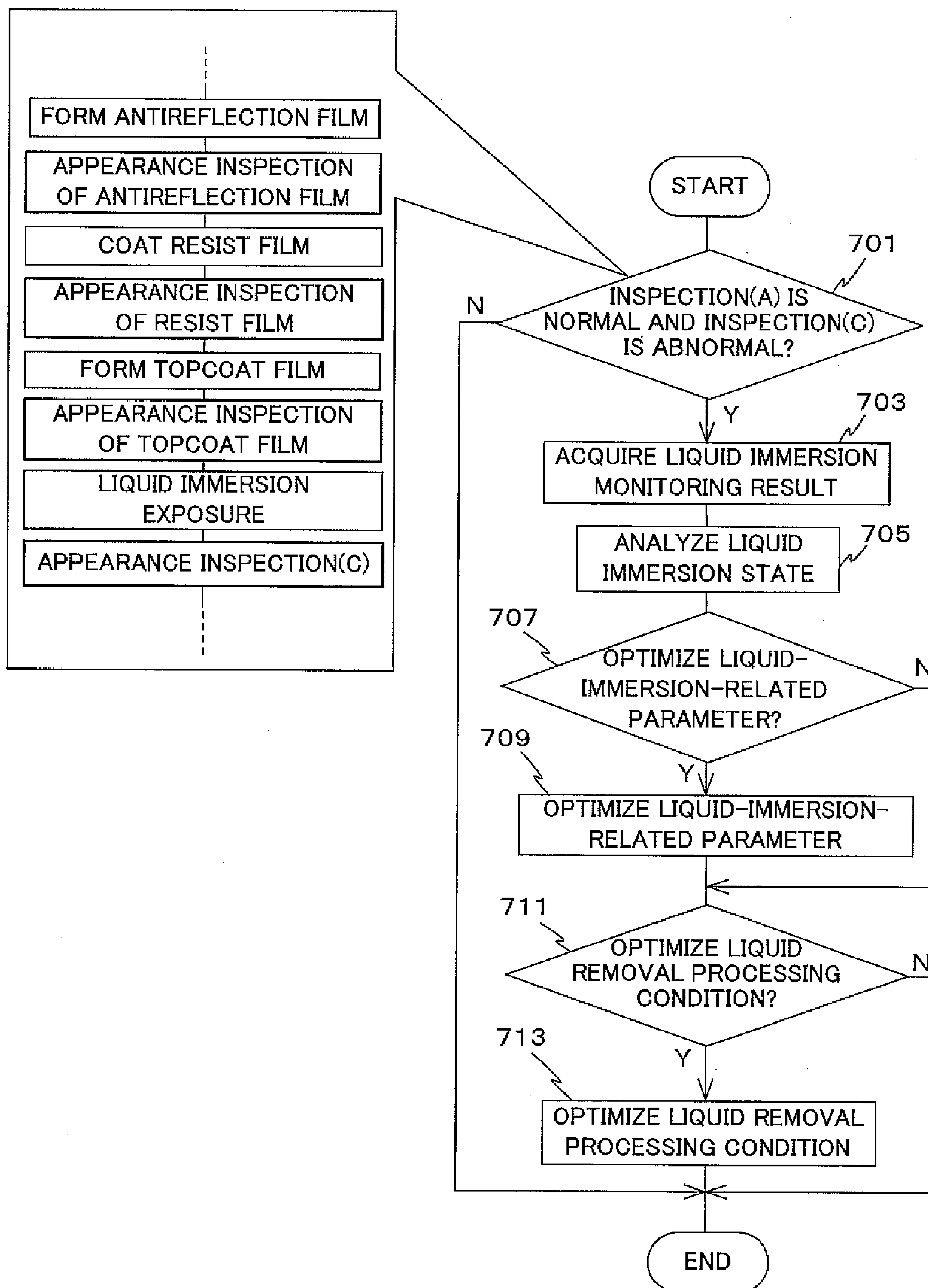


Fig. 36

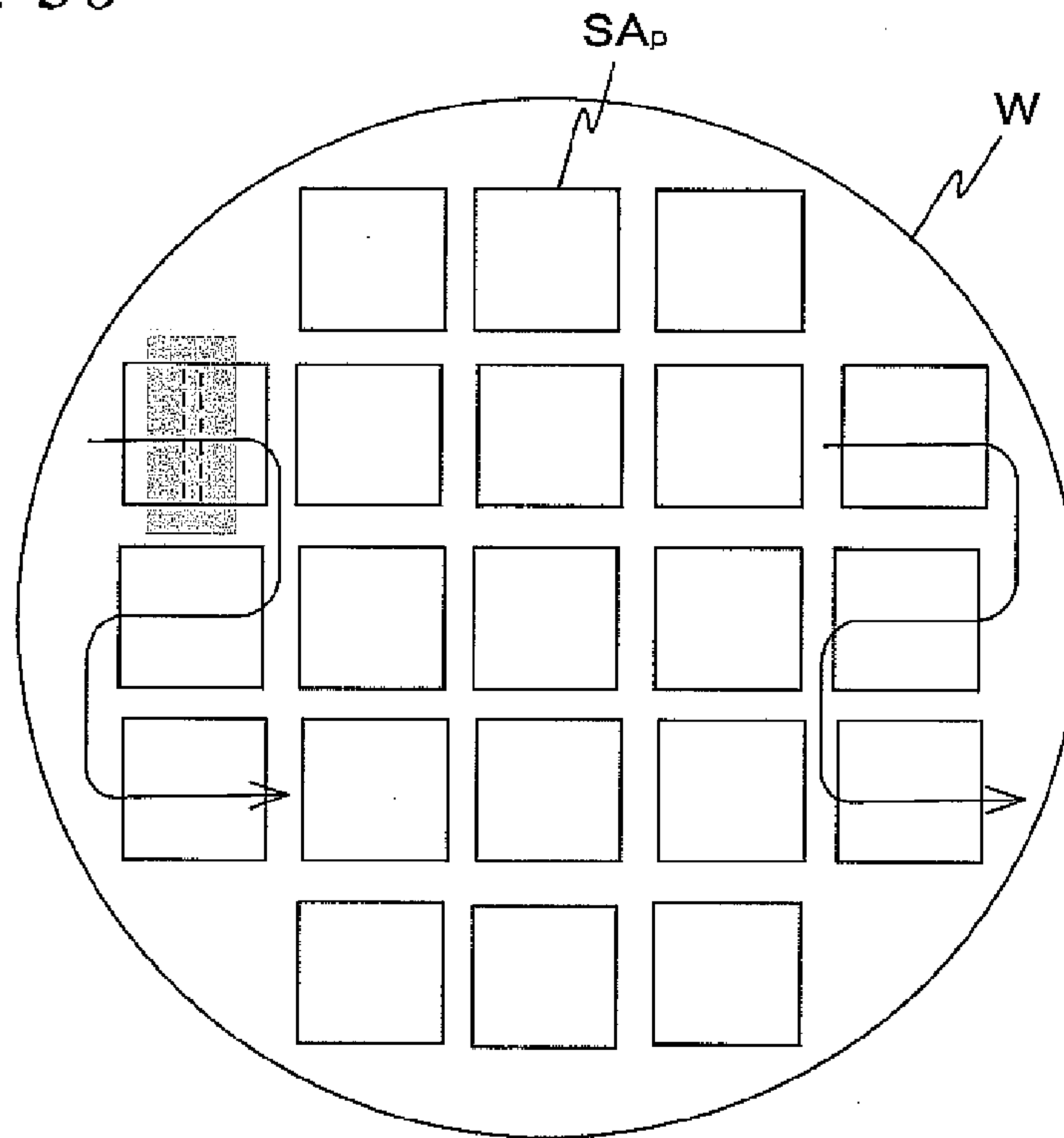


Fig. 37

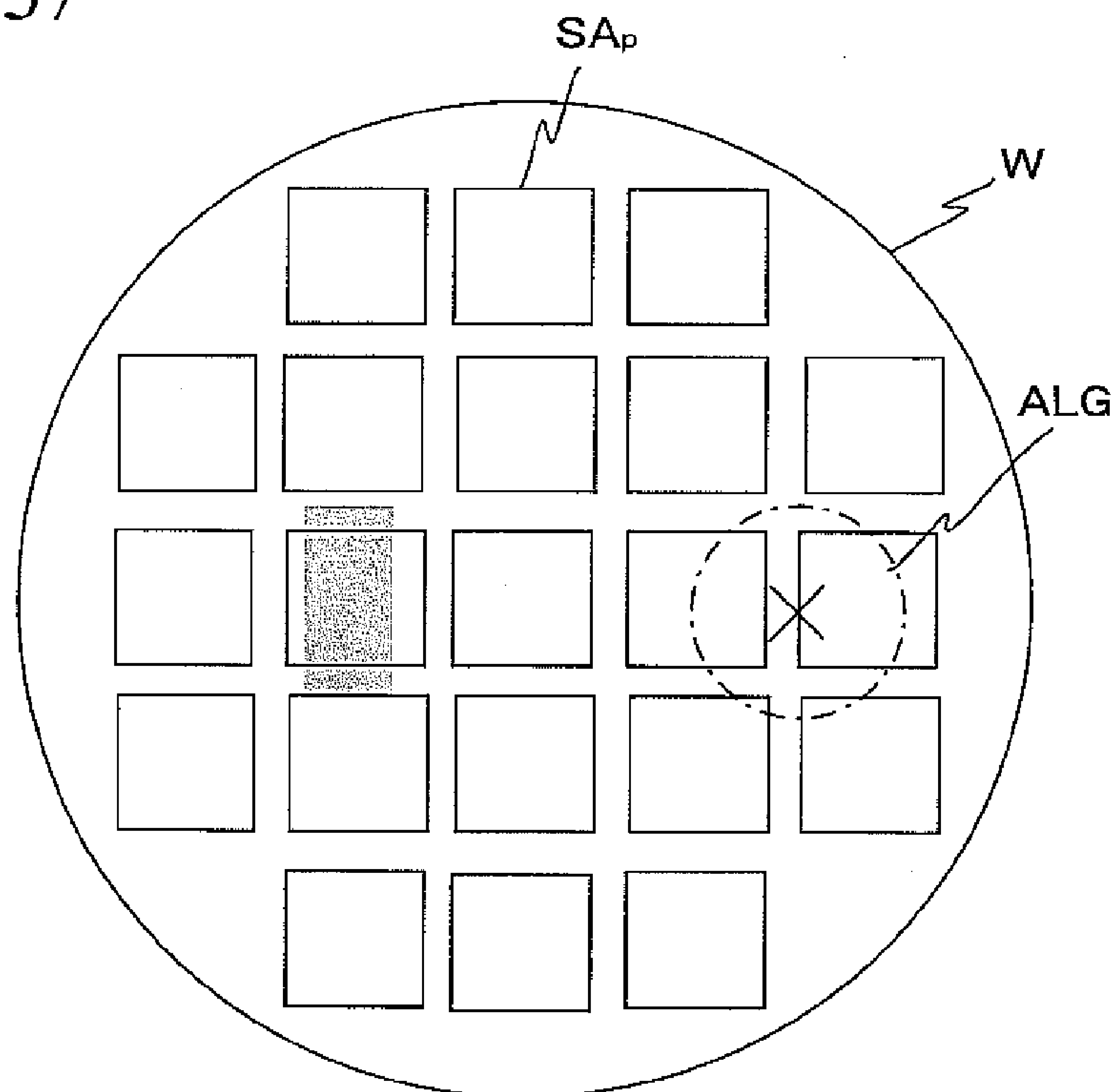


Fig. 38

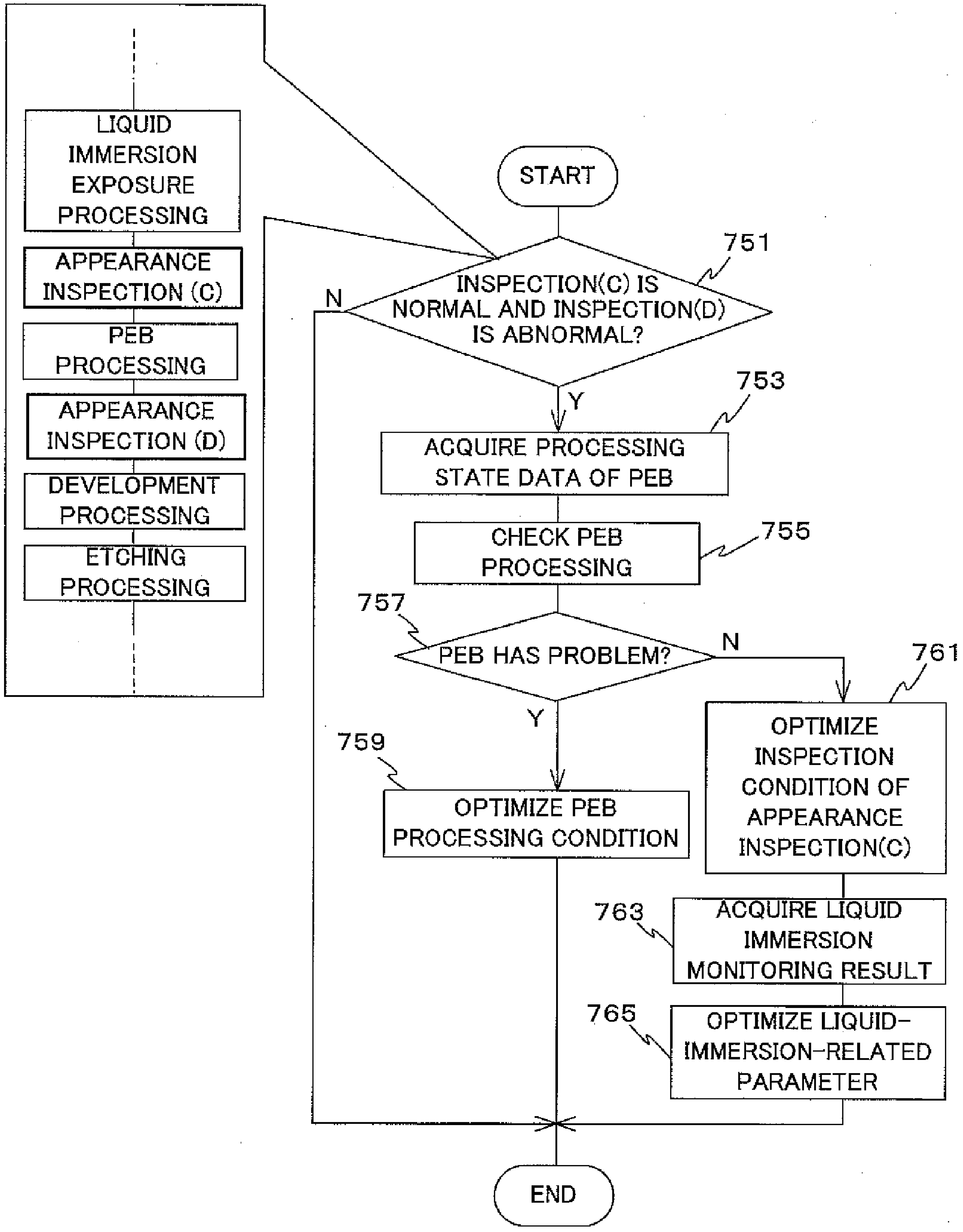
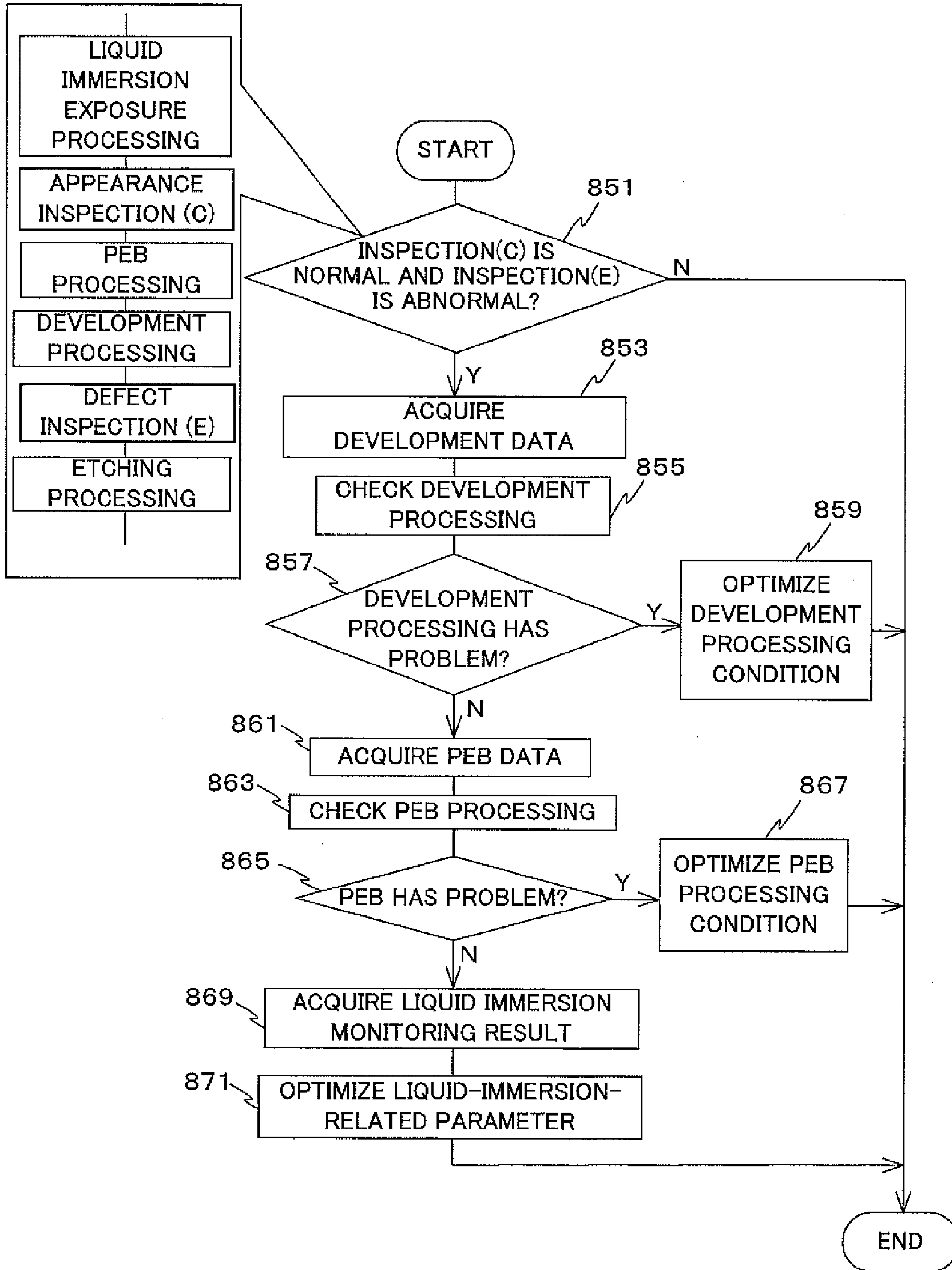


Fig. 39



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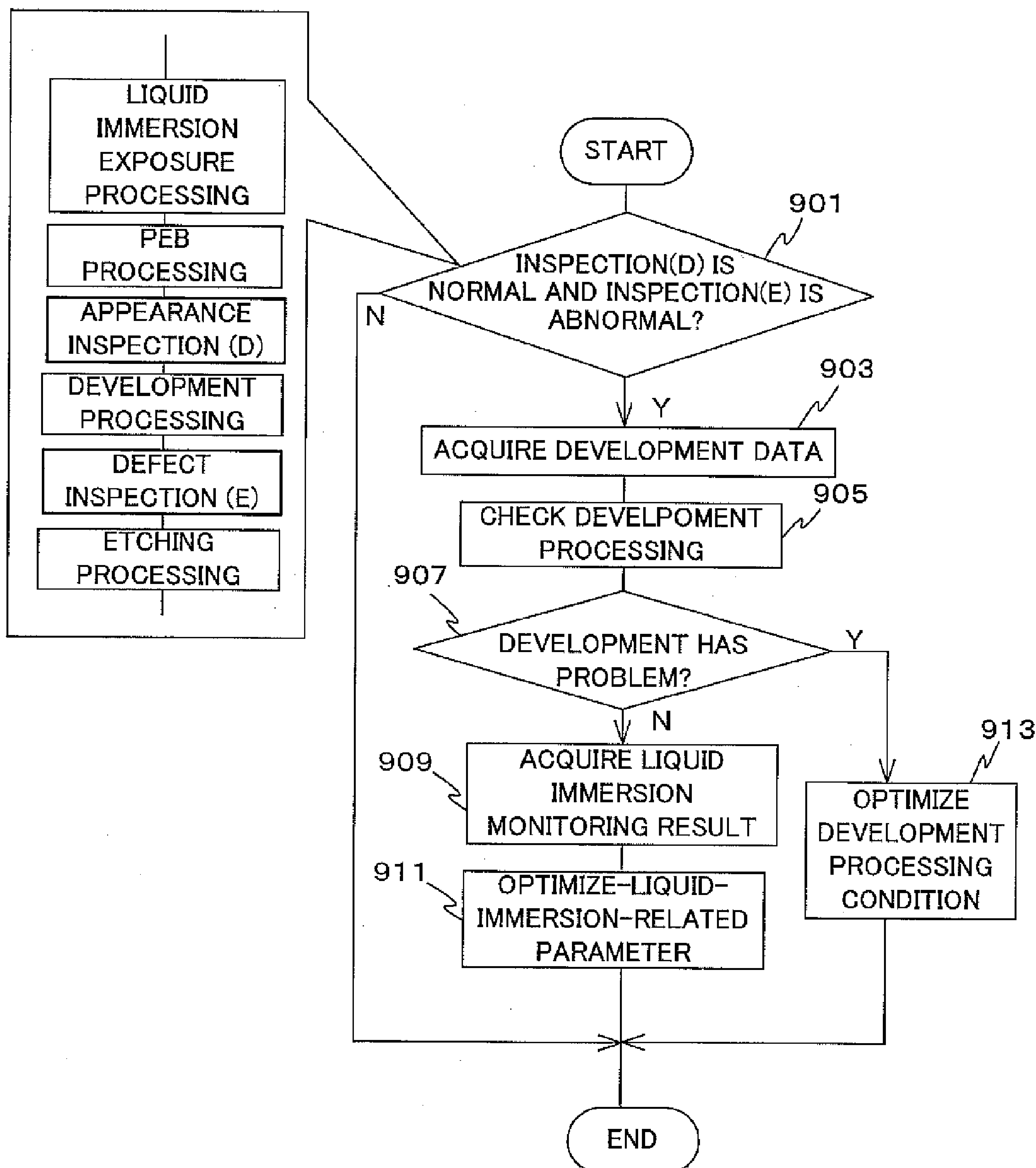

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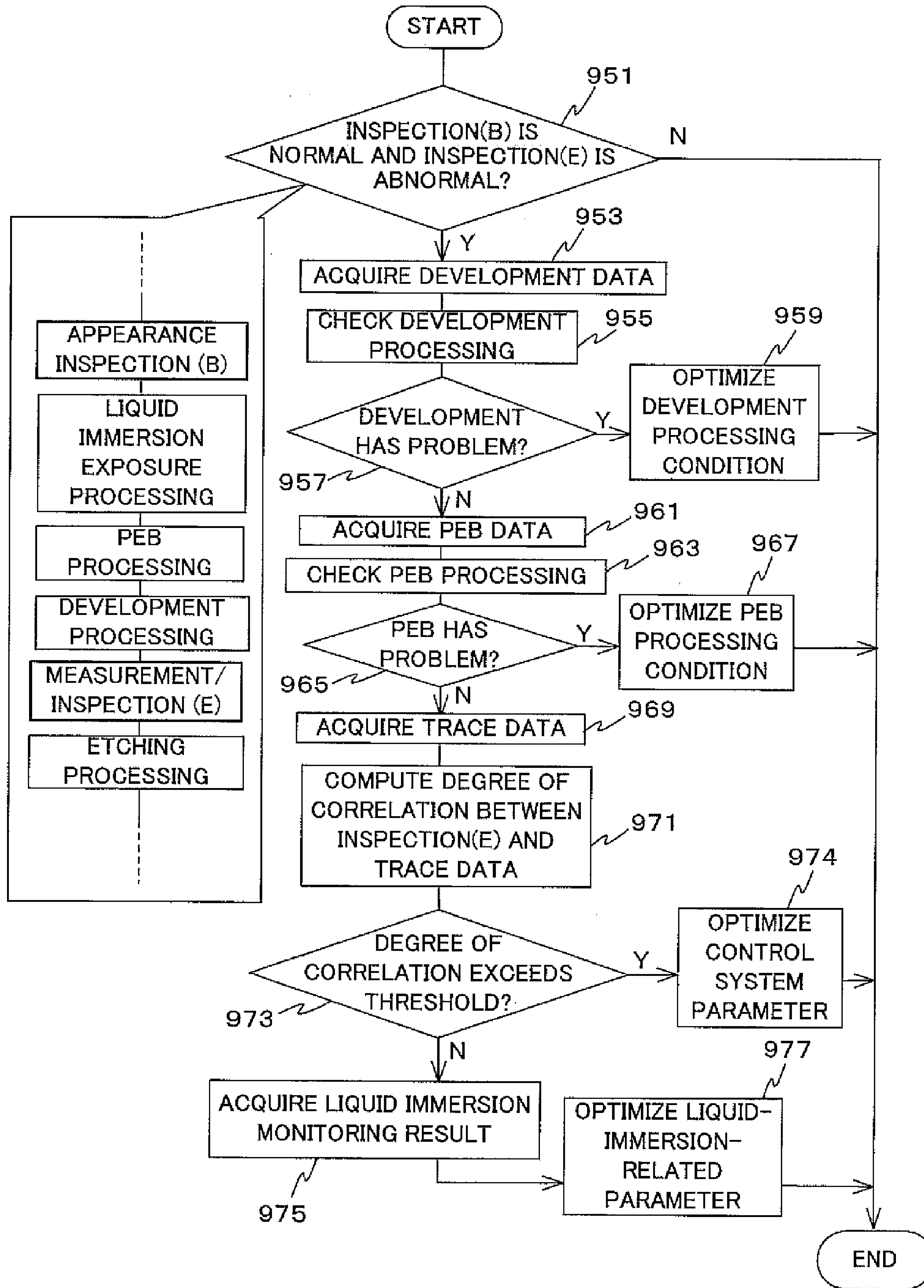


Fig. 42

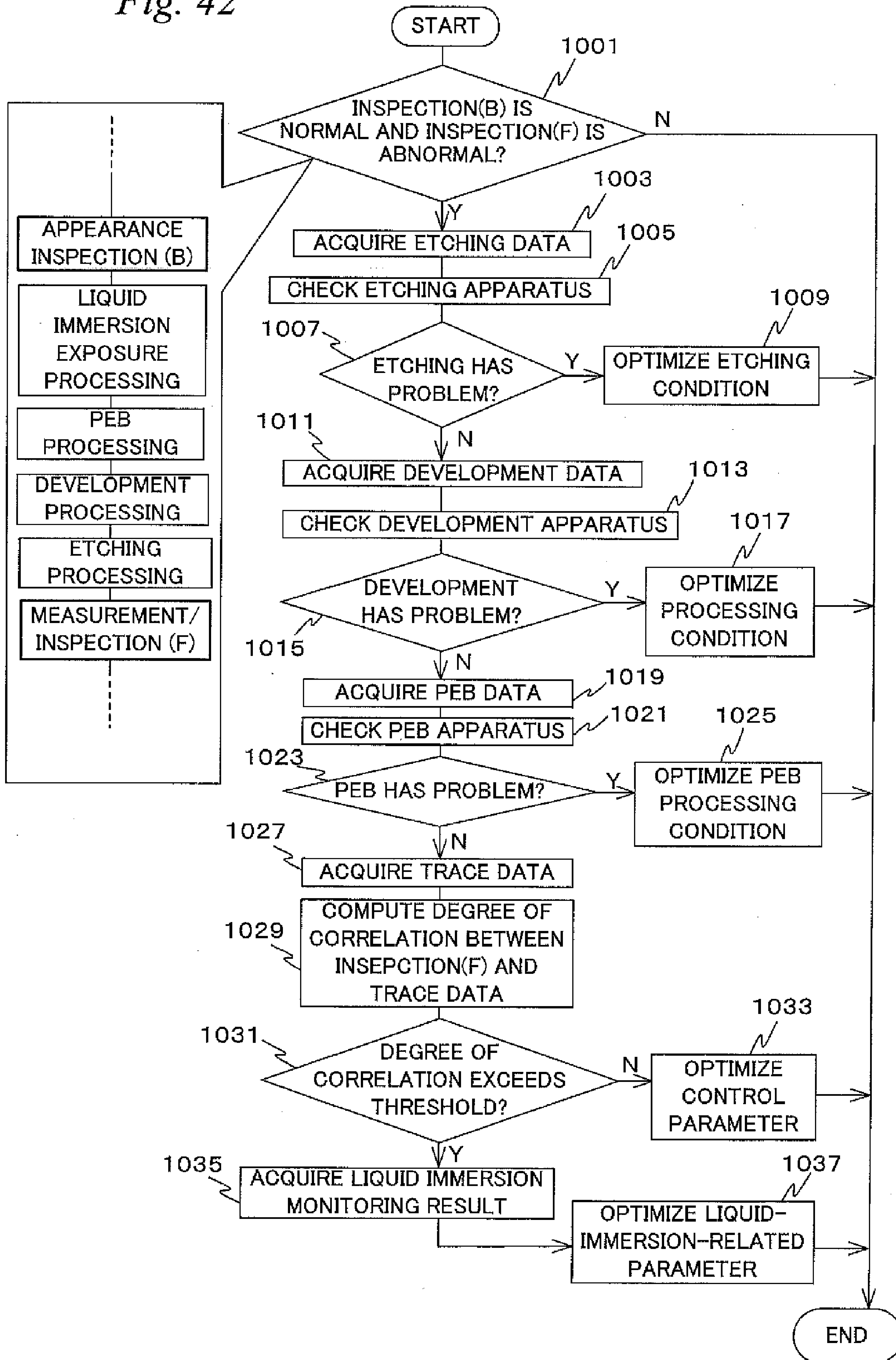


Fig. 43

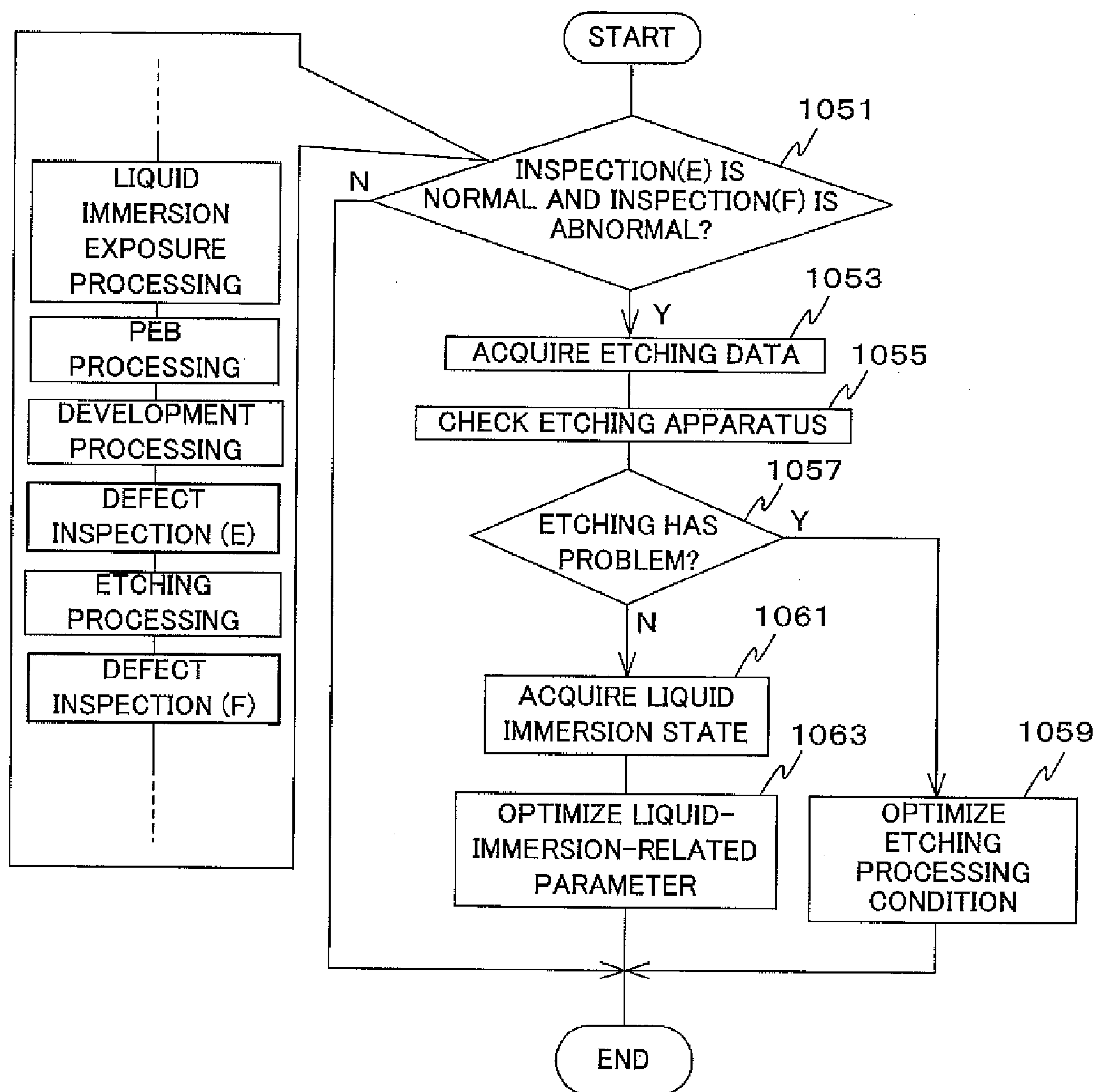


Fig. 44

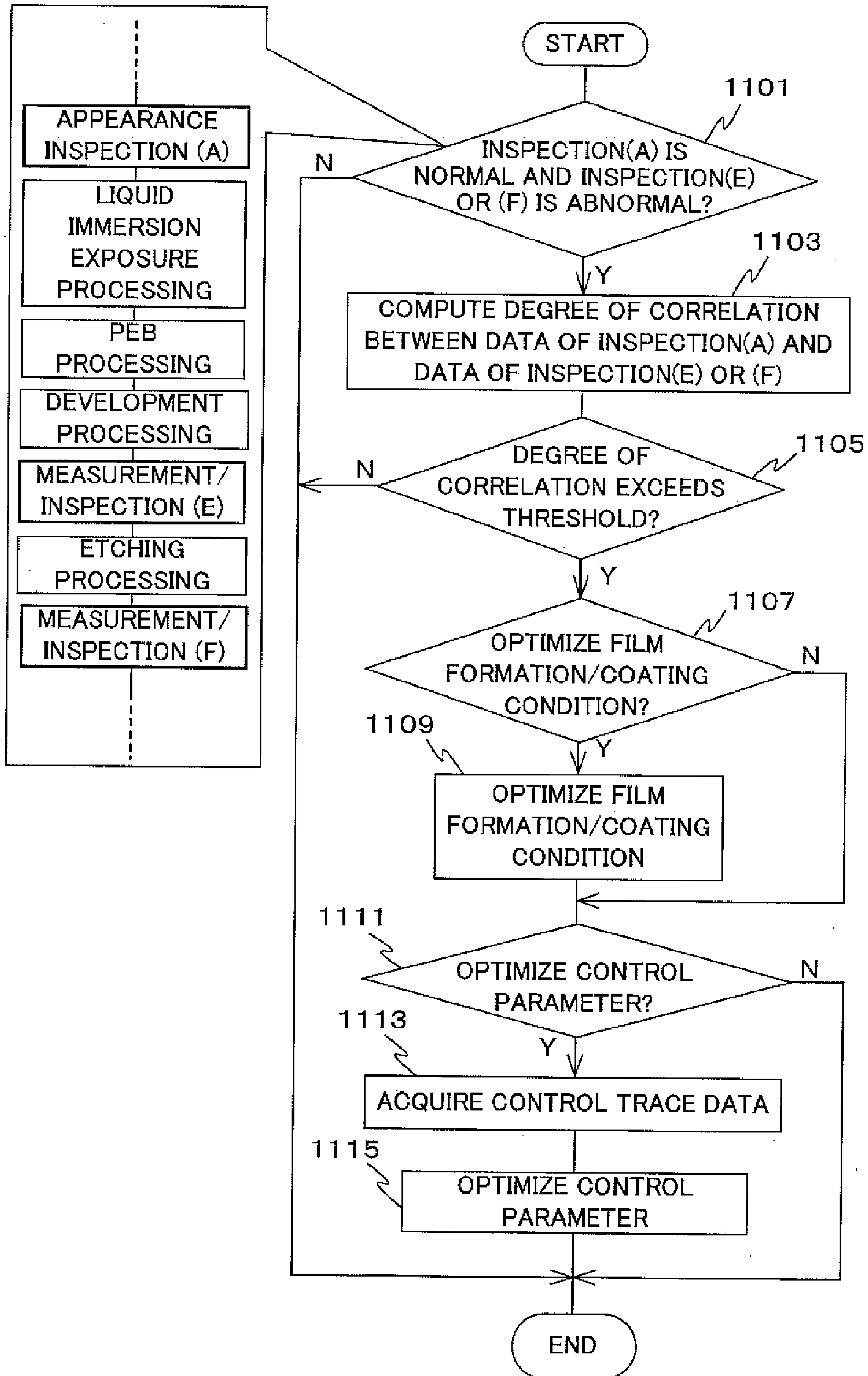


Fig. 45

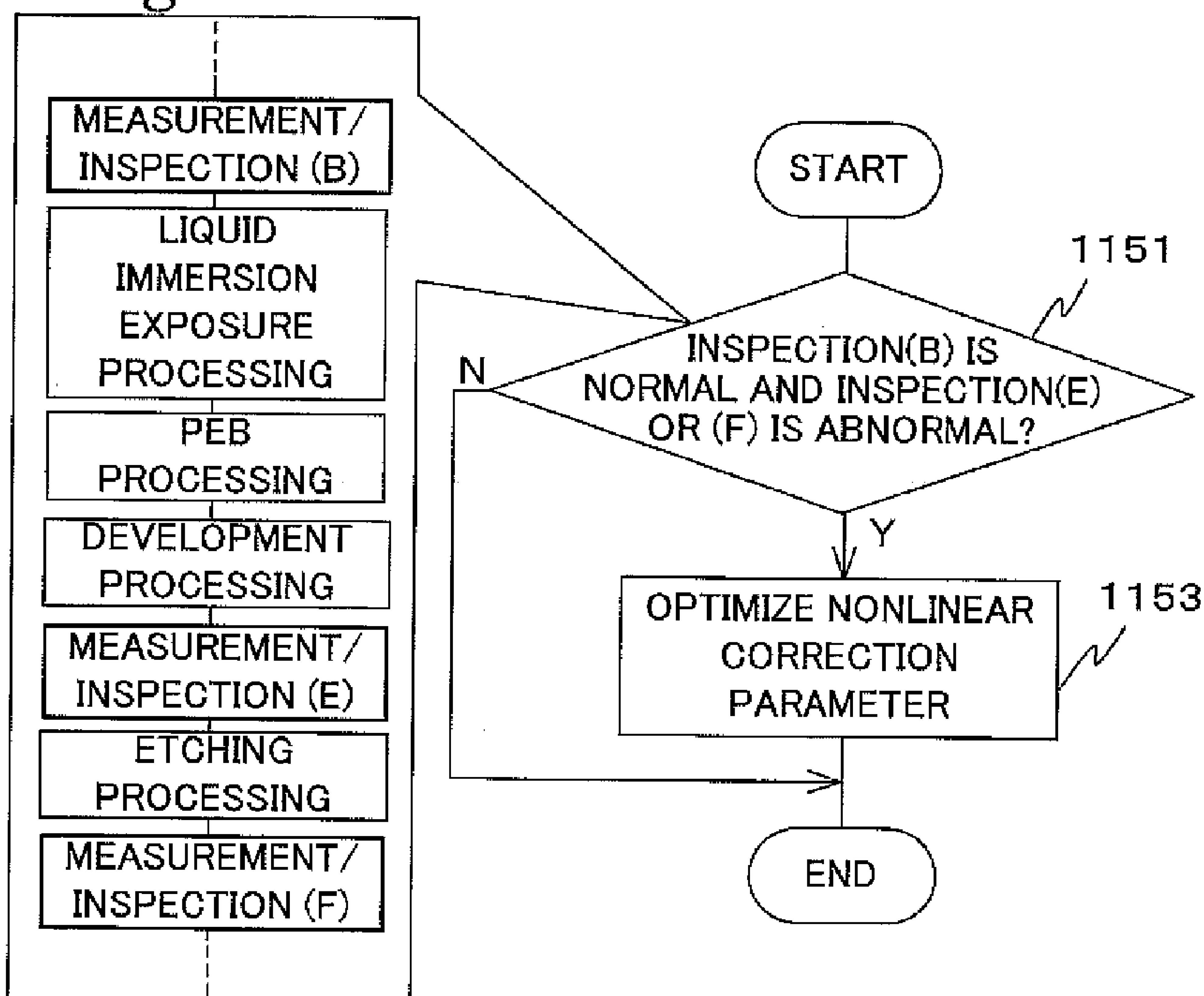
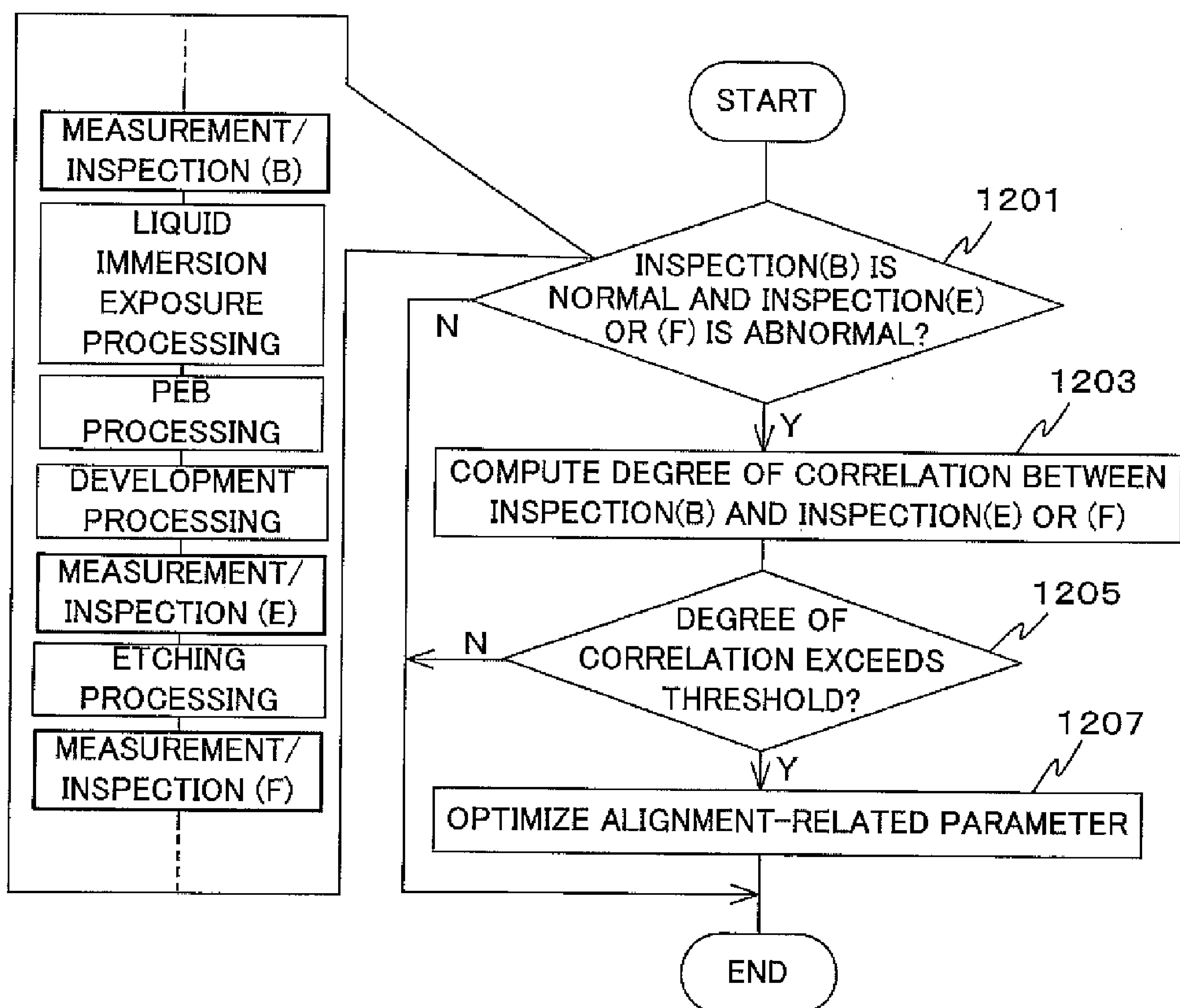


Fig. 46



ADJUSTMENT METHOD, SUBSTRATE PROCESSING METHOD, SUBSTRATE PROCESSING APPARATUS, EXPOSURE APPARATUS, INSPECTION APPARATUS, MEASUREMENT AND/OR INSPECTION SYSTEM, PROCESSING APPARATUS, COMPUTER SYSTEM, PROGRAM AND INFORMATION RECORDING MEDIUM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of U.S. patent application Ser. No. 11/706,377 filed Feb. 15, 2007 which claims the benefit of Provisional Application No. 60/872,504 filed Dec. 4, 2006, the disclosures of which are hereby incorporated herein by reference in their entireties.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to adjustment methods, substrate processing methods, substrate processing apparatuses, exposure apparatuses, inspection apparatuses, measurement and/or inspection systems, processing apparatuses, computer systems, programs and information recording media, and more particularly, an adjustment method in which processing conditions of a series of a plurality of substrate processings that include a measurement and/or inspection processing are adjusted, a substrate processing method in which a plurality of substrate processings that include an exposure processing of forming a pattern on a substrate and an inspection processing of inspecting a substrate are performed, a substrate processing apparatus that uses the adjustment method or the substrate processing method, an exposure apparatus and an inspection apparatus, a measurement and/or inspection system that implements at least one of a measurement processing and an inspection processing to a substrate that is subject to an exposure processing, a processing apparatus that executes a specific processing to a substrate that is subject to a liquid immersion exposure processing, a computer system that controls a processing process of the specific processing, a program that makes a computer execute a plurality of substrate processings that include an exposure processing of forming a pattern on a substrate and an inspection processing of inspecting a substrate, and a computer-readable information recording medium in which the program is recorded.

[0004] 2. Description of the Background Art

[0005] A semiconductor device, a liquid crystal display device, an imaging device such as CCD (Charge Coupled Device), or a microdevice (electron device) such as a thin film magnetic head is manufactured by repeating a series of a plurality of substrate processings such as a film formation/resist coating processing, an exposure processing, a postbake (PEB) processing, a development processing and an etching processing to a substrate such as a wafer. In the series of substrate processings, when the individual substrate processing ends, a measurement and/or inspection processing to a substrate is performed and whether a state of the substrate is favorable or not is checked, for the purpose of improving the yield. A measurement and/or inspection processing of a film on a substrate after the film formation/resist coating processing, a defect inspection of a pattern formed on a substrate after the development processing or the etching processing, and the like are the examples. Measurement and/or inspection results of such a measurement and/or inspection processing are used for adjustment of various processing apparatuses that performs a substrate processing, such as a film forming apparatus, a coater/developer (C/D), an exposure apparatus, and an etching apparatus, in addition to judgment of quality of the substrate.

[0006] Adjustment of device manufacturing apparatuses based on a single measurement and/or inspection result has been conventionally preformed by, for example, adjusting the film forming apparatus or the coater in the case abnormality of a film is recognized in the measurement and/or inspection processing of the film on a substrate after the film formation/resist coating processing, or adjusting the exposure apparatus in the case abnormality is recognized in a pattern on a substrate after the exposure processing.

[0007] Recently, since the processing contents of a series of a plurality of substrate processings have been further complicated due to, for example, multilayered films formed on a substrate to cope with a finer device pattern, it is gradually becoming difficult to efficiently remove the cause of the abnormality based on a single measurement and/or inspection result.

[0008] Meanwhile, in the recent exposure apparatuses, the higher resolution has been required to cope with a finer device pattern, and an exposure apparatus that uses liquid immersion exposure techniques (liquid immersion exposure apparatus) that realizes the higher resolution and the wider depth of focus has begun to be introduced. By the introduction of the liquid immersion exposure, transfer of a finer device pattern can be performed than before. At present, in order to efficiently operate the liquid immersion exposure apparatus and the conventional exposure apparatus (dry exposure apparatus), the liquid immersion exposure apparatus is used for exposure of a layer that requires critical pattern transfer accuracy, for example, exposure in a contact hole process or a gate formation process (isolated line), and the conventional exposure apparatus is used for exposure of a layer that requires a relatively relaxed pattern transfer accuracy.

[0009] In general, the required accuracy becomes higher for a pattern that is formed on a substrate by liquid immersion exposure. Further, since liquid that remains on a substrate (remaining liquid) affects the processings such as the postbake, the development and the etching after exposure, it is necessary to remove the liquid completely and confirm that there is no remaining liquid. In this manner, an inspection such as an inspection of the remaining liquid that is different from a measurement and/or inspection for a substrate to which exposure is performed in the conventional exposure apparatus is preferably performed to a substrate to which liquid immersion exposure is performed. Under the present situation, however, the measurement and/or inspection processings under the similar measurement and/or inspection conditions are constantly performed to both of a substrate to which dry exposure is performed and a substrate to which liquid immersion exposure is performed because of the standalone configuration of a measurement and/or inspection instrument or the like.

SUMMARY OF THE INVENTION

[0010] The present invention has been made under such circumstances, and according to a first aspect of the present invention, there is provided an adjustment method in which a processing condition of a series of a plurality of substrate

processings that include a measurement and/or inspection processing is adjusted, the method comprising: a collection process of collecting information on at least two types of measurement and/or inspection results related to at least one substrate; an optimization process of optimizing a processing condition of at least part of the plurality of substrate processings based on the collected information on at least two types of measurement and/or inspection results; and a transmission process of transmitting information on the optimized processing condition to an apparatus that performs a relevant processing.

[0011] With this method, information on at least two types of measurement and/or inspection results of measurement and/or inspection processings that are included in a series of a plurality of substrate processings is collected, and based on the collected information on two types of measurement and/or inspection results, optimization of a processing condition of at least part of the plurality of substrate processings is performed. Then, information on the optimized processing condition is transmitted to an apparatus that performs a relevant processing. Therefore, more efficient optimization of the processing condition can be performed than the case when the processing condition is optimized using only one type of measurement and/or inspection result.

[0012] According to a second aspect of the present invention, there is provided a first substrate processing method, comprising: an adjustment process of adjusting a processing condition of a substrate processing using the adjustment method of the present invention. With this method, a processing condition of a substrate processing can appropriately be adjusted using the adjustment method of the present invention.

[0013] According to a third aspect of the present invention, there is provided a second substrate processing method in which a plurality of substrate processings that include an exposure processing of forming a pattern on a substrate by exposing the substrate and an inspection processing of inspecting the substrate afterward are performed, the method comprising: an acquisition process of acquiring information as to whether the exposure processing has been performed by liquid immersion exposure or dry exposure; and an adjustment process of adjusting a processing condition of a substrate processing using the adjustment method of the present invention, in the case the exposure processing is judged to have been performed by liquid immersion exposure based on the acquired information. With this method, a substrate condition of a substrate processing can appropriately be adjusted depending on whether the exposure processing has been performed by liquid immersion exposure or dry exposure.

[0014] According to a fourth aspect of the present invention, there is provided a third substrate processing method in which a plurality of substrate processings that include an exposure processing of forming a pattern on a substrate by exposing the substrate and an inspection processing of inspecting the substrate afterward are performed, the method comprising: an acquisition process of acquiring information as to whether the exposure processing is performed by liquid immersion exposure or dry exposure; an adjustment process of adjusting a processing content of at least part of the plurality of substrate processings in accordance with the acquired information; and a transmission process of transmitting the adjustment result to an apparatus that performs a relevant processing.

[0015] With this method, a processing content of at least part of the plurality of substrate processings is adjusted in accordance with information as to whether the exposure processing is performed by liquid immersion exposure or dry exposure. Then, the adjustment result is transmitted to an apparatus that performs a relevant processing. Therefore, by appropriately adjusting the processing condition in accordance with the exposure method that is performed to a substrate, the yield can be improved.

[0016] According to a fifth aspect of the present invention, there is provided a substrate processing apparatus that performs a substrate processing according to transmitted information using any one of four methods that are the adjustment method of the present invention and the first, second and third substrate processing methods of the present invention. With this apparatus, since a substrate processing can be performed under the processing condition that is optimized using any one of four methods that are the adjustment method of the present invention and the first to third substrate processing methods of the present invention, the yield can be improved.

[0017] According to a sixth aspect of the present invention, there is provided an exposure apparatus that performs exposure to a substrate according to transmitted information using the third substrate processing method of the present invention. With this apparatus, since exposure can be preformed under the processing condition that is optimized using the third substrate processing method of the present invention, the yield can be improved.

[0018] According to a seventh aspect of the present invention, there is provided a measurement and/or inspection apparatus that performs measurement and/or inspection of a substrate according to transmitted information using the third substrate processing method of the present invention. With this apparatus, since a measurement and/or inspection processing can be performed under the processing condition that is optimized using the third substrate processing method of the present invention, the yield can be improved.

[0019] According to an eighth aspect of the present invention, there is provided a first program that makes a computer execute a plurality of substrate processings that include an exposure processing of forming a pattern on a substrate by exposing the substrate and an inspection processing of inspecting the substrate afterward, the program making the computer execute: an acquisition procedure of acquiring information as to whether the exposure processing is performed by liquid immersion exposure or dry exposure; an adjustment procedure of adjusting a processing content of at least part of the plurality of substrate processings in accordance with the acquired information; and a transmission procedure of transmitting the adjustment result to an apparatus that performs a relevant processing.

[0020] With this program, since a processing content of at least part of the plurality of substrate processing is adjusted in accordance with information as to whether the exposure processing is performed by liquid immersion exposure or dry exposure, the processing condition can appropriately be adjusted in accordance with the exposure that is performed to a substrate and the yield can be improved.

[0021] According to a ninth aspect of the present invention, there is provided a first computer-readable information recording medium in which the first program of the present invention is recorded. Accordingly, by setting the first information recording medium in a computer and installing the first program inside the first information recording medium,

the computer can be made to execute the first program of the present invention, which makes it possible to make the processing content of the substrate processing be appropriate.

[0022] According to a tenth aspect of the present invention, there is provided a second program that makes a computer system execute a processing process of a specific processing in which the specific processing that is unnecessary for a substrate that is subject to a dry exposure processing of irradiating exposure light on the substrate without liquid is executed to a substrate that is subject to a liquid immersion exposure processing of exposing the substrate with exposure light via liquid, the program making the computer system execute: a procedure of changing whether or not to execute the specific processing in the processing process to a substrate based on information that shows whether the substrate is subject to the liquid immersion exposure processing or the dry exposure processing.

[0023] With this program, with respect to only a substrate subject to the liquid immersion exposure processing, the processing process of a specific processing that is required for the substrate (processing peculiar to liquid immersion) can be executed.

[0024] According to an eleventh aspect of the present invention, there is provided a second computer-readable information recording medium in which a program that makes a computer system execute a processing process of a specific processing in which the specific processing that is unnecessary for a substrate that is subject to a dry exposure processing of irradiating exposure light to the substrate without liquid is executed to a substrate that is subject to a liquid immersion exposure processing of exposing the substrate with exposure light via liquid is recorded, wherein the program is a program that makes the computer system execute a procedure of changing whether or not to execute the specific processing in the processing process to a substrate based on information that shows whether the substrate is subject to the liquid immersion exposure processing or the dry exposure processing.

[0025] Accordingly, by setting the second information recording medium in a computer and installing the program inside the information recording medium (which is substantially the same as the second program of the present invention), the computer can be made to execute the second program of the present invention, and thus, with respect to only a substrate subject to the liquid immersion exposure processing, the processing process of the specific processing that is required for the substrate (processing peculiar to liquid immersion) can be executed.

[0026] According to a twelfth aspect of the present invention, there is provided a measurement and/or inspection system that implements at least one of a measurement processing and an inspection processing to a substrate that is subject to any one of a liquid immersion exposure processing of exposing the substrate with exposure light via liquid and a dry exposure processing of irradiating exposure light on the substrate without liquid, the system comprising: a specific measurement and/or inspection section that executes a specific measurement and/or inspection processing that is unnecessary for a substrate that is subject to the dry exposure processing to a substrate that is subject to the liquid immersion exposure processing, wherein whether or not the specific measurement and/or inspection section executes the specific measurement and/or inspection processing is changed, in accordance with information that shows whether a substrate is subject to the liquid immersion exposure processing or the dry exposure processing.

[0027] With this system, with respect to only a substrate subject to the liquid immersion exposure processing, a specific measurement and/or inspection processing that is required for the substrate (measurement and/or inspection processing peculiar to liquid immersion) can be executed.

[0028] According to a thirteenth aspect of the present invention, there is provided a processing apparatus that executes a specific processing that is unnecessary for a substrate that is subject to a dry exposure processing of irradiating exposure light to the substrate without liquid to a substrate that is subject to a liquid immersion exposure processing of exposing the substrate with exposure light via liquid, wherein whether or not to execute the specific processing to a substrate is changed in accordance with information that shows whether the substrate is subject to the liquid immersion exposure processing or the dry exposure processing.

[0029] With this apparatus, with respect to only a substrate subject to the liquid immersion exposure processing, a specific processing that is required for the substrate (processing peculiar to liquid immersion) can be executed.

[0030] According to a fourteenth aspect of the present invention, there is provided a computer system that controls a processing process of a specific processing in which the specific processing that is unnecessary for a substrate that is subject to a dry exposure processing of irradiating exposure light to the substrate without liquid is executed to a substrate that is subject to a liquid immersion exposure processing of exposing the substrate with exposure light via liquid, wherein whether or not to execute the specific processing in the processing process to a substrate is changed in accordance with information that shows whether the substrate is subject to the liquid immersion exposure processing or the dry exposure processing.

[0031] With this computer system, with respect to only a substrate subject to the liquid immersion exposure processing, a specific processing that is required for the substrate (processing peculiar to liquid immersion) can be executed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] FIG. **1** is a view showing a schematic configuration of a device manufacturing system related to an embodiment of the present invention;

[0033] FIG. **2** is a view showing a schematic configuration of a dry exposure apparatus;

[0034] FIG. **3**A is an entire view of a wafer and FIG. **3**B is an enlarged view of part of the wafer;

[0035] FIG. **4** is a view used to explain a liquid immersion exposure apparatus;

[0036] FIG. **5** is a view used to explain an exposure apparatus main section in FIG. **4**;

[0037] FIG. **6** is a view used to explain a liquid immersion system in FIG. **5**;

[0038] FIGS. **7**A to **7**C are views each used to explain a problem peculiar to the liquid immersion system;

[0039] FIG. **8**A and FIG. **8**B are views each used to explain a liquid immersion monitor;

[0040] FIG. **9** is a view used to explain a CCD sensor module of the liquid immersion monitor;

[0041] FIG. **10** is a view used to explain an object plane position of each line sensor in the CCD sensor module in FIG. **9**;

[0042] FIG. **11** is a view used to explain the line sensor in FIG. **10**;

[0043] FIG. **12** is a view used to explain the liquid immersion monitor installed on a substrate holder;

[0044] FIG. **13** is a view used to explain a removal unit T in FIG. **4**;

[0045] FIG. **14** is a view used to explain a generating unit in FIG. **13**;

[0046] FIG. **15** is a view used to explain an elastic stator and an oscillating body in FIG. **13**;

[0047] FIG. **16** is a view (No. 1) used to explain the working of the generating unit in FIG. **14**;

[0048] FIG. **17** is a view (No. 2) used to explain the working of the generating unit in FIG. **14**;

[0049] FIG. **18** is a view (No. 3) used to explain the working of the generating unit in FIG. **14**;

[0050] FIG. **19** is a view (No. 4) used to explain the working of the generating unit in FIG. **14**;

[0051] FIG. **20**A and FIG. **20**B are views each used to explain an elastic stator that has gas outlets;

[0052] FIG. **21**A and FIG. **21**B are views each used to explain an elastic stator that has suction openings;

[0053] FIG. **22** is a view showing the control operation of an exposure apparatus by a host;

[0054] FIG. **23** is a view showing the control operation of a C/D by the host;

[0055] FIG. **24** is a view showing the control operation of a device manufacturing apparatus group by the host;

[0056] FIG. **25** is a view showing the control operation of a measurement and/or inspection instrument by the host;

[0057] FIG. **26**A is an example of an image showing a pattern defect peculiar to liquid immersion at the time of liquid immersion exposure, and FIG. **26**B is a view showing the characteristics of a pattern peculiar to liquid immersion;

[0058] FIG. **27** is a view showing the control operation of an analytical apparatus by the host;

[0059] FIG. **28** is a table showing an individual processing in the process;

[0060] FIG. **29**A is a sectional view of part of a wafer, FIG. **29**B is an example of mark waveform data, and FIG. **29**C is an example of film thickness data;

[0061] FIG. **30** is a flowchart of optimization of wafer alignment;

[0062] FIG. **31**A is a view showing a section of part of a wafer,

[0063] FIG. **31**B is an example of measurement data of a surface shape of the wafer, and FIG. **31**C is an example of measurement data of film thickness;

[0064] FIG. **32** is a flowchart of optimization of focus-control-related parameters;

[0065] FIG. **33**A is a view showing an example of foreign substance inspection data (B), and FIG. **33**B is a view showing an example of foreign inspection data (C);

[0066] FIG. **34** is a flowchart of optimization of processing conditions of a wafer appearance inspection before exposure;

[0067] FIG. **35** is a flowchart of optimization of liquid-immersion-exposure-related processing conditions (No. 1);

[0068] FIG. **36** is a view showing an exposure route on wafer W;

[0069] FIG. **37** is a view showing a liquid immersion state during alignment;

[0070] FIG. **38** is a flowchart of analytical processing in optimization of liquid-immersion-exposure-related processing conditions (No. 2);

[0071] FIG. **39** is a flowchart of analytical processing in optimization of liquid-immersion-exposure-related processing conditions (No. 3);

[0072] FIG. **40** is a flowchart of analytical processing in optimization of liquid-immersion-exposure-related processing conditions (No. 4);

[0073] FIG. **41** is a flowchart of analytical processing in optimization of liquid-immersion-exposure-related processing conditions (No. 5);

[0074] FIG. **42** is a flowchart of analytical processing in optimization of liquid-immersion-exposure-related processing conditions (No. 6);

[0075] FIG. **43** is a flowchart of analytical processing in optimization of liquid-immersion-exposure-related processing conditions (No. 7);

[0076] FIG. **44** is a flowchart of analytical processing in optimization of liquid-immersion-exposure-related processing conditions (No. 8);

[0077] FIG. **45** is a flowchart of analytical processing of optimization of pattern-overlay-accuracy-related processing conditions (No. 1); and

[0078] FIG. **46** is a flowchart of analytical processing in optimization of pattern-overlay-accuracy-related processing conditions (No. 2).

BEST MODE FOR CARRYING OUT THE INVENTION

[0079] An embodiment of the present invention will be described below, referring to FIGS. **1** to **46**.

[Device Manufacturing System]

[0080] FIG. **1** shows the schematic configuration of a device manufacturing system **1000** related to an embodiment of the present invention. Device manufacturing system **1000** is, for example, a system: that is constructed in a semiconductor plant, and is a system that manufactures semiconductor devices by processing wafers as substrates. As is shown in FIG. **1**, device manufacturing system **1000** is equipped with an in-house production control main host system **600**, an exposure cell **700**, a carrier line **800**, a device manufacturing apparatus group **900**, an exposure process management controller **160**, and an analytical apparatus **170**.

[In-House Production Control Main Host System]

[0081] In-house production control main host system (hereinafter referred to as a "host") **600** is a main host computer that grasps the state of the entire (respective constituents of) device manufacturing system **1000** and performs the overall control of exposure cell **700**, carrier line **800**, device manufacturing apparatus group **900**, exposure process management controller **160** and analytical apparatus **170**. Host **600**, exposure cell **700**, carrier line **800** (to be more specific, the controller thereof), device manufacturing apparatus group **900**, exposure process management controller **160** and analytical apparatus **170** are connected to each other via wired or wireless communication network or dedicated communication line, and data communication can be performed between them. Host **600** realizes the overall control of the entire system by the data communication.

[0082] Exposure cell **700** is equipped with two exposure apparatuses **100** and **101**, two tracks **200**A and **200**B, a measurement and/or inspection instrument **120**, and a carrier line **140**.

[0083] Exposure apparatuses **100** and **101** are apparatuses that transfer a device pattern onto a wafer that is coated with photoresist. Exposure apparatus **100** is an exposure apparatus that performs exposure without using liquid immersion exposure techniques (so-called dry exposure), and exposure apparatus **101** is an exposure apparatus that performs exposure using liquid immersion exposure techniques (so-called liquid immersion exposure). In the following description, exposure apparatus **100** is also referred to as a dry exposure apparatus, and exposure apparatus **101** is also referred to as a liquid immersion exposure apparatus.

[Dry Exposure Apparatus]

[0084] First of all, the configuration of exposure apparatus **100** will be described. FIG. **2** shows an example of the schematic configuration of exposure apparatus **100**. Exposure apparatus **100** is equipped with an illumination system **10** that emits a coherent illumination light EL, a reticle stage RST that holds a reticle R on which a device pattern and the like that are illuminated by illumination light EL are formed, a both-side telecentric projection optical system PL that projects the device pattern and the like that have been illuminated by illumination light EL, a wafer stage WST that holds a wafer W that becomes subject to exposure, a main controller **20** that performs the overall control of these constituents, and the like.

[0085] Illumination light EL from illumination system **10** illuminates a device pattern such as a circuit pattern that is formed on reticle R held on reticle stage RST. An irradiation area of illumination light EL is to be an illumination area IAR. Illumination light EL passing through illumination area IAR is incident on wafer W held on wafer stage WST via projection optical system PL (whose optical axis is to be "AX"). With this operation, a projected image of the device pattern within illumination area IAR is formed in an irradiation area (exposure area) IA on wafer W of illumination light EL that is conjugate with illumination area IAR.

[0086] Herein, an XYZ coordinate system that uses a coordinate axis parallel to optical axis AX of projection optical system PL as a Z-axis will be considered. Wafer stage WST can move on a moving plane parallel to an XY plane, and also can adjust the surface of wafer W in a Z-axis direction, a θx (rotation around an X-axis) direction and a θy (rotation around a Y-axis) direction. Reticle stage RST can move in a Y-axis direction synchronously with wafer stage WST. By the synchronous scanning of both stages WST and RST in the Y-axis direction in accordance with a projection magnification of projection optical system PL, the surface of wafer W traverses exposure area IA synchronously with a device pattern on reticle R traversing illumination area TAR. With this operation, the entire device pattern on reticle R is transferred onto wafer W. Exposure apparatus **100** transfers the device pattern on reticle R in a plurality of different areas on wafer W by repeating the relative synchronous scanning of both stages RST and WST described above and the stepping of wafer stage WST with respect to illumination light EL. That is, exposure apparatus **100** is an exposure apparatus by a scanning exposure (step-and-scan) method.

[0087] Main controller **20** is quipped with an exposure dose control system that controls intensity (exposure dose) of illumination light, a stage control system that performs synchronous control of both stages RST and WST, autofocus-leveling control (hereinafter, simply referred to as "focus control") that matches the surface of wafer W within a depth of focus of projection optical system PL, and the like, a lens control system that controls image-forming performance of projection optical system PL (none of which is shown), and the like.

[0088] The exposure dose control system performs feedback control in which an exposure dose is controlled so as to coincide with a target value based on detection values of various exposure dose sensors that can detect the exposure dose.

[0089] The stage control system performs position control and velocity control of both stages RST and WST in which the positions of stages RST and WST are controlled so as to coincide with the target positions, based on measurement values of interferometers and the like that measure the positions of stages RST and WST.

[0090] Out of the stage control system, a control system that performs synchronous control of both stages WST and RST is to be a synchronous control system and a control system that controls the Z-position of the stage position (wafer surface) (i.e. the position of wafer W in the focus direction of projection optical system PL), and a rotation amount around the X-axis and the Y-axis (a tilt of the wafer surface with respect to a projected image of a device pattern) is to be a focus control system.

[0091] The synchronous control system performs synchronous control of both stages RST and WST during scanning exposure, and performs feedback control based on the measurement values of the interferometers and the like so that the synchronous error between the stages can be reduced. Further, in exposure apparatus **100**, a multipoint AF (Autofocus) sensor (**60***a*, **60***b*) that detects the focus/leveling deviation of the wafer surface at a plurality of detection points is arranged. The focus control system performs feedback control in which, for example, around 9 detection points are selected among the plurality of (e.g. $7\times7=49$) detection points of the multipoint AF sensor (**60***a*, **60***b*), the height and tilt of the wafer surface are obtained from the detection values of 9 channels at the selected detection points, and the wafer surface corresponding to exposure area IA is made to match the image plane of projection optical system PL.

[0092] The target value of exposure dose in the exposure control system and the target value of focus of the focus control system are decided taking a device pattern to be transferred onto wafer W into consideration. Consider a plane having an exposure dose as a horizontal axis and focus as a vertical axis. Within this plane, consider a frame (window) that indicates a range that can be set as the target value of exposure dose and the target value of focus. This frame is called a process window. Any exposure dose or focus within the process window can be set as the control target value. The process window is decided, taking into consideration a line width in design of a device pattern, a relation between the exposure dose and the focus with which a pattern line becomes uniform, a balance between the resolution of projection optical system PL and the depth of focus, and the like. When the depth of focus of the projection optical system becomes larger, the width of the process window in the focus direction can be set wider.

[0093] Projection optical system PL contains a plurality of optical systems (not shown) such as dioptric elements (lens elements). Out of theses lens elements, some lens elements are movable lenses whose position and attitude can be adjusted from the outside by the lens control system. Each of the lens elements can be shifted and driven in the X-axis, Y-axis, and Z-axis (optical axis) directions and can also be

rotated and driven in a rotation direction around each axis (θx, θy and θz), that is, can be driven in directions of six degrees of freedom. The lens control system monitors the atmospheric pressure, the temperature within a chamber of exposure apparatus **100**, the exposure dose and the temperature of lenses of projection optical system PL, computes the magnification variation amount of projection optical system PL and the focus variation amount based on the monitoring results, and then performs adjustment of the pressure inside projection optical system PL and adjustment of lens spacing of the movable lens elements based on the variation amounts using an image-forming characteristics correction controller **48**. With this operation, the best focus position and the magnification follow the target values.

[Control System Parameter]

[0094] In exposure apparatus **100**, several factors that set the operations of the exposure dose control system, the stage control system and the lens control systems described above are parameterized. They are called control system parameters. The values of the control system parameters can freely be set within an appropriate range. The control system parameters are roughly divided into adjustment system parameters that require suspension of the process and apparatus adjustment when the setting values are changed, and non-adjustment system parameters that do not require apparatus adjustment.

[0095] Several representative examples of the adjustment system parameters will be described. First, regarding the exposure dose control system, there are an adjustment parameter of an exposure dose sensor (not shown) that detects an exposure dose, an adjustment parameter of an illuminance measurement sensor (not shown) that measures intensity of illumination light on the wafer surface, and the like. Further, regarding the synchronous control system, there are parameters such as a coefficient value of a correction function for correcting bending of movable mirrors that are arranged on stages WST and RST to reflect a laser beam from interferometers for position measurement of stages WST and RST, position loop gain of feedback control, velocity loop gain, constant of integration and the like. Further, regarding the focus control system, there are a focus offset that is an offset adjustment value of focus control when matching the wafer surface and an optimal image-forming plane by projection optical system PL on exposure, a leveling adjustment parameter for matching the wafer surface and the optimal image-forming plane of projection optical system PL on exposure, linearity of a position detection device (PSD) that is a sensor at an individual detection point of the multipoint AF sensor (**60***a*, **60***b*), offset among sensors, detection repeatability of each sensor, offset among channels, an AF beam irradiation position (i.e. detection point) on the wafer, other parameters relating to AF plane correction, and the like. Either of the values of these adjustment system parameters needs to be adjusted by calibration or test operation of the apparatus.

[0096] Next, several representative examples of the non-adjustment system parameters will be described. First, regarding the exposure dose control system, for example, there are a parameter related to selection of an ND filter in illumination system **10**, an exposure dose target value and the like. Further, regarding the synchronous control system, for example, there are scan velocity of both stages WST and RST during exposure and the like. Further, regarding the focus control system, for example, there are the number and the placement of focus sensors, that is, the selection state of focus sensors, a parameter related to focus level difference correction, a fine adjustment amount of focus offset, a scan direction on an edge shot (chipped shot) of the wafer outer edge, and the like. Among the foregoing parameters, the selection state of focus sensors is an important parameter for highly accurate focus control. The wafer surface is not completely flat, and has unevenness even within an area that is covered by all the detection points of the multipoint AF sensor (**60***a*, **60***b*). Accordingly, in order to accurately position the wafer surface within exposure area IA into the depth of focus of projection optical system PL, it is preferable to select the detection points so that the surface height of the wafer surface that is detected by each detection point becomes as uniform as possible. Further, the height of the wafer surface that is detected by each detection point of the multipoint AF sensor (**60***a*, **60***b*) is sometimes affected by a film thickness of a resist film or the like at the detection point. In order to reduce the influence of the film thickness, it is preferable to select detection points so that the film thickness of the resist film at points that are detected by the detection points becomes as uniform as possible.

[0097] Either of the setting values of these parameters are a parameter whose value can be changed without performing calibration of the apparatus, and most of them are designated by the exposure recipe. Incidentally, the ND filter is selected by the result of a check (average power check) that is performed only once in a state where an exposure dose target value is properly set (e.g. to the minimum) at the time of starting exposure to a certain wafer W. Further, by the selection of the ND filter, the scan velocity is also finely adjusted to some extent.

[0098] A line width and a transfer position of a device pattern on wafer W are deviated from design values due to each control error of exposure dose, synchronous accuracy and focus. Then, in exposure apparatus **100**, time-series data of control amount related to exposure dose error obtained from the exposure dose control system (exposure dose trace data), time-series data of control amount related to synchronous accuracy error obtained from the synchronous control system (synchronous accuracy trace data), time-series data of control amount related to focus error obtained from the focus control system (focus trace data), and time-series data of control amount related to lens control error obtained from the lens control system of projection optical system PL (lens trace data) are logged. The logged trace data are utilized for optimization of parameters in analytical apparatus **170**, as will be described later.

[Wafer]

[0099] FIG. **3**A shows an example of wafer W that becomes subject to exposure in exposure apparatus **100**. As is shown in FIG. **3**A, on wafer W, a device pattern is formed in a plurality of areas SA_p. Area SA_p is also called a shot area. As is shown in FIG. **3**B, in each shot area SA_p, wafer marks (MX_p, MY_p) are arranged. The wafer mark (MX_p, MY_p) is a mark with which position information can be detected from its shape or the like. For example, in FIG. **3**B, the wafer mark (MX_p, MY_p) is shown as a line-and-space mark. As the shape of the wafer mark, besides the line-and-space mark, a box mark or a cross mark can be employed, or the wafer mark may also be a level difference mark that is formed by unevenness of a base of the wafer, or a bright-dark mark that is formed by difference of reflectance.

[0100] In exposure apparatus **100**, a device pattern on reticle R needs to be accurately overlaid and exposed to shot areas SA_p on wafer W. In order to realize accurate overlay exposure, the position of each shot area SA_p needs to be known accurately.

[0101] The wafer marks are arranged for knowing the position of each shot area SA_p (position of the center C_p). Since the wafer marks (MX_p, MY_p) are transferred and formed together with the device pattern of shot area SA_p where the wafer marks are arranged, the positional relation between the wafer marks and the shot area is substantially fixed, and when the positions of the marks are obtained, the center position C_p of the shot area can be obtained.

[0102] Incidentally, wafer W, shot areas SA_p and the wafer marks (MX_p, MY_p) shown in FIGS. **3**A and **3**B are merely examples, and the size, the number per shot area, the array state, the shape and the like can appropriately be changed.

[0103] Referring back to FIG. **2**, in exposure apparatus **100**, an alignment system ALG is arranged for measuring the positions of the wafer marks (MX_p, MY_p). Alignment system ALG photoelectrically detects unevenness of the base of wafer W or distribution of reflectance in the vicinity of the wafer mark (MX_p, MY_p), using an alignment sensor that is equipped inside. A photoelectric conversion signal equivalent to the wafer surface including the wafer mark (MX_p, MY_p) is obtained by the photoelectric detection, and waveform data corresponding to the photoelectric conversion signal can be obtained. Alignment system ALG extracts a waveform (mark waveform) corresponding to the wafer mark (MX_p, MY_p) from the detected waveform data, and detects the position of the mark based on the extraction results. Alignment system ALG computes the position of the wafer mark (MX_p, MY_p) on the XY coordinate system based on the detected position of the mark within the detection field and the XY position of the detection field itself of the alignment sensor. In exposure apparatus **100**, the transfer position of the device pattern is decided based on the computation results.

[0104] Incidentally, in order to perform accurate overlay exposure of a device pattern, position information of all shot areas SA_p on wafer W may be measured. However, the throughput could be affected by doing so. Thus, in exposure apparatus **100**, the global alignment technique is employed in which the wafer marks that are actually measured are limited and the array of shot areas SA_p on the wafer (the shot array that is set by an $\alpha\beta$ coordinate system in FIG. **3**A) is statistically estimated from position information of the measured wafer marks. In exposure apparatus **100**, as the global alignment, wafer alignment by a so-called EGA method is employed in which the deviation of actual shot array with respect to design shot array is expressed in a polynomial with X and Y as independent variables, and valid coefficients in the polynomial are obtained by performing statistical computation. In the wafer alignment by the EGA method, first, several shot areas SA_p with which the wafer marks subject to measurement are measured are selected. The selected shot areas are called samples shots. Alignment system ALG measures the positions of the wafer marks (sample marks) that are arranged with the sample shots. Hereinafter, such measurement operation is referred to as the EGA measurement.

[0105] In the wafer alignment by the EGA method, a correction amount that indicates the XY position coordinate of each shot area is estimated by statistical computation based on the measurement results of the EGA measurement, that is, position information of the several sample marks. Hereinafter, such computation is referred to as the EGA computation. Incidentally, the wafer alignment by the EGA method is disclosed in, for example, Kokai (Japanese Unexamined Patent Application Publication) No. 61-044429 (the corresponding U.S. Pat. No. 4,780,617) and the like.

[0106] The XY correction amount of the position of each shot area that is obtained by the above-described polynomial is referred to as the EGA correction amount. Since the coefficients of the polynomial obtained in the wafer alignment by the EGA method are obtained by the least-squares method, the difference (nonlinear error component) remains between the actually measured value of the mark position and the mark position corrected by the EGA correction amount. The difference is called a residual error. As a matter of course, the residual error is preferably smaller from the viewpoint of the accuracy.

[0107] One of measures to be taken to reduce the residual error is to heighten the order of the EGA polynomial model. For example, when making the EGA polynomial model not be a primary expression but be a quadratic expression or a cubic expression, the residual error naturally becomes smaller. In the case the order of the polynomial is heightened, however, the number of sample shots need to be increased accordingly.

[0108] Further, in the case the measurement results of some sample marks remarkably deviate from the actual shot array, the entire residual error tends to be larger. Accordingly, the measurement positions of such sample marks are preferably rejected so as not to be used in the EGA computation. That is, it is also possible to increase estimation accuracy by not using some of the positions of sample marks obtained by the EGA measurement in the EGA computation. Thus, the selection of the number and/or the placement of sample marks is an important factor for the wafer alignment by the EGA method.

[Alignment-Related Parameter]

[0109] In exposure apparatus **100**, several factors that set the operation related to wafer alignment by the EGA method using alignment system ALG are parameterized, and the setting values thereof can be adjusted as alignment-related parameters. The alignment-related parameters are roughly divided into waveform processing parameters that do not require re-measurement by the alignment system for adjustment of the values, and actual-measurement-required parameters that require the re-measurement.

[0110] As the waveform processing parameters, for example, there is the combination of sample marks (the number and/or positions of sample marks) that are selected from the already measured sample marks and are actually used for the EGA computation. In other words, in the case all the measured sample marks are not used in the EGA computation but the EGA computation is performed using the appropriate combination of the sample marks out of the measured sample marks, the combination becomes the waveform processing parameter. Further, designation of sample marks to be rejected per mark or per shot area, a reject limit value (a threshold that serves as a datum when judging whether or not to reject a sample mark from the EGA computation) at the time of mark detection, and the like are included in the waveform processing parameters.

[0111] Further, in the case the alignment system is equipped with plural types of alignment sensors and performs mark detection with all the sensors, the type of alignment sensor that detects waveform data used in actual detection of

mark position (the FIA (Field Image Alignment) method or the LSA (Laser Step Alignment) method) is also included in the waveform processing parameters. Further, processing conditions with respect to the waveform data, that is, signal processing conditions (signal processing algorithm (an edge extraction method, a template matching method, a loopback autocorrelation method or the like, a slice level or the like) are also included in the waveform processing parameters.

[0112] Further, the types of the EGA polynomial model (such as a 6-parameter model, a 10-parameter model, an inside-shot averaging model, a shot factor indirect application model, and a high-order EGA processing condition (usage order and usage correction coefficient)), a weighted EGA processing condition, an extension EGA processing condition of EGA optional function (such as an inside-shot multipoint EGA implementing condition, an EGA computation model, and a shot component correction condition), a correction amount (such as an alignment correction value) to be added to a measurement position of the measured mark, and the like are also included in the waveform processing parameter. These parameters used to express the shot array such as the EGA polynomial model can also be classified into linear correction parameters that correct a liner component of the shot array, and nonlinear correction parameters that are used to correct a nonlinear component of the shot array. Since a nonlinear component of the shot array is expressed as a high-order function or a map of the XY coordinate system in most cases, the nonlinear correction parameter generally becomes the coefficient or a correction amount on the map.

[0113] Further, in the actual-measurement-required parameters, the types of sample marks (including the case where the mark shapes are different), the number and/or the placement (in the case of measuring new sample points), an illumination condition (such as an illumination wavelength, a bright/dark field, illumination intensity, or the existence/nonexistence of phase difference illumination) when illuminating marks at the time of mark measurement, a focus state (such as a focus offset) at the time of mark detection, and the designation of an alignment sensor when changing an alignment sensor to be used for mark detection, and the like are included. In particular, the detected mark waveform changes due to a resist film depending on the wavelength of illumination light in some cases, the wavelength of illumination light should carefully be set.

[0114] The control parameters and the alignment-related parameters are not limited to those described above. Further, all the control parameters and the alignment-related parameters are basically variable. However, it is also possible that all the control parameters and the alignment-related parameters are not made to be variable but some of the parameters are made to be invariable (fixed). When doing so, which parameters are made to be fixed can be appropriately selected at a user's discretion.

[0115] As is described above, in exposure apparatus **100**, as the apparatus parameters, the control parameters and the alignment-related parameters can be set. The setting values of these parameters need to be adjusted beforehand to some extent so that a device pattern on reticle R is favorably transferred onto wafer W.

[0116] Main controller **20** is a computer system that controls various constituents of exposure apparatus **100** as is described above. Various operations of exposure apparatus **100** described above are realized by overall control by main controller **20**, and the exposure dose control system, the synchronous control system, the focus control system, the lens control system, and the like described above are contained within main controller **20**. Further, main controller **20** is connected to a communication network that is set up within device manufacturing system **1000**, and data can be sent to and received from the outside via the communication network. Via the communication network, main controller **20** receives the command and operates, or sends trace data of various control errors to analytical apparatus **170**, or receives information on parameters that have been optimized by analytical apparatus **170** and sets them inside.

[Liquid Immersion Exposure Apparatus]

[0117] Next, the configuration of exposure apparatus **101** will be described. As is described earlier, exposure apparatus **101** is an exposure apparatus that exposes wafer W via liquid (performs exposure using so-called liquid immersion exposure techniques) in order to improve the resolution by substantially shortening the exposure wavelength and also to substantially widen the depth of focus.

[0118] As is shown in FIG. **4** as an example, exposure apparatus **101** is equipped with an exposure apparatus main section S that performs exposure processing to wafer W and a removal unit T that removes liquid, foreign substances and the like that adhere to wafer W.

[0119] The configuration of exposure apparatus main section S shown in FIG. **4** is substantially similar to the configuration of exposure apparatus **100**, and exposure apparatus main section S is equipped with illumination system **10** that irradiates exposure light EL, reticle stage RST that holds reticle R, a wafer stage WST' that holds wafer W, projection optical system PL that projects a projected image of a device pattern of reticle R that is illuminated with exposure light EL on wafer W, and the like. The structure of wafer stage WST' is slightly different from the structure of wafer stage WST of exposure apparatus **100**, as will be described later. Further, although omitted in FIG. **4**, main controller **20** also performs the overall control of the inside of exposure apparatus **101**.

[0120] Further, as is shown in FIG. **5** that enlargedly shows part of FIG. **4**, besides, exposure apparatus main section S is quipped with a liquid immersion system **19** and a liquid immersion monitor **260**.

[0121] Wafer stage WST' has a holder **43** that alternatively holds wafer W or liquid immersion monitor **260** by vacuum suction. Holder **43** is placed on the bottom surface of a recessed section **44** that is formed on the surface on the +Z side of wafer stage WST'.

<<Liquid Immersion System>>

[0122] Liquid immersion system **19** forms an area (hereinafter, also referred to as a "liquid immersion area") that is filled with liquid LQ between projection optical system PL and wafer W. Herein, as is shown in FIG. **5** as an example, liquid immersion system **19** is quipped with a nozzle member **40**, a supply pipe **13**, a light source for illumination **15** (not shown in FIG. **5**, refer to FIG. **6**), a recovery pipe **23**, a liquid supply unit **11**, a liquid recovery unit **21**, and the like.

[0123] Nozzle member **40** is an annular member that is arranged so as to enclose an optical element FL that is closest to the image plane of projection optical system PL among a plurality of optical elements of projection optical system PL, and has a supply opening **12** for supplying liquid LQ to the space below optical element FL and a recovery opening **22** for

recovering liquid LQ in the liquid immersion area that is formed by supplied liquid LQ between optical element FL and wafer W on holder **43**, as is shown in FIG. **6** as an example. At recovery opening **22**, for example, a mesh member made of titanium or a porous member made of ceramics is placed. Further, inside nozzle member **40**, a flow channel **14** that connects supply opening **12** and one end of supply pipe **13** and a flow channel **24** that connects recovery opening **22** and one end of recovery pipe **23** are formed. Incidentally, in the embodiment, as an example, pure water is used as liquid LQ.

[0124] In the embodiment, among of a plurality of optical elements of projection optical system PL, only optical element FL comes into contact with liquid LQ.

[0125] Light source for illumination **15** is installed at a periphery portion of the liquid immersion area, and illuminates the vicinity of the liquid immersion area and optical element FL while liquid immersion monitor **260** is operating.

[0126] Liquid supply unit **11** is connected to the other end of supply pipe **13**. Liquid supply unit **11** has a temperature adjustment unit that adjusts the temperature of liquid LQ to be supplied, a degassing unit that reduces gas components in liquid LQ to be supplied, a filter unit that removes foreign substances in liquid LQ to be supplied and the like, and sends out liquid LQ that is clean and whose temperature has been adjusted. That is, liquid LQ sent out from liquid supply unit **11** is supplied to the liquid immersion area via supply pipe **13**, flow channel **14** and supply opening **12**. Incidentally, liquid supply unit **11** is controlled by main controller **20**.

[0127] Liquid recovery unit **21** is connected to the other end of recovery pipe **23**. Liquid recovery unit **21** has an exhaust system that includes a vacuum unit, and recovers liquid LQ. That is, liquid LQ in the liquid immersion area is recovered by liquid recovery unit **21** via recovery opening **22**, flow channel **24** and recovery pipe **23**. Incidentally, liquid recovery unit **21** is controlled by main controller **20**.

[0128] Main controller **20** performs liquid supply by liquid supply unit **11** and liquid recovery by liquid recovery unit **21** in parallel at least while the exposure processing is being performed.

[0129] Meanwhile, as is shown in FIG. **7**A as an example, sometimes liquid LQ enters a boundary portion between a resist film RL and a topcoat film TC. In this case, liquid LQ infiltrates inside the resist and changes the resist performance, which could result in deteriorating uniformity of an exposure pattern that will be described later. Herein, topcoat film TC is a film that has liquid repellency (water repellency in this case) to liquid LQ. Further, as is shown in FIG. **7**B as an example, sometimes a foreign substance **1**B such as a particle or a watermark adheres on topcoat film TC. In this case, a post-bake (PEB: Post-Exposure-Bake) processing and a development processing after exposure are affected even if exposure is normally performed, which could generate defects such as break of a device pattern that is formed on a wafer by exposure (hereinafter, shortly referred to as an "exposure pattern" as needed), or ununiformity of line width. Further, as is shown in FIG. **7**C as an example, sometimes foreign substances such as bubbles BB and/or a particle PT exist in the liquid immersion area. In this case, the optical path of exposure light EL changes, which could generate defects of the exposure pattern. Further, the resist is eluted into liquid LQ and contaminates optical element FL, which could generate defects of the exposure pattern. Incidentally, there is the possibility that bacteria comes into existence at the members (such as supply pipe **13**, and optical element FL) that are in liquid LQ and/or come into contact with liquid LQ, and the bacteria becomes one of foreign substances. Further, the reference code HL in FIGS. **7**A to **7**C indicates an antireflection film.

[0130] The occurrence of the states shown in FIGS. **7**A to **7**C and the like can be prevented to some extent by changing the temperature of liquid LQ, increasing the flow speed of liquid LQ, tightening processing conditions of filter processing when circulating liquid LQ, or shortening a period of time for liquid immersion when the same area on wafer W is immersed in liquid LQ by changing the exposure route of shot areas SA_p on wafer W (the route of wafer stage WST' during the step-and-scan) or the like. Accordingly, in liquid immersion exposure apparatus **101**, the processing conditions that affect these liquid immersion states are parameterized and can be adjusted. Hereinafter, these parameters are generally referred to also as liquid-immersion-related parameters.

<<Liquid Immersion Monitor>>

[0131] In order to judge whether or not the liquid-immersion-related parameters are appropriately set, liquid immersion monitor **260** that monitors whether foreign substances are contained in the liquid immersion area or not, and whether optical element FL and the like are contaminated or not is needed. Herein, as is shown in FIG. **8**A and FIG. **8**B as an example, liquid immersion monitor **260** has a base material **261** that has the substantially same outer shape as wafer W, a plurality of CCD sensor modules **262** that are embedded on base material **261**, a liquid immersion analytical unit **263** that analyzes an output signal of each CCD sensor module **262** and wirelessly transmits the analytical results, and the like. Liquid immersion analytical unit **263** has a flash memory in which various programs to be used in liquid immersion analytical unit **263** are stored, a work memory and the like. Herein, in the center portion of base material **261**, one CCD sensor module **262** is embedded, and four CCD sensor modules **262** are substantially equiangularly embedded at the peripheral area of base material **261**. Incidentally, the analytical results at liquid immersion analytical unit **263** are notified from liquid immersion analytical unit **263** to main controller **20**, exposure process management controller **160**, analytical apparatus **170**, and the like.

[0132] The material of base material **261** only has to be the one that hardly affect liquid LQ when coming into contact with liquid LQ. For example, the material may also be the same as the material of wafer W, or may also be metal such as titanium, or the material containing fluorine resin such as PTFE or PFA. Further, in order to apply water repellency to the surface of base material **261** that comes into contact with liquid LQ, a film having water repellency may also be formed on the surface.

[0133] As is shown in FIG. **9** as an example, each CCD sensor module **262** has six one-dimensional line sensors that have a longitudinal direction in the X-axis direction. Herein, the one-dimensional line sensors that are located from the −Y side end portion to the +Y side end portion in order are referred to as line sensors **267**A, **267**B, **267**C, **267**D, **267**E and **267**F respectively. Further, in each line sensor, a plurality of microlenses **264** that correspond to respective photodetection sections are arranged.

[0134] The focal distances of microlenses **264** are different per line sensor. That is, the distances to an observation subject position (object plane position) are each different per line sensor. And, the offset amount of the object plane position per

line sensor is set, taking into consideration the substantial depth of focus in accordance with the detection resolution of foreign substances. Herein, as is shown in FIG. **10** as an example, the observation subject position of each of line sensors **267**A, **267**B, **267**C, **267**D, **267**E and **267**F is the position at a distance of d**1**, d**2** (>d**1**), d**3** (>d**2**), d**4** (>d**3**), d**5** (>d**4**) and d**6** (>d**5**) from the surface of base material **261**, respectively. Thus, for example, when the thickness (the length in the Z-axis direction) of the liquid immersion area is around 3 mm, almost all of the liquid immersion area can be inspected by setting d**1**=0.25 mm, d**2**=0.75 mm, d**3**=1.25 mm, d**4**=1.75 mm, d**5**=2.25 mm and d**6**=2.75 mm.

[0135] For example, assuming that a diameter D of microlens **264** is 8 μm and a focal distance f is 12.0 μm, an F number becomes 1.5 (=f/D). When a white LED (a wavelength λ: 560 nm) is used as an illumination light source, a depth of focus becomes $\pm 0.61\lambda F/NA = \pm 01.22\lambda F^2 = \pm 1.54$ μm. Incidentally, a center thickness t of microlens **264** (refer to FIG. **11**) can be 2 to 3 μm. In FIG. **11**, the reference code **262**A indicates a CCD pixel, the reference code **262**B indicates a transfer electrode, the reference code **262**C indicates a resin layer, and the reference code **262**D indicates an insulation layer.

[0136] Liquid immersion monitor **260** is housed in advance in a predetermined position within exposure apparatus main section S, and is set on holder **43** by a carrier unit **210** (refer to FIG. **5**) as is shown in FIG. **12** as an example, when performing a liquid immersion monitor processing.

[0137] Meanwhile, there are an interline method, a frame interline method and a frame transfer method for CCD (charge-coupled device) depending on the structure that transfers signal charge. Either of these methods may be used, but it is preferable to employ the frame transfer method in which the large photodetection area size can be used because the photodetection section also serves as the transfer section.

[0138] Further, when it is assumed that a CCD pixel size Cs is 8.0 μm (including 2.0 μm of a dead zone), an effective pixel number Cp of a line sensor is 4000 (32 mm length), and a CCD scan data rate Cd is 25 nsec/pixel (=40 MHz), one line scan time Tc of the line sensor becomes Cp×Cd=100 μsec. Then, a stage scan speed Sp at the time of liquid immersion monitoring becomes Cs/Tc=80 mm/sec.

[0139] Incidentally, in liquid immersion monitor **260**, each line sensor may be formed on base material **261** using the photolithography method, or a CCD sensor module that has been created in advance may be embedded in the recessed portion formed on base material **261**.

<<Removal Unit>>

[0140] Removal unit T shown in FIG. **4** is a unit that removes liquid LQ, foreign substances and the like (hereinafter, also described as "liquid/foreign substance" for the sake of convenience) that adhere to wafer W. Herein, as is shown in FIG. **13** as an example, removable unit T has a stage unit **30**, a holder **31** that holds wafer W by vacuum suction, a rotation unit **32** that rotates and drives holder **31**, a generating unit **60** that generates a flexure traveling wave for moving liquid/foreign substance adhering to wafer W, a chamber **35**, a liquid suction unit **39**, an observation unit (now shown) that observes the surface of wafer W, and the like. Sage unit **30**, holder **31**, rotation unit **32** and generating unit **60** are housed within chamber **35**. Incidentally, the observation results by the observation unit are notified to main controller **20**, measurement and/or inspection instrument **120**, analytical apparatus **170**, and the like.

[0141] Chamber **35** has an opening section **36** that is formed on the wall surface on the +Y side and an opening section **37** that is formed on the wall surface on the −Y side in FIG. **13**. A shutter **36**A that Opens/closes opening section **36** is arranged at opening section **36**, and a shutter **37**A that opens/closes opening section **37** is arranged at opening section **37**. Wafer W to which liquid immersion exposure has been performed is carried into chamber **35** via opening section **36**, and wafer W to which a removal processing of liquid/foreign substance has been performed is carried outside chamber **35** via opening section **37**. The opening/closing of shutters **36**A and **37**A are controlled by main controller **20**.

[0142] Liquid suction unit **39** is connected to chamber **35** via a flow channel **38** at which a valve **38**A is arranged. When valve **38**A is in an opened state, the liquid within chamber **35** is drained outside chamber **35** by liquid suction unit **39**. Incidentally, during the liquid/foreign substance removal processing, valve **38**A is in an opened state.

[0143] Rotation unit **32** has a motor that is placed inside stage unit **30** and an axis **33** that is rotated and driven by the motor. At the upper end of axis **33**, holder **31** is fixed. Rotation unit **32** rotates wafer W held on holder **31** via axis **33** by the motor. Incidentally, holder **31** is drivable together with axis **33** in the Z-axis direction, the θx direction and the θy direction by a holder drive unit (not shown).

[0144] As is shown in FIG. **14** as an example, generating unit **60** has an elastic stator **61** that is placed facing wafer W held on holder **31** and generates a flexure traveling wave, a oscillating body **62** that is placed on the surface on the +Z side of elastic stator **61** and includes a piezoelectric element that excites a flexure traveling wave, a support member **63** that supports oscillating body **62**, and a drive mechanism **64** that drives support member **63** in the X-axis direction, the Y-axis direction, the Z-axis direction, the θX direction, the θY direction and the θZ direction. Drive mechanism **64** is controller by main controller **20**. That is, the distance between elastic stator **61** and wafer W, the tilt angle of elastic stator **61** with respect to wafer W, the position of elastic stator **61** with respect to wafer W within the XY plane, and the like can be adjusted by main controller **20**.

[0145] As is shown in FIG. **15** as an example, elastic stator **61** is an elastic member having a roughly circular shape that is slightly larger than wafer W. On the surface of elastic stator **61** on the −Z side, water repellent coat is applied. Then, on the peripheral area on the surface of elastic stator **61** on the +Z side, a piezoelectric element **62**A is placed in a ring-shaped arrangement so that a desirable flexure traveling wave can be obtained. Incidentally, elastic stator **61** may also have a ring shape.

[0146] The piezoelectric element of oscillating body **62** is uniformly polarized in a direction of the thickness (the Z-axis direction in this case), and a plurality of electrodes (hereinafter, also referred to as an electrode group) are arranged at a half-wave pitch of flexural oscillation. When the electric signal of resonance frequency is input to the electrode group, a standing wave of flexural oscillation is excited. With this operation, as is shown in FIG. **16** as an example, a flexure traveling wave B is generated and an acoustical field is generated between elastic stator **61** and wafer W by flexure traveling-wave B. Then, a liquid/foreign substance G adhering to wafer W is moved by an acoustical viscous flow V in the acoustical field. In other words, generating unit **60** can move liquid/foreign substance G adhering to wafer W in a noncontact state with wafer W. Further, when a recessed portion is

formed on the surface of wafer W, even if the liquid/foreign substance enters inside the recessed portion, the liquid/foreign substance entering inside the recessed portion can be taken out to the outside of the recessed portion. Herein, as is shown in FIG. **17** as an example, flexure traveling wave B whose traveling direction is a circumferential direction of elastic stator **61** is generated. Thus, acoustical viscous flow V flows in a circumferential direction of wafer W as its traveling direction. Incidentally, the electrode group does not have to be arranged on the entire surface of oscillating body **62**, but may be arranged on a part thereof. In this case, another electrode group is arranged and set so that the phase difference of standing wave that is excited by another electrode becomes $\pi/2$(=¼ wavelength), thereby exciting oscillation and generating a flexure traveling wave.

[0147] When inclining holder **31** along with the generation of flexure traveling wave B, the liquid/foreign substance adhering to wafer W can be favorably removed by the synergistic action between the action of gravity and the action by the flexure traveling wave.

[0148] Further, when rotating wafer W along with the generation of flexure traveling wave B, the centrifugal force is added, which makes it possible to better move the liquid/foreign substance adhering to wafer W. In this case, as is shown in FIG. **18** as an example, when making a rotation direction PR of wafer W coincide with a traveling direction of flexure traveling wave B, the direction of acoustical viscous flow V and the direction of centrifugal force substantially coincide, which makes it possible to favorably remove the liquid/foreign substance adhering to wafer W, even if wafer W is rotated at a relatively low speed. Thus, it becomes possible to reduce the burden to wafer W, reduce the electric power consumption of rotation unit **32**, suppress the heat generation of rotation unit **32**, and decrease the size of rotation unit **32**.

[0149] Meanwhile, the generation start of flexure traveling wave B and the rotation start of wafer W may be performed substantially at the same time, or the generation of flexure traveling wave B may be started after starting the rotation of wafer W. However, for example, when the liquid/foreign substance enters inside a recessed portion formed on the surface of wafer W, the rotation of wafer W may be started after a predetermined period of time elapses from the generation start of flexure traveling wave B. In this case, after the liquid/foreign substance that enters inside the recessed portion is once moved to the outside of the recessed portion by flexure traveling wave B, the liquid/foreign substance can be removed from the surface of wafer W by the rotation of wafer W.

[0150] Incidentally, in the case the liquid/foreign substance adheres near the center of wafer W, as is shown in FIG. **19** as an example, the rotation center of wafer W and the center of elastic stator **61** may be displaced.

[0151] Further, the rotation of wafer W and the tilt of wafer W may be used in combination. By using them in combination, the liquid/foreign substance adhering to wafer W can be removed further favorably.

[0152] Then, the liquid removed from wafer W is drained outside chamber **35** by liquid suction unit **39**. Accordingly, the humidity within chamber **35** does not fluctuate greatly. Also, the humid gas is not discharged outside chamber **35** when opening shutter **36**A and shutter **37**A.

[0153] Incidentally, instead of elastic stator **61**, a rectangular-plate-shaped elastic stator **161**A that has the surface on the −Z side on which a plurality of gas outlets **71** are formed may be used, as is shown in FIG. **20**A and FIG. **20**B as an example. In this case, a gas supply unit (omitted in the drawing) that blows gas k from a plurality of gas outlets **71** toward the surface of wafer W is further arranged. Herein, a gas outlet group arranged in a line in the Y-axis direction is to be one block, and blocks are to be a first block Ba**1**, a second block Ba**2**, a third block Ba**3**, . . . , and a seventeenth block Ba**17** from the −X direction end portion toward the +X direction in order. Then, in accordance with traveling of flexure traveling wave B, gas blowing from first block Ba**1** is started, next, gas blowing from second block Ba**2** is started, and subsequently, gas blowing from third block Ba**3**, . . . , and seventeenth block Ba**17** is started in order. Further, when a predetermined period of time elapses after starting gas blowing from first block Ba**1**, the gas blowing from first block Ba**1** is stopped. Similarly, when a predetermined period of time elapses after starting gas-blowing from second block Ba**2**, the gas blowing from second block Ba**2** is stopped. Afterwards, in the similar manner, the gas blowing from the block is stopped after a predetermined period of time elapses after starting the gas blowing. With this operation, it becomes possible to remove the liquid/foreign substance adhering to wafer W in a shorter period of time. Incidentally, the number of blocks is not limited to 17. In this case, wafer W and elastic stator **161**A may be tilted in the traveling direction of flexure traveling wave B.

[0154] Further, instead of elastic stator **61**, a rectangular-plate-shaped elastic stator **161**B that has the surface on the −Z side on which a plurality of suction openings **81** are formed may be used, as is shown in FIG. **21**A and FIG. **21**B as an example. In this case, a suction unit (omitted in the drawing) that suctions liquid or the like adhering to the surface of wafer W from a plurality of suction openings **81** is further arranged. Herein, a suction opening group arranged in a line in the Y-axis direction is to be one block, and blocks are to be a first block Bb**1**, a second block Bb**2**, a third block Bb**3**, . . . , and a seventeenth block Bb**17** from the −X direction end portion toward the +X direction in order. Then, in accordance with traveling of flexure traveling wave B, suction by first block Bb**1** is started, next, suction by second block Bb**2** is started, and subsequently, suction by third block Bb**3**, . . . , and seventeenth block Bb**17** is started in order. Further, when a predetermined period of time elapses after starting suction by first block Bb**1**, the suction by first block Bb**1** is stopped. Similarly, when a predetermined period of time elapses after starting suction by second block Bb**2**, the suction by second block Bb**2** is stopped. Afterwards, in the similar manner, the suction by the block is stopped after a predetermined period of time elapses after starting the suction. With this operation, it becomes possible to remove the liquid/foreign substance adhering to wafer W in a shorter period of time. Incidentally, the number of blocks is not limited to 17. In this case, wafer W and elastic stator **161**B may be tilted in the traveling direction of flexure traveling wave B.

[0155] Further, instead of liquid suction unit **39** or together with liquid suction unit **39**, a drying unit that supplies dry gas into chamber **35** may also be arranged. With the drying unit, removal of liquid LQ adhering to wafer W can be enhanced.

[0156] Several processing conditions of removal unit T are also parameterized, and removal unit T is designed so that the processing state of liquid removal processing changes depending on the values of the parameters. Removal unit T may also be arranged within track **200**B of liquid immersion exposure apparatus **101**.

[Track]

[0157] Referring back to FIG. **1**, tracks **200**A and **200**B are placed so as to have contact with a chamber (not shown) that

encloses exposure apparatus **100** or **101**. Tracks **200**A and **200**B perform carrying-out and carrying-in of wafer W mainly from/to exposure apparatuses **100** and **101** by a carrier line that is equipped inside tracks **200**A and **200**B.

[Coater Developer]

[0158] Within tracks **200**A and **200**B, a coater-developer (C/D) **110** that is equipped with a coater that performs a resist coating processing, a developer that performs a development processing, a PEB unit that performs a PEB processing, and the like is arranged. C/D **110** can observe the processing states of resist coating, development, PEB processings, and record the observation data as log data. As the processing states that can be observed, for example, each state of the rotation speed of a spin coater, the temperature during development, a development module processing, the temperature uniformity of PEB (hotplate temperature uniformity), and the wafer heating history management (to avoid overbake after the PEB processing, a cooling plate) can be cited. The processing state of C/D **110** can also be adjusted to some extent by setting the apparatus parameters. As such apparatus parameters, for example, there are a parameter that can correct the thickness of resist on wafer W (a dripping quantity and a dripping interval of resist), the set temperature within the apparatus, the rotation speed of a spin coater, and the like.

[0159] C/D **110** can operate independently from the external apparatuses such as exposure apparatuses **100** and **101**, and measurement and/or inspection instrument **120**. C/D **110** is placed along the carrier line within tracks **200**A and **200**B, and by the carrier line, wafer W can be carried between exposure apparatuses **100** and **101**, C/D **110**, and the outside of tracks **200**A and **2008**. Further, C/D **110** is connected to a communication network within device manufacturing system **1000** and data transmission with the outside is possible.

[0160] In other words, exposure apparatus **100** and C/D **110** within track **200**A, and exposure apparatus **101** and C/D **110** within track **200**B are inline connected to each other, respectively. Herein, the inline connection means the connection between the apparatuses, and between processing units within each apparatus via a carrier unit that performs automating transport of wafer W such as a robot arm or a slider. By the inline connection, a period of time required for delivery of wafer W between exposure apparatus **100** and C/D **110**, or between exposure apparatus **101** and C/D **110** can be remarkably shortened.

[0161] Exposure apparatus **100** and track **200**A that are inline connected and exposure apparatus **101** and track **200**B that are inline connected can be considered as one substrate processing apparatus (**100**, **200**A) or (**101**, **200**B) as a unit. To wafer W, the substrate processing apparatus (**100**, **200**A) or (**101**, **200**B) performs a coating process of coating photosensitive agent such as photoresist, an exposure process of projecting and exposing an image of a pattern of a mask or reticle R on wafer W which is coated with photosensitive agent, a PEB process after finishing the exposure process, a development process of developing wafer W after that, and the like. Exposure cell **700** can be regarded to be quipped with one substrate processing apparatus (**100**, **200**A) and one substrate processing apparatus (**101**, **200**B).

[Measurement and/or Inspection Instrument]

[0162] Measurement and/or inspection instrument **120** is a composite measurement and/or inspection instrument that can perform various types of measurement and/or inspection to wafer W. Measurement and/or inspection instrument **120** is equipped with a stage that holds wafer W similar to wafer stage WST in exposure apparatus **100**. The XY position of the stage is measured by an interferometer (not shown) as in the case of wafer stage WST. The controller of measurement and/or inspection instrument **120** controls the XY position of the stage based on the measurement position of the interferometer. For measurement and/or inspection of wafer W, first of all, the alignment of wafer W is necessary. Measurement and/or inspection instrument **120** can position wafer W as in the case of exposure apparatus **100** or **101**, and is quipped with an alignment system that is similar to alignment system ALG of exposure apparatus **100**. The alignment of wafer W in measurement and/or inspection instrument **120** can be performed under alignment-related parameters that are similar to those of exposure apparatus **100** or **101**.

[0163] Besides, measurement and/or inspection instrument **120** is equipped with the following sensors to perform measurement and/or inspection that will be described below.

[0164] (1) Measurement and/or Inspection of an Antireflection Film, a Photoresist Film and a Topcoat Film on Wafer W (Film Thickness, Peeling of Film)

[0165] An interferometer that can measure the film thickness of each film

[0166] (2) Measurement of Wafer Marks (MX_p, MY_p) on Wafer W

[0167] The alignment system described above (by an image processing method) similar to alignment system ALG of exposure apparatus **100** or **101**

[0168] (3) Measurement of Surface Shape of Wafer W (So-Called Shot Flatness (Device Topography, Focus Level Difference))

[0169] A multipoint AF sensor that matches the multipoint AF sensor in exposure apparatus **100** or **101**

[0170] (4) Inspection of Foreign Substances and/or Stains on Wafer W

[0171] An alignment system (a sensor by an image processing method) or a sensor by a laser scan method

[0172] (5) Measurement of Line Width and Overlay Error of a Pattern Formed on Wafer W

[0173] A high-powered imaging device that can pick up an image of a device pattern

[0174] (6) Pattern Defects on Wafer W

[0175] An imaging device or a sensor by a laser scan method

[0176] Measurement and/or inspection instrument **120** can operate independently from exposure apparatuses **100** and **101**, and C/D **110**. Carrier line **140** within exposure cell **700** can carry wafer W one by one between exposure apparatus **100** or **101**, C/D **110** and measurement and/or inspection instrument **120**. Further, measurement and/or inspection instrument **120** can input/output data via a communication network.

[Device Manufacturing Apparatus Group]

[0177] As device manufacturing apparatus group **900**, a film forming apparatus **910**, an oxidation/ion-implantation apparatus **920**, an etching apparatus **930**, a CMP (Chemical Mechanical Polishing) apparatus **940** that performs a processing of planarizing wafer W by performing chemical mechanical polishing, and the like are arranged. Film forming apparatus **910** is an apparatus that forms a thin film such as an antireflection film and a topcoat film on wafer W using CVD (Chemical Vapor Deposition) or the like. Oxidation/ion-implantation apparatus **920** is an apparatus used to form an oxide

film on the surface of wafer W or implant impurities in a predetermined position on wafer W. Etching apparatus **930** is an apparatus that performs etching to developed wafer W. CMP apparatus **940** is a polishing apparatus that planarizes the surface of the wafer by chemical mechanical polishing. The processing state of each apparatus can be adjusted by adjustment of the processing parameters thereof, and also each apparatus can observe the processing state and can log data related to the processing state as log data. Further, each apparatus can input/output data via a communication network.

[0178] Between film forming apparatus **910**, oxidation/ion-implantation apparatus **920**, etching apparatus **930** and CMP apparatus **940**, a carrier route in which wafer W can be carried between them is arranged. Besides these apparatuses, device manufacturing apparatus group **900** includes apparatuses that perform a probing processing, a repair processing, a dicing processing, a packaging processing, a bonding processing and the like.

[Carrier Line]

[0179] Carrier line **800** performs carriage of wafer W between various units in device manufacturing apparatus group **900** and exposure cell **700**. Wafer W is carried from the apparatus that finishes a processing to wafer W to the apparatus that is to perform a processing to wafer W next, by concerted operation between carrier line **800** and carrier line **140** within exposure cell **700**.

[Management Controller]

[0180] Management controller **160** intensively controls an exposure process that is implemented by exposure apparatus **100** or **101**, and also performs management of C/D **110** within tracks **200**A and **200**B and control of their cooperative operation. As such a controller, for example, a personal computer (PC) can be employed. Management controller **160** receives information that shows the progress of processings and operations, information that shows processing results, measurement and/or inspection results and the like from each apparatus through the communication network within device manufacturing system **1000**, grasps the status of the entire manufacturing line of device manufacturing system **1000**, and performs management and control of each apparatus so that the exposure process and the like are appropriately performed.

[Analytical Apparatus]

[0181] Analytical apparatus **170** is connected to the communication network within device manufacturing system **1000** and can perform data transmission with the outside. Analytical apparatus **170** collects various types of data (data of various measurement and/or inspection results of measurement and/or inspection instrument **120** and data related to processing states of other apparatuses) via the communication network, and performs analysis of data related to processes to wafer W and optimization of processing conditions of each apparatus. As hardware to realize such analytical apparatus **170**, for example, a personal computer can be employed. In this case, the analytical processing is realized by the execution of an analytical program that is executed by the CPU (not shown) of analytical apparatus **170**. The analytical program is supplied by media (information recording medium) such as CD-ROM and executed in a state of being installed on the PC.

[0182] Analytical apparatus **170** compositely analyzes log data of exposure apparatus **100** and at least two types of measurement and/or inspection results in measurement and/or inspection instrument **120**, and based on the analytical results, performs optimization of the processing conditions of various apparatuses. Herein, the processing conditions to be optimized differ depending on the analytical results, and are varied such as the control system parameters of exposure apparatus **100**, the alignment-related parameters, the liquid-immersion-related parameters and a liquid immersion removal processing condition, processing conditions for the resist coating processing, the postbake (PEB) processing and the development processing in C/D **110**, a measurement and/or inspection condition of measurement and/or inspection instrument **120**, processing conditions of various apparatuses in device manufacturing apparatus group **900**, and the like.

[0183] Further, analytical apparatus **170** has databases related to the measurement and/or inspection results of measurement and/or inspection instrument **120** and the processing contents of various apparatuses. One of the databases that are quipped in analytical apparatus **170** is a CD table group. The CD table group is a database that shows a relation between a pattern line width and each control error of an exposure dose, synchronous accuracy, focus and a lens. In the CD table group, a relation between the statistical value of each control error of an exposure dose, synchronous accuracy, focus and a lens in a period from when exposure area IA reaches a certain point on wafer W until when exposure area IA passes the certain point during relative synchronous scanning of wafer stage WST or WST' and reticle stage RST, and a line width of the certain point is stored.

[0184] The statistical value of each control error at a certain point (sample point) on the wafer can be computed based on the exposure dose trace data, synchronous accuracy trace data, focus trace data, lens trace data that are acquired from exposure apparatuses **100** and **101**.

[0185] As will be described later, analytical apparatus **170** can estimate the pattern line width based on the statistical values of control errors of the exposure dose, the synchronous accuracy or the focus, referring to the CD table group as needed. Incidentally, in the case the statistical value of control error of the exposure dose, the synchronous accuracy or the focus is a value that is not registered as a line-width estimated value, the pattern line width can be estimated by interpolation of several values that are nearest to the value.

[0186] In order to effectively estimate the pattern line width based on the CD table group, the relation between the statistical values of various control errors and the pattern width needs to be registered in advance. When performing the registration, the statistical value of each control error that is computed from the trace data during exposure by the exposure apparatus (**100**, **101**) to wafer W and the pattern line width that is measured by measurement and/or inspection instrument **120** only have to be actually stored in the table group. Incidentally, the pattern line width registered in the CD table group may be not based on the measurement results of measurement and/or inspection instrument **120**, but may be based on the values measured by the SEM or the values measured by the OCD method or the like, or may be the values that are obtained from an aerial image of a test pattern

that is measured by an aerial image sensor that measures an aerial image of the test pattern.

[0187] Incidentally, even with the completely same exposure dose error, synchronous accuracy error, focus error and lens error, the pattern line width differs depending on the exposure conditions of exposure apparatus **100** or **101** and the design conditions of a pattern to be transferred. Therefore, the table group is prepared for each exposure condition and each pattern design condition. In this manner, it is necessary to compile a database of the table groups beforehand so that an estimated value of pattern line width can be searched using the exposure condition, the pattern design condition, the exposure dose error, the synchronous accuracy error, the focus error as keys. Incidentally, as the exposure conditions, there are an exposure wavelength, projection optical system NA, illumination NA, illumination σ, illumination types, depth of focus and the like, and as the pattern design conditions, there are mask line width, target line width (e.g. 130 nm), pattern pitch, mask types (binary, halftone, Levenson), pattern types (an isolated line, a line-and-space pattern) and the like. The relation between these exposure conditions and pattern design conditions and the pattern line width, and the setting method of other conditions such as an image height in the table are disclosed in detail in, for example, Kokai (Japanese Unexamined Patent Application Publication) No. 2001-338870.

[0188] The CD table group is used for optimization of parameters related to pattern line width in analytical apparatus **170**. For example, when obtaining the combination of exposure-dose-control-related, synchronous-control-related, focus-control-related and lens-control-related system parameters, or the illumination condition as a precondition, or the like which makes the line width be closer to the design value, the CD table group is referred to.

[0189] In addition, analytical apparatus **170** is equipped with a database to store analytical results.

[Overall Control by Host]

[0190] As is described earlier, host **600** performs the overall control of device manufacturing system **1000**, and each apparatus in device manufacturing system **1000** operates according to instructions from host **600**. In the following description, the operation of the individual apparatus will be described.

[Operation of Exposure Apparatus]

[0191] FIG. **22** shows a flow of operations of exposure apparatuses **100** and **101**. As is shown in FIG. **22**, first of all, host **600** outputs an exposure instruction for a certain wafer W to management controller **160** (step **201**). In the exposure instruction, the designation of exposure recipe of the wafer W is also included. Management controller **160** judges whether or not a layer subject to exposure this time is a layer that requires high transfer accuracy (e.g. a layer where a contact hole is formed) referring to the exposure recipe, and transmits a processing start order to liquid immersion exposure apparatus **101** in the case the layer requires high transfer accuracy, or transmits a processing start order to dry exposure apparatus **100** if this is not the case (step **203**).

[0192] When receiving the processing start order, dry exposure apparatus **100** loads relevant reticle R referring to the designated exposure recipe, and performs preparatory operations such as reticle alignment and baseline measurement (step **205**). Then, after roughly aligning wafer W, dry exposure apparatus **100** loads wafer W on wafer stage WST (step **207**). Next, dry exposure apparatus **100** measures search alignment marks and wafer marks (MX_p, MY_p) that are formed on wafer W using alignment system ALG and performs alignment of wafer W (step **209**). Then, dry exposure apparatus **100** performs exposure by a step-and-scan method (step **211**). After the exposure, dry exposure apparatus **100** unloads wafer W (step **213**).

[0193] On the other hand, when receiving the processing start order, liquid immersion exposure apparatus **101** loads relevant reticle R referring to the designated exposure recipe and performs preparatory operations such as reticle alignment and baseline measurement (step **205'**). Then, after roughly aligning wafer W, liquid immersion exposure apparatus **101** loads wafer W on wafer stage WST' (step **207'**). Next, liquid immersion exposure apparatus **101** measures wafer marks (MX_p, MY_p) formed on wafer W using alignment system ALG and performs wafer alignment (step **209'**). Then, liquid immersion exposure apparatus **101** performs exposure to wafer W by driving wafer stage WST' in a predetermined route and synchronously scanning reticle stage RST appropriately (step **211'**). After the exposure, liquid immersion exposure apparatus **101** unloads wafer W (step **213'**) and then performs a liquid removal processing of wafer W using removal unit T (step **215'**). Incidentally, although not shown in FIG. **22**, monitoring by liquid immersion monitor **260** is also performed as needed.

[0194] After completing all the processings described above, dry exposure apparatus **100** or liquid immersion exposure apparatus **101** transmits a processing end notice to management controller **160** (step **217**). Management controller **160** notifies the exposure end to host **600**. (step **219**).

[0195] FIG. **23** shows a flow of operations of C/D **110**. As is shown in FIG. **23**, first of all, host **600** transmits a processing start instruction to management controller **160** (step **271**). Management controller **160** transmits a processing start order to C/D **110** (step **237**). In the processing start order, information on the processing contents (resist coating, development and postbake) to be performed to wafer W is included. C/D **110** loads wafer W on a stage of a unit that performs a processing to be performed, for example, the coater, the developer or the postbake unit (step **275**). Then, C/D **110** performs the ordered processing (resist coating, postbake, development) to wafer W (step **277**). After the processing, C/D **110** unloads wafer W (step **279**). C/D **110** transmits a processing end notice to management controller **160** (step **281**), and management controller **160** transmits the processing end notice to host **600** (step **283**).

[0196] FIG. **24** shows a flow of operations of each apparatus of device manufacturing apparatus group **900**. The flow of operations of each apparatus of device manufacturing apparatus group **900** shown in FIG. **24** is substantially the same as the flow of operations of C/D **110** shown in FIG. **23**. That is, each apparatus that receives a processing start order from host **600** (step **301**) loads wafer W (step **303**), performs a predetermined processing to wafer W (step **305**), unloads the wafer W (step **307**) and sends a processing end notice to host **600** (step **309**).

[0197] FIG. **25** shows a flow of processings of host **600** and measurement and/or inspection instrument **120**. Host **600** sends a processing start order to measurement and/or inspection instrument **120** (step **351**). Next, measurement and/or inspection instrument **120** loads wafer W (step **353**). Then,

measurement and/or inspection instrument **120** sends a request for transmission of measurement and/or inspection content information to host **600** (step **355**), and host **600** transmits information of measurement and/or inspection contents to measurement and/or inspection instrument **120** (step **356**). The measurement and/or inspection contents include, for example, information with which whether or not wafer W has been exposed by liquid immersion exposure can be identified, besides measurement and/or inspection contents such as inspection of films on wafer W, detection of wafer marks, appearance inspection of foreign substances, stains or the like, line width measurement, and measurement of overlay error. Next, measurement and/or inspection instrument **120** judges whether or not loaded wafer W has been exposed by liquid immersion exposure, referring to information such as IC chip (IC tag) embedded in wafer W or barcode, or measurement and/or inspection content information sent from host **600** (step **357**). When the judgment is affirmed, the procedure proceeds to step **359**, and when the judgment is denied, the procedure proceeds to step **361**. In the embodiment, the measurement and/or inspection contents of measurement and/or inspection instrument **12** are changed between liquid immersion exposure and dry exposure. Then, in step **359**, the processing contents of the apparatus and the like are set so that measurement and/or inspection is performed under the measurement and/or inspection conditions for liquid immersion exposure, and in step **361**, the processing contents of the apparatus and the like are set so that measurement and/or inspection is performed under the measurement and/or inspection conditions for dry exposure. In this manner, the measurement and/or inspection contents in measurement and/or inspection instrument **120** are different between dry exposure and liquid immersion exposure. The inspection conditions in liquid immersion exposure will be described next.

[0198] First, in the case of wafer W that is exposed in a liquid immersion exposure method, as is shown in FIGS. **7**A to **7**C, since topcoat film TC is formed on resist film RL, measurement and/or inspection of topcoat film TC is added to the measurement and/or inspection contents in the case of liquid immersion exposure.

[0199] Further, since the size of a pattern formed by liquid immersion exposure is smaller than the size of a pattern formed by dry exposure in general, the required accuracy for pattern line width and overlay error are to be set higher. For example, when measuring the pattern line width or the overlay error by the image processing method, the magnification of image data only has to be set larger, or the pixel size only has to be changed in a direction of increasing the detection sensitivity.

[0200] Regardless of the detection method, in the case of measurement and/or inspection in liquid immersion exposure, the sensitivity of the pattern defect is preferably set higher than that in the case of dry exposure. This is because the size of a pattern formed by liquid immersion exposure is smaller as is described above, and therefore, the size of the defect of the pattern that affects the yield is also relatively smaller.

[0201] Further, in the case the wavelength of illumination light that illuminates wafer W in measurement and/or inspection instrument **120** can be selected, the shorter wavelength is preferably selected. For example, when the selectable range of wavelengths is 260 nm to 500 nm, the wavelength of illumination light is set to 260 nm in the measurement and/or inspection in liquid immersion exposure.

[0202] Further, when either one of an optical method and an electron beam (EB) method can be selected as a detection method of a pattern defect, the EB method is preferably selected. Further, when the bright field and the dark field can be selected, the bright field is preferably selected because films on wafer W are formed in multi layers in liquid immersion exposure. Further, when the detection method is the optical method and a layer having a high level difference is a target, a confocal system is preferably selected in the case the confocal system can be selected as the optical system.

[0203] Further, in the case an image comparison algorithm, a design data comparison algorithm, a feature extraction algorithm and the like can be selected as a detection algorithm of a pattern defect, the image comparison algorithm or the feature extraction algorithm is preferably selected. Herein, the image comparison algorithm is an algorithm in which a pattern defect is extracted by, for example, comparing image data of two shot areas in which the same device pattern should have been formed are compared by die-to-die or cell-to-cell. Further, the design data comparison algorithm is an algorithm in which a pattern defect is extracted by, for example, comparing a line width of a pattern that is extracted from image data of a device pattern with the value in design thereof. Further, the feature extraction algorithm is an algorithm in which a feature included in image data of a device pattern is extracted and a pattern defect is extracted from the feature.

[0204] Further, in the case detection of foreign substances by a laser scan method or the like is performed, the sensitivity, the number and the angle of a photomultiplier that detects the scattered light can also be adjusted.

[0205] Further, at the time of liquid immersion exposure, detection processings are added and/or changed as will be described below.

[0206] (1) Inspection of pattern defects peculiar to liquid immersion

[0207] (2) Inspection of watermarks, stains due to exuding of a resist component, resist peeling and the like

[0208] (3) Inspection of particles/foreign substances adhering to the remaining liquid that is left on wafer W

[0209] (4) Intensive inspection of points at which the liquid immersion state is expected to be unfavorable

[0210] Among the inspections referred to above, the inspection of pattern defects peculiar to liquid immersion in (1) is important. In the state as is shown in FIG. **7**A where liquid LQ and a foreign substance (bubble, particle) enters into a boundary portion between resist film RL and topcoat film TC, in the state as is shown in FIG. **7**B where foreign substance IB such as a particle or a watermark adheres on topcoat film TC, in the state as is shown in FIG. **7**C where a foreign substance such as bubbles BB and/or particle PT exists in the liquid immersion area, and besides, in a state where a part of topcoat film TC is peeled off, sometimes a pattern that is foreign to a device pattern appears on the wafer surface due to the state, after the PEB processing.

[0211] FIG. **26**A shows an example of an image showing a pattern defect peculiar to liquid immersion. In FIG. **26**A, the line width of part of the linear device pattern becomes thinner due to the above-described liquid immersion states shown in FIGS. **7**A to **7**C. When extracting the pattern defect portion by obtaining the difference between the image data in FIG. **26**A and image data corresponding to an original device pattern (design pattern), a circular pattern appears as is shown

in FIG. **26**B. In this manner, in liquid immersion exposure, when the exposure state deteriorates, a pattern that is completely irrelevant to a device pattern and is peculiar to liquid immersion appears due to the foreign substance, the bubble, or the watermark, and therefore, measurement and/or inspection instrument **120** needs to inspect whether or not such a pattern is formed. In order to detect such a pattern peculiar to liquid immersion, a composite processing may also be performed by using the combination of plural types of algorithms such as the feature extraction algorithm and the image comparison algorithm as described above.

[0212] Further, for example, in the case of the defect due to the bubble, there are the characteristics that a circular bright section exists in the vicinity outside the bubble, and inside the bubble, a dark section serves as a base and a pattern different from that in the vicinity appears. Further, as a peculiar pattern due to the watermark, a pattern like a dark mass is entirely formed.

[0213] Further, the intensive inspection of points at which the liquid immersion state is expected to be unfavorable in (4) is also important.

[0214] In other words, when performing exposure to shot areas SA_p near the wafer outer circumference, the liquid immersion area protrudes from wafer W, and sometimes a pattern defect occurs frequently in these shot areas since the state in these shot areas is different from the case where shot areas in the center portion of wafer W are exposed. Thus, in the case of liquid immersion exposure, it can be considered that pattern defect inspection near the outer circumference is performed more intensively than near the center of wafer W.

[0215] Moreover, in liquid immersion exposure, it is known that the temperature of wafer W is lowered due to volatilization of liquid from the wafer W surface and the like, and the deformation degree of wafer W becomes larger than that in dry exposure and the wafer scaling fluctuates. Therefore, regarding the overlay error measurement of a device pattern, the measurement frequency for the outer circumference of wafer W may also be increased.

[0216] Further, in liquid immersion exposure, it can be said that measurement of distortion of shot area itself (shot distortion), measurement of aberration of projection optical system PL and the like are preferably set to be performed frequently.

[0217] Referring back to FIG. **25**, after the measurement and/or inspection conditions are set in step **359** or **361**, measurement and/or inspection is performed under the set measurement and/or inspection conditions (step **363**). In the next step, step **365**, measurement and/or inspection instrument **120** sends the measurement and/or inspection results to host **600**. In the next step, step **367**, measurement and/or inspection instrument **120** unloads wafer W. In the next step, step **369**, measurement and/or inspection instrument **120** returns a processing end notice to the host.

[0218] FIG. **27** shows a flow of processings of host **600** and analytical apparatus **170**. Host **600** sends an analysis order to analytical apparatus **170** (step **401**). The analysis order includes specific analysis contents that are to be analyzed in the analytical apparatus. Next, analytical apparatus **170** reads the analysis contents and requests measurement and/or inspection instrument **120** for a measurement and/or inspection result (No. 1) required for the analysis (step **403**). Measurement and/or inspection instrument **120** sends measurement and/or inspection result data (No. 1) to analytical apparatus **170** (step **405**). Incidentally, the measurement and/or inspection result data also includes information on measurement and/or inspection conditions, besides the measurement and/or inspection results. Furthermore, analytical apparatus **170** requests measurement and/or inspection instrument **120** for a measurement and/or inspection result (No. 2) required for analysis (step **407**). Measurement and/or inspection instrument **120** sends measurement and/or inspection result data (No. 2) to analytical apparatus **170** (step **409**). Incidentally, the measurement and/or inspection result data also includes information on measurement and/or inspection conditions, besides the measurement and/or inspection results.

[0219] Next, analytical apparatus **170** performs an analytical processing (step **411**). When, performing the analytical processing, analytical apparatus **170** requests the processing apparatus such as exposure apparatus **100** or **101** for transmission of processing contents data required for the analysis, as needed. The processing apparatus that receives the request transmits the processing contents data to analytical apparatus **170**. After finishing the analytical processing, analytical apparatus **170** performs an accumulation processing of accumulating the collected measurement and/or inspection results and data of analytical results in a database (step **413**). Next, analytical apparatus **170** sends the analytical results (optimization results) to the processing apparatus such as measurement and/or inspection instrument **120** and/or exposure apparatus **100** or **101**, as needed (step **415**). Finally, analytical apparatus **170** returns a processing end notice to host **600** (step **417**).

[0220] As is described above, host **600** uses the control operation to each apparatus shown in FIGS. **22** to **25** and FIG. **27** as one processing unit to make each apparatus operate and execute a series of processes. Incidentally, these operations are merely examples, and exposure apparatuses **100** and **101** may be made to operate according to instructions from analytical apparatus **170** via the management controller or without it.

[Device Manufacturing Process]

[0221] Next, a flow of a series of processes in device manufacturing system **1000** will be described. The series of processes of device manufacturing system **1000** are scheduled and controlled by host **600**. The table in FIG. **28** shows processing items that can be executed in the series of processes. In the columns of a main item in the table, rough processing procedures that could be executed in order are described in the processing order. As is shown in the table, in the series of processes, first of all, a film formation/resist coating processing and a wafer measurement and/or inspection processing (A), a wafer measurement and/or inspection processing (B), an exposure processing and a wafer measurement and/or inspection processing (C), a PEB processing and a wafer measurement and/or inspection processing (D), a development processing and a wafer measurement and/or inspection processing (E), an etching processing and a wafer measurement and/or inspection processing (F), and an impurity diffusion processing and a wiring processing are repeatedly performed, and after the device pattern of each layer is all formed, a probing processing, a repair processing, a dicing processing, a packaging processing and a bonding processing are performed and finally a device is completed. Incidentally, the abnormality detected in the measurement and/or inspection processing is used for adjustment or the like of processing contents of the various processings described above, that is, the film formation/resist coating processing, the exposure

processing, the PEB processing, the development processing, the etching processing, the impurity diffusion processing and the wiring processing, the probing processing, the repair processing and the like.

[0222] In the embodiment, the processings corresponding to the main items shown in FIG. **28** are to be repeated with respect to each wafer, for example, in a pipeline manner.

[0223] In the columns of subitems, specific processing contents that are actually performed during the corresponding processings in the main items are described. In the columns of the subitem (essential), the processings that are performed without fail in the series of processes are indicated. Further, in the columns of the subitem (liquid immersion), the processings, which are performed without fail in the process in which exposure in liquid immersion exposure apparatus **101** is performed, are described. For example, in the film formation/resist coating processing, antireflection film formation (film formation) and resist coating are the essential processings, but topcoat film coating is essential only in the case of performing liquid immersion exposure. In the case of performing liquid immersion exposure, the processings in the subitems (liquid immersion) also become the essential processings.

[0224] Further, in the columns of the subitem (selection), the processings whose execution or non-execution is selected by host **600** are described. The processings designated as the subitems (selection) are the measurement and/or inspection processings that are performed in each stage of the series of processes.

[0225] First, in film formation/resist coating processing and wafer measurement and/or inspection processing (A), film thickness measurement of an antireflection film, a resist film and a topcoat film, appearance inspection of films (inspection of physical abnormality such as scratch and chemical abnormality such as entry of foreign substances such as infiltrating of liquid), and the like are selectively performed. Besides, in wafer measurement and/or inspection processing (B), alignment pre-measurement (pre-measurement of wafer mark M), focus pre-measurement (measurement of surface shape of wafer W), and appearance inspection of wafer W (mainly, inspection of foreign substances on wafer W) are selectively performed.

[0226] Further, in wafer measurement and/or inspection processing (C), appearance inspection (mainly, inspection of foreign substances on wafer W) is performed, and in wafer measurement and/or inspection processing (D), appearance inspection (mainly, pattern inspection such as inspection of stains on wafer W) is performed. In wafer measurement and/or inspection processings (E) and (F), pattern defect inspection, pattern line width (size) measurement, overlay error measurement and the like are selectively performed.

[0227] Host **600** creates a series of processing procedures by selecting in advance the processings of performing measurement and/or inspection required for the analysis performed in analytical apparatus **170** from among the subitems (selection), and combining the subitems (essential) (or the subitems (essential) and the subitems (liquid immersion)) and the selected subitems (selection) in the order in the table shown in FIG. **28**, and executes the created processing procedures. In the following description, the combination of the processing procedures in the series of processes created in host **600** and analytical contents that can be performed in analytical apparatus **170** will be described.

(1) Optimization of Processing Conditions Related to Wafer Alignment

[0228] First, the case will be described where optimization of processing conditions related to wafer alignment is performed. In the case of performing the optimization, host **600** creates processing procedures by selecting the subitem (selection): film thickness measurement processing of each film in the main item: wafer measurement and/or inspection processing (A) and the subitem (selection): alignment pre-measurement in the main item: wafer measurement and/or inspection processing (B). Herein, the alignment pre-measurement is a processing where pre-measurement of the wafer marks (MX_p, MY_p) in measurement and/or inspection instrument **120** is performed before carrying wafer W into exposure apparatus **100** or **101**.

[0229] FIG. **29**A shows a sectional view of part of wafer W. As is shown in FIG. **29**A, uneven marks are formed on the base of wafer W, and a resist film is coated on the uneven marks by C/D **110** in the film formation/resist coating processing (refer to FIG. **28**). Incidentally, in actual, an antireflection film is formed under the resist film, and in the case liquid immersion exposure is performed, a topcoat film is further formed on the resist film. However, theses films are omitted in FIG. **29**A for simplification of the description. Alignment system ALG photoelectrically detects intensity images of the uneven marks on the base shown in FIG. **29**A with epi-illumination and acquires waveform data corresponding to the photoelectrically detected intensity images.

[0230] FIG. **29**B shows an example of the one-dimensional waveform data. As is shown in FIG. **29**B, the one-dimensional waveform data shows the waveform having three peaks in accordance with the unevenness of the marks.

[0231] Further, FIG. **29**C shows an example of film thickness data of a resist film on wafer W corresponding to the one-dimensional waveform data. Incidentally; in actual, the film thickness data of a resist film is two-dimensional (XY coordinate system) data, but herein, the film thickness data is converted into one-dimensional data in the measurement axis direction so as to accord with the mark waveform data. Various methods can be employed as the method of conversion, and the one-dimensional data can be obtained by totaling and/or averaging data in a direction orthogonal to the measurement axis direction. It is known that since alignment system ALG episcopically illuminates the wafer mark from above the resist film and photoelectrically detects an intensity image by a reflected light and/or a diffracted light from the wafer mark in the wafer alignment, the intensity image is easily affected by the resist film or the like. Then, in optimization of this case, the processing conditions related to wafer alignment are efficiently optimized, by analyzing the correlativity between the mark waveform data shown in FIG. **29**B and the film thickness data shown in FIG. **29**C, determining whether the cause of abnormality in the mark waveform data is the resist film or the like, or the base (mark itself) in accordance with the degree of correlation, and narrowing down the processing conditions that are effective for solving the cause.

[0232] For example, in the examples shown in FIG. **29**A and FIG. **29**C, the film thickness on the right side of the waveform is slightly thinner, and also in the waveform data shown in FIG. **29**B, the rightmost peak is smaller, and the correlativity between the mark waveform data and the film thickness data is considered to be high. Since it is difficult to accurately detect position information of the mark using such waveform data, any measures needs to be taken. As the measures to be taken in such a case, for example, the method in which the ununiformity of a resist film shown in FIG. **29**A is solved can be considered. This is because it can be considered

that asymmetry property of the mark waveform is solved by solving the ununiformity, and it becomes possible to accurately detect the mark position. Further, the measures can also be considered in which actual-measurement-required parameters used to acquire the mark waveform data in alignment system ALG are re-set to a state that is not affected by the ununiformity of film thickness.

[0233] As such actual-measurement-required parameters, for examples, there are the wavelength of illumination light of epi-illumination, and the like. By setting the wavelength of illumination light in the range that is insensitive to a resist film or the like, the intensity image of the mark can be detected regardless of the ununiformity of film thickness.

[0234] On the other hand, in the case there is no correlation between the asymmetry property of the mark waveform data and the film thickness data, which is different from the examples shown in FIG. **29**B and FIG. **29**C, the mark itself as the base is considered to have asymmetry property. Then, in such a case, the mark only has to be excluded from the measurement subject.

[0235] In the case of trying to perform optimization in this case, host **600** selects film thickness measurement of an antireflection film, film thickness measurement of a resist film and film thickness measurement of a topcoat film by measurement and/or inspection instrument **120** from among the subitems (selection) in the main item: film formation/resist coating processing and wafer measurement and/or inspection processing (A), and alignment pre-measurement by measurement and/or inspection instrument **120** from among the subitems (selection) in the main item: wafer measurement and/or inspection processing (B), and creates processing procedures of a series of processes so that the selected processings are executed. In this case, in actual, as is shown in a frame in FIG. **30**, a film formation processing of an antireflection film in film forming apparatus **910**, a film thickness measurement processing of the antireflection film in measurement and/or inspection instrument **120**, a resist film coating processing in C/D **110**, a film thickness measurement processing of the resist film in measurement and/or inspection instrument **120**, (in the ease of liquid immersion exposure, in addition to these processings, a film formation processing of a topcoat film in film forming apparatus **910**, a film thickness measurement processing of the topcoat film in measurement and/or inspection instrument **120**), an alignment pre-measurement processing in measurement and/or inspection instrument **120**, and an exposure processing are to be executed in this order. By executing this process, each film thickness data of an antireflection film, a resist film and a topcoat film and waveform data of wafer marks are measured. Incidentally, in the case abnormality is detected in the inspection processing of each film, the film is to be removed once, and a film is to be newly formed or coated. Further, an antireflection film and a topcoat film are formed by the coating in C/D **110** in some cases.

[0236] Host **600** issues a processing start order to analytical apparatus **170** according to the processing in FIG. **27**, before exposure is started (step **401**). The processing start order is an order that optimization of processing conditions related to wafer alignment in (1) should be performed. Analytical apparatus **170** performs steps **403** to **409**, and acquires various film thickness data, data of alignment pre-measurement and the like from measurement and/or inspection instrument **120**.

[0237] FIG. **30** shows a flowchart of an analytical processing in step **411** in FIG. **27** for the optimization processing. The analytical processing is performed with respect to each wafer mark for which waveform data has been acquired. As is shown in FIG. **30**, first, in step **551**, whether or not there is abnormality in mark waveform data is judged. When the judgment is denied, the processing is finished, and when the judgment is affirmed, the procedure proceeds to step **553**.

[0238] In step **553**, the degree of correlation between the mark waveform data having abnormality and the film thickness data is computed, and in step **555**, whether or not the degree of correlation exceeds a threshold is judged. When the judgment is denied, the procedure proceeds to step **557**, and when the judgment is affirmed, the procedure proceeds to step **561**.

[0239] When the judgment is denied, it can be considered that there is no correlation between the mark waveform data and the film thickness data and the mark waveform data has abnormality due to the base of wafer W. Then, in step **557**, the alignment-related parameters are optimized so that the wafer mark is rejected from measurement subject.

[0240] On the other hand, when the judgment in step **555** is affirmed, it can be considered that there is the correlation between the mark waveform data and the film thickness date and the mark waveform data has abnormality due to the ununiformity of film thickness of various films. In this case, the procedure proceeds to step **561**, in which whether or not to optimize the alignment-related-parameters is judged. When the judgment is affirmed, that is, in the case the instruction from host **600** is set so as to adjust the alignment-related-parameters, the procedure proceeds t step **563**, in which actual-measurement-required parameters among the alignment-related-parameters are optimized. As the actual-measurement-required parameters to be optimized, an alignment sensor to be selected (FIA or LSA), the wavelength of illumination light that is not affected by a resist film or the like, a detection algorithm in which a mark position can be accurately detected even if the mark waveform has a high degree of asymmetry, and the like can be cited. Meanwhile, when the judgment in step **561** is denied, the procedure proceeds to step **565**, in which data related to a processing state of film formation/coating (i.e. processing parameters, and monitoring data of a processing state) is acquired from film forming apparatus **910** or C/D **110**. In step **567**, based on the acquired processing state, optimization of film formation/coating conditions is performed. In other words, in this case, the processing conditions in C/D **110** and/or film forming apparatus **910** (such as a film formation condition of an antireflection film, a coating condition of a resist film, and a film formation condition of a topcoat film) are optimized so that the ununiformity of film thickness that has caused the asymmetry of the mark is solved.

[0241] After this processing, as is shown in FIG. **27**, in the accumulation processing in step **413**, data such as the mark waveform data and the film thickness data, and the optimized alignment-related parameters and history related to film formation/coating conditions, and the like are accumulated in the database of analytical apparatus **170**. Then, in step **415**, information on the parameters that have been optimized in steps **557**, **563** and **567** is sent to the relevant apparatus, that is, exposure apparatus **100** or **101**, or C/D **110** and film forming apparatus **910**. Each apparatus changes the relevant parameters to the optimum values and performs the subsequent processings. Thus, feedback control of the film formation/coating conditions in film forming apparatus **910** and C/D

110 is realized, and feedforward control of the alignment-related parameters in exposure apparatus **100** or **101** is realized.

[0242] Analytical apparatus **170** returns a processing end notice to host **600** (step **417**).

[0243] Incidentally, in the embodiment, either one of the optimization of the alignment-related parameters or the optimization of the film formation/coating conditions is performed, but both the optimizations may be performed.

[0244] Further, the subject for computation of the correlation with the mark waveform data is not limited to film thickness data of an individual film, that is, an antireflection film, a resist film, and a topcoat film, but film thickness data that is obtained by totaling all the films' thickness, or film thickness data of thickness of two films in total out of the three films may be employed. Thus, it becomes possible to analyze in more detail which film out of the three films affects the mark waveform data.

[0245] Incidentally, in the embodiment, the case has been described where the mark waveform data is one-dimensional data and the film thickness data is converted from two-dimensional data into one-dimensional data, but the mark waveform data may be two-dimensional data of the XY coordinate system. In this case, in step **553**, the correlation between both two-dimensional data is to be computed.

(2) Optimization of Focus-Control-Related Parameters

[0246] Next, the case will be described where optimization of focus-control-related parameters on exposure is performed. In this case, host **600** selects the subitem (selection): film thickness measurement of each film in the main item: wafer measurement and/or inspection processing (A) and the subitem (selection): focus pre-measurement in the main item: wafer measurement and/or inspection processing (B), and creates processing procedures. The focus pre-measurement is the processing of performing pre-measurement of a surface shape of wafer W in measurement and/or inspection instrument **120** before carrying wafer W into exposure apparatus **100** or **101**.

[0247] FIG. **31**A shows a sectional view of part of wafer W. An antireflection film and a topcoat film are not shown and only a resist film is shown also in FIG. **31**A, similar to FIG. **29**A. It is not the surface of a resist film but a base of wafer W that is measured by the multipoint AF sensor (**60***a*, **60***b*) during exposure, and it is the surface shape of the base of wafer W that is measured in the focus pre-measurement. FIG. **31**B shows an example of measurement data of the surface shape of wafer W measured by the focus pre-measurement.

[0248] As is show in FIG. **31**B, the data is two-dimensional data in the XY coordinate system, which shows that the surface shape of wafer W is not flat when exactly viewing it. In order to transfer a device pattern with high accuracy to such a surface, the parameters related to focus control need to be optimized to some extent. As the parameters that can be optimized, for example, there are selection of a focus sensor (measurement point) in the multipoint AF sensor (**60***a*, **60***b*), and the like. The focus sensor is preferably selected so that the Z-position of the base between measurement points becomes as flat as possible.

[0249] FIG. **31**C shows an example of measurement data of film thickness corresponding to the measurement data of surface shape in FIG. **31**B. The measurement data of film thickness of a resist film or the like shown in FIG. **31**C is also two-dimensional data in the XY coordinate system. The measurement values of the multipoint AF sensor (**60***a*, **60***b*) are affected by the ununiformity of film thickness of a resist film or the like in some cases. This is because an offset component of the multipoint AF sensor changes depending on the measurement point due to the ununiformity of film thickness, and a surface shape that is different from the actual surface shape of wafer W is observed in some cases. Accordingly, in the embodiment, concerning the place that is regarded as being abnormal because the gradient of surface shape is steep in the measurement data of surface shape of wafer W, the degree of correlation between the measurement data of surface shape shown in FIG. **31**B and the film thickness data shown in FIG. **31**C is analyzed, and in accordance with the degree of correlation, whether the cause of considerable change of the surface shape is due to the ununiformity of a resist film or the like, or the base of wafer W (i.e. the original surface shape) is determined, and optimization of processing conditions are optimized in accordance with the determined cause.

[0250] In this case, in host **600**, film thickness measurement of an antireflection film, film thickness measurement of a resist film and film thickness measurement of a topcoat film (only when performing liquid immersion exposure) by measurement and/or inspection instrument **120** are selected from among the subitems (selection) of the main item: film formation/resist coating processing and wafer measurement and/or inspection processing (A) (refer to FIG. **28**), and focus pre-measurement by measurement and/or inspection instrument **120** is selected from among the subitems (selection) of the main item: wafer measurement and/or inspection processing (B) (refer to FIG. **28**). In this case, in actual, as is shown in a frame in FIG. **32**, a film formation processing of an antireflection film in film forming apparatus **910**, a film thickness measurement processing of the antireflection film in measurement and/or inspection instrument **120**, a resist film coating processing in C/D **110**, a film thickness measurement processing of the resist film in measurement and/or inspection instrument **120**, a film formation processing of a topcoat film in film forming apparatus **910**, a film thickness measurement processing of the topcoat film in measurement and/or inspection instrument **120**, a focus pre-measurement processing in measurement and/or inspection instrument **120** and an exposure processing are to be executed in this order. By executing this process, each film thickness of an antireflection film, a resist film and a topcoat film and the surface shape of the wafer are measured by measurement and/or inspection instrument **120** before performing the exposure processing.

[0251] As is shown in FIG. **27**, in step **401**, host **600** issues a processing start order to analytical apparatus **170**. Analytical apparatus **170** acquires measurement data of various film thickness and measurement data of the surface shape by the processings in steps **403** to **409**, and the execution of the analytical processing in step **411** is started in analytical apparatus **170**.

[0252] FIG. **32** shows a specific flowchart of optimization processing in analytical apparatus **170**. As is shown in FIG. **32**, first, in step **601**, whether or not there is a portion whose surface shape is abnormal (e.g. a portion whose gradient or level difference exceeds a predetermined level) is judged. When the judgment is denied, the processing is finished, and when the judgment is affirmed, the procedure proceeds to step **603**. In step **603**, the degree of correlation between measurement data of the abnormal portion and measurement data of film thickness of the portion is computed. Herein, the degree of correlation is computed using the measurement data of film

thickness of various films and the measurement data of surface shape of wafer W. In step **605**, whether or not the computed degree of correlation exceeds a threshold is judged. When the judgment is denied, the base of wafer W itself is judged to have been measured and the procedure proceeds to step **613**, and when the judgment is affirmed, the procedure proceeds to step **607**.

[0253] In step **607**, whether or not to optimize film formation/coating conditions is judged according to instruction contents from host **600**. The procedure proceeds to step **609** only in the case the judgment is affirmed, and data related to processing state of the film formation/coating processing is acquired from film forming apparatus **910** or C/D **110**, and in step **611**, the film formation/coating conditions of film forming apparatus **910** or C/D **110** are optimized. The detailed description of processing contents in this case will be omitted because they are the same as those in step **567** in FIG. **30**.

[0254] In the next step, step **613**, whether or not to optimize the focus-related parameters is judged according to instruction contents from host **600**. The procedure proceeds to step **615** only in the case the judgment is affirmed, and the focus-related parameters are optimized by selecting a focus sensor on the surface as flat as possible, or the like.

[0255] Incidentally, when performing the optimization, the processing is slightly different between the case when the judgment is made that there is no correlation between the film thickness data and the surface shape data and the case when the judgment is made that there is the correlation. In the case the judgment is made that there is no correlation, selection of a focus sensor or the like is performed based on only the measurement data of surface shape. Further, in the case the judgment is made that there is the correlation, selection of a focus sensor or the like is performed taking the measurement data of film thickness into consideration in addition to the measurement data of surface shape, that is, based on the total (summation) of the measurement data of surface shape and the measurement data of film thickness.

[0256] After this processing, as is shown in FIG. **27**, in the accumulation processing in step **413**, the measurement data of surface shape, the measurement data of film thickness, and history related to the optimized focus-related parameters and film formation/coating conditions are accumulated in the database of analytical apparatus **170**. Then, in step **415**, data related to parameters that have been optimized in steps **611** and **615** in FIG. **32** is sent to the relevant apparatus, that is, exposure apparatus **100** or **101**, or C/D **110** and film forming apparatus **910**. Each apparatus changes the relevant parameters to optimum values and performs the subsequent processing. Thus, feedback control of film formation/coating conditions in film forming apparatus **910** and C/D **110** is realized, and feedforward control of the focus-related parameters in exposure apparatus **100** or **101** is realized. Analytical apparatus **170** returns a processing end notice to host **600** (step **417** in FIG. **27**).

[0257] Incidentally, in the flowchart in FIG. **32**, optimization of the focus-related parameters on exposure is performed only in the case abnormality of surface shape is detected, but the present invention is not limited to this. That is, step **601** does not always have to performed, and the processings in step **603** and the succeeding steps can be performed to the wafer entire surface.

[0258] Further, the case can also be considered where the surface shape is measured as flat due to the ununiformity of film thickness even if the surface shape of the base has level difference or gradient in actual. In this case, even if the correlation between film thickness and surface shape is not recognized, selection of a focus sensor is preferably performed based on the total of the measurement data of film thickness and the measurement data of surface shape.

(3) Optimization of Processing Conditions of Wafer Appearance Inspection Before Exposure

[0259] Next, the case will be described where optimization of processing conditions of wafer appearance inspection before exposure, that is, wafer appearance inspection in wafer measurement and/or inspection processing (B) is performed. In this case, host **600** selects the subitem (selection): appearance inspection (foreign substance inspection) in the main item: wafer measurement and/or inspection processing (B) and the subitem (selection): appearance inspection (foreign substance inspection) in the main item: wafer measurement and/or inspection processing (C), and creates processing procedures. FIG. **33**A shows an example of data of inspection results of appearance inspection of wafer W in wafer measurement and/or inspection processing (B) (foreign substance inspection data (B)). Incidentally, the data is actually XY two-dimensional data, but is shown as one-dimensional data for the sake of simplification of the description. In the foreign substance inspection, a foreign substance is judged to exist at the portion at which a level of data exceeds an abnormality detection level (shown in a dotted line). In the data shown in FIG. **33**A, since the portion that exceeds the abnormality detection level does not exist, the judgment is made that there is no foreign substance.

[0260] FIG. **33**B shows an example of data of inspection results of appearance inspection of wafer Win wafer measurement and/or inspection processing (C) (foreign substance inspection data (C)). Also in this foreign substance inspection, a foreign substance is judged to exist at the portion at which a level of data exceeds an abnormality detection level shown in a dotted line. In the data shown in FIG. **33**B, since the portion that exceeds the threshold exists, the judgment is made that there is a foreign substance at the portion.

[0261] When comparing the data in FIG. **33**A with the data in FIG. **33**B, however, the portion that is judged to have abnormality in FIG. **33**B has a peak also in the data in FIG. **33**A, and the correlativity between them is estimated to be high. In such a case, it can be considered that a foreign substance already adhered on wafer W before exposure, and the foreign substance could have been detected when performing wafer measurement and/or inspection processing (B), if the sensitivity of abnormality inspection in wafer measurement and/or inspection processing (B) had been increased (i.e. the abnormality detection level had been lowered). Accordingly, in such a case, by adjusting the abnormality detection level of appearance inspection in wafer measurement and/or inspection processing (B), the foreign substance adhering on wafer W can be detected earlier.

[0262] In this case, in actual, as shown in a frame in FIG. **34**, an appearance inspection in wafer measurement and/or inspection processing (B) (which is shortly referred to as an appearance inspection (B) in FIG. **34**), an exposure processing, an appearance inspection in wafer measurement and/or inspection processing (C) (which is shortly referred to as an appearance inspection (C) in FIG. **34**), a PEB processing, a development processing and an etching processing are to be executed in this order. By executing this process, inspection data of appearance inspection (B) on wafer W before per-

forming the exposure processing and inspection data of appearance inspection (C) on wafer W after the exposure processing can be obtained. Host **600** issues a processing start order to analytical apparatus **170** according to the processing in FIG. **27** before exposure is stared (step **401**). The processing start order is the order that (3) optimization of wafer appearance inspection before exposure should be performed. Analytical apparatus **170** acquires inspection data of appearance inspections (B) and (C) by performing steps **403** to **409**.

[0263] FIG. **34** shows a flowchart of some of processing procedures created by host **600**. As is shown in FIG. **34**, in step **651**, the judgment is made of whether or not a result of appearance inspection (B) is normal and abnormality is detected in appearance inspection (C). When the judgment is denied, the processing is finished, and when the judgment is affirmed, the procedure proceeds to step **653**. In step **653**, the degree of correlation of inspection data between inspection (B) and inspection (C) is computed. In the next step, step **655**, whether or not the computed degree of correlation exceeds a threshold is judged. The procedure proceeds to step **657** only in the case the judgment is affirmed, and the abnormality detection level of appearance inspection (B) is adjusted.

[0264] After this processing, as is shown in FIG. **27**, in the accumulation processing in step **413**, the inspection data of inspection (B) and inspection (C), and history related to adjustment of the abnormality detection level are accumulated in the database of analytical apparatus **170**. Then, in step **657**, the adjusted abnormality detection level is sent to the relevant apparatus, that is, measurement and/or inspection instrument **120**. Measurement and/or inspection instrument **120** changes the relevant parameters to optimum values and performs the subsequent processing. Thus, feedback control of abnormality detection level of measurement and/or inspection instrument **120** is realized. Analytical apparatus **170** returns a processing end notice to host **600** (step **417** in FIG. **27**).

(4) Optimization of Liquid-Immersion-Exposure-Related Processing Conditions (No. 1)

[0265] Next, the case will be described where optimization of liquid-immersion-exposure-related processing conditions (No. 1) is performed. Herein, optimization of processing conditions in liquid immersion exposure is performed based on the appearance inspection result of each film on wafer W before exposure and the appearance inspection result of wafer W after exposure. In this case, host **600** selects the subitem (selection): film inspection of each film (appearance inspection (A)) in the main item: wafer measurement and/or inspection processing (A) and the subitem (selection): appearance inspection (appearance inspection (C)) in the main item: wafer measurement and/or inspection processing (C), and creates processing procedures. In a frame (call-out) in FIG. **35**, a flow of processing procedures created by host **600** in order to perform this optimization processing is shown. That is, herein, an antireflection film formation, an inspection of the antireflection film, a resist film coating, an inspection of the resist film, a topcoat film formation, an inspection of the topcoat film, a liquid immersion exposure and appearance inspection (C) are performed in this order. By executing this process, inspection data of appearance inspection (A) of each film on wafer W is obtained before performing the exposure processing, and inspection data of appearance inspection (C) on wafer W is obtained after the exposure processing.

[0266] Host **600** issues a processing start order to analytical apparatus **170** according to the processing in FIG. **27** before exposure is started (step **401**). Analytical apparatus **170** acquires inspection data of appearance inspection (A) and appearance inspection (C) and the like from measurement and/or inspection instrument **120** by performing steps **403** to **409**, and then executes an analytical processing (step **411**).

[0267] FIG. **35** shows a specific flowchart of the analytical processing in this case. As is shown in FIG. **35**, in step **701**, the judgment is made of whether or not a result of appearance inspection (A) is normal and a result of appearance inspection (C) is abnormal. When the judgment is denied, the processing is finished, and when the judgment is affirmed, the procedure proceeds to step **703**. In step **703**, data of liquid immersion monitoring result by liquid immersion monitor **260** is acquired from exposure apparatus **101**. In step **705**, based on the acquired data of liquid immersion monitoring result, the cause of abnormality in inspection (C) is analyzed. As the cause of such abnormality, for example, as is shown in FIGS. **7**A to **7**C, elution of a resist film into liquid during exposure, a particle or foreign substance adhering to the remaining liquid, a watermark or the like can be considered.

[0268] In step **707**, whether or not host **600** has designated optimization of liquid-immersion-related parameters is judged, and only in the case the judgment is affirmed, the procedure proceeds to step **709**, in which optimization of the liquid-immersion-related parameters is performed so that the abnormality is solved. As the liquid-immersion-related parameters, for example, there are the flow speed or the temperature of liquid LQ, a filter condition of liquid LQ, a period of time when the place where abnormality occurs is immersed in liquid (liquid immersion time), and the like.

[0269] In order to adjust the liquid immersion time of a certain place on wafer W, an exposure route on wafer W needs to be changed. FIG. **36** shows an exposure route that shows the order in which shot areas on wafer W are exposed. In step **709**, the exposure route is changed so that the liquid immersion time of the point where abnormality is detected is shortened. Further, as is shown in FIG. **37**, in some cases, another place of wafer W is immersed in liquid also during wafer mark measurement by alignment system ALG, and therefore, in the case the point where abnormality is detected seems to be immersed in liquid for a long period of time during the alignment, the wafer marks to be measured may be changed.

[0270] In step **711**, the judgment is made of whether or not optimization of liquid removal processing conditions is set to be performed referring to instructions from host **600**, and only in the case the judgment is affirmed, the procedure proceeds to step **713**, in which optimization of liquid removal processing conditions is performed. Herein, processing conditions of a liquid removal processing, for example, the processing time is lengthened, or a period of time from when exposure ends until when liquid removal is performed is shortened, so that the degree of removal of the remaining liquid on wafer W is improved (i.e. wafer W is completely dried). Incidentally, in the following description, the processing conditions of the liquid removal processing are also included in the liquid-immersion-related parameters.

[0271] After this processing, as is shown in FIG. **27**, in the accumulation processing in step **413**, data such as data of inspection (A) and data of inspection (C), history of the optimized liquid-immersion-related parameters and the like are accumulated in the database of analytical apparatus **170**. Then, information on the parameters that have been opti-

mized in steps **709** and **713** is sent to the relevant apparatus, that is, exposure apparatus **101**. Exposure apparatus **101** changes the relevant parameters to optimum values, and performs the subsequent processing. Thus, feedback control of the liquid-immersion-related parameters and liquid removable conditions of removal unit T is realized. Incidentally, accumulation of measurement and/or inspection results and optimization results, and transmission to various apparatuses are to be performed in all the optimization processings at the time of liquid immersion exposure which will be described below, and therefore, their detailed description will be omitted.

[0272] Analytical apparatus **170** returns a processing end notice to host **600** (step **417**).

[0273] Incidentally, in the embodiment, removal unit T is to be arranged within exposure apparatus **101**, but the removal unit may be arranged within track **200**B. In this case, feedback of optimization results of processing conditions of liquid removal is performed to track **200**B, not to exposure apparatus **101**.

(5) Optimization of Liquid-Immersion-Exposure-Related Processing Conditions (No. 2)

[0274] Next, the case will be described where optimization of liquid-immersion-exposure-related processing conditions (No. 2) is performed. Herein, as is shown in a frame in FIG. **38**, optimization of processing conditions in liquid immersion exposure is performed based on an appearance inspection in wafer measurement and/or inspection processing (C) before a PEB processing (appearance inspection (C)) and an appearance inspection in wafer measurement and/or inspection processing (D) after the PEB processing (appearance inspection (D)). Host **600** selects the subitem (selection): wafer appearance inspection (foreign substance inspection) in the main item: wafer measurement and/or inspection processing (C) and the subitem (selection): wafer appearance inspection (inspection of stains due to the remaining liquid, or the like) in the main item: wafer measurement and/or inspection processing (D), and creates processing procedures.

[0275] As is shown in FIG. **38**, first, in step **751**, the judgment is made of whether or not a result of inspection (C) is normal and a result of inspection (D) is abnormal. When the judgment is denied, the processing is finished, and when the judgment is affirmed, the procedure proceeds to step **753**. In step **753**, processing state data of PEB (e.g. data of the temperature or the processing time) is acquired from C/D **110** of track **200**B. In step **755**, based on the acquired data of processing state of PEB, the PEB processing is checked.

[0276] In step **757**, whether or not there is any problem in the processing state of the PEB processing is judged. Only in the case the judgment is affirmed, the procedure proceeds to step **759**, in which the processing conditions of the PEB processing are optimized. As such processing conditions, for example, the setting temperature of PEB can be cited. In the case the judgment in step **757** is denied, the procedure proceeds to step **761**, in which inspection conditions of appearance inspection (C) are optimized. Since this processing is the same as step **657** in FIG. **34**, the detailed description will be omitted. In the next step, step **763**, data of liquid immersion monitoring results is acquired from exposure apparatus **101**, and in step **765**, the liquid-immersion-related parameters (which include processing conditions of the liquid removable processing, as is described above) are optimized. Since this optimization processing is the same as steps **709** and **713** in FIG. **35**, the detailed description will be omitted.

[0277] Incidentally, herein, instead of optimization of liquid-immersion-related parameters in steps **763** and **765**, the film formation/coating conditions in film forming apparatus **910** or C/D **110** may be optimized. That is, optimization of top coat processing such as thickening a topcoat film, or change of types of resist, and/or change of coating conditions of resist, or the like may be performed, so that liquid does not infiltrate into a resist film.

(6) Optimization of Processing Conditions of Liquid Immersion Exposure (No. 3)

[0278] Next, the case will be described where optimization of processing conditions of liquid immersion exposure (No. 3) is performed. Herein, as is shown in FIG. **39**, optimization of the processing conditions is performed based on results of appearance inspection (C) of wafer W before a PEB processing and pattern defect inspection (E) of wafer W after a development processing. That is, optimization of processing conditions is performed in accordance with the difference in detection results between before and after the PEB processing and the development processing. In this case, host **600** selects the subitem (selection): wafer appearance inspection (foreign substance and/or remaining liquid inspection) (appearance inspection (C)) in the main item: wafer measurement and/or inspection processing (C) and the subitem (selection): pattern defect inspection in the main item: wafer measurement and/or inspection processing (E) (defect inspection (E)), and creates processing procedure.

[0279] As is shown in FIG. **39**, first, in step **851**, the judgment is made of whether or not a result of inspection (C) is normal and a result of inspection (E) is abnormal. When the judgment is denied, the processing is finished. In step **853**, data of processing state of a development processing of C/D **110** of track **200**B is acquired. In step **855**, based on the acquired data of processing state of the development processing of C/D **110**, the development processing is checked. In step **857**, whether or not there is any problem in the development processing of C/D **110** is judged. When the judgment is affirmed, the procedure proceeds to step **859**, in which the processing conditions of the development processing are optimized. After step **859** ends, the processing is finished. On the other hand, when the judgment in step **857** is denied, the procedure proceeds to step **861**, in which data of processing state of the PEB processing is acquired from C/D **110** of track **200**B.

[0280] In the next step **863**, whether or not there is any problem in the processing state of the PEB processing of CID **110** is judged. When the judgment is affirmed, the procedure proceeds to step **867**, the processing conditions of the PEB processing are optimized so that the occurrence frequency of pattern defect is reduced. When the judgment is denied, the procedure proceeds to step **869**, in which data of liquid immersion monitoring results is acquired from exposure apparatus **101**. In the next step, step **871**, the liquid-immersion-related parameters are optimized so that the occurrence frequency of pattern defect is reduced.

[0281] That is, in this optimization processing, the processing state is selected in the order of the development processing, the PEB processing and the liquid immersion exposure processing, in accordance with the difference in detection results between before and after the PEB processing and the

development processing, and the processing conditions of the processing that is judged to have a problem are optimized.

(7) Optimization of Processing Conditions of Liquid Immersion Exposure (No. 4)

[0282] Next, the case will be described where optimization of processing conditions of liquid immersion exposure (No. 4) is performed. Herein, as is shown in FIG. **90**, the processing conditions are optimized based on the difference in appearance inspection results before and after a development processing. In this case, host **600** selects the subitem (selection): appearance inspection in the main item: wafer measurement and/or inspection processing (D) before the development processing (appearance inspection (D)) and the subitem (selection): pattern defect inspection in the main item: wafer measurement and/or inspection processing (E) after the development processing (defect inspection (E)), and creates processing procedures.

[0283] FIG. **40** shows a flowchart of an analytical processing of analytical apparatus **170** in this case. As is shown in FIG. **40**, first, in step **901**, the judgment is made of whether or not a result of inspection (D) is normal and a result of inspection (E) is abnormal. When the judgment is denied, the processing is finished. In step **903**, data of processing state of a development processing of C/D **110** of track **200**B is acquired. In the next step, step **905**, based on the acquired data of the development processing, the development processing is checked. In the next step, step **907**, whether or not there is any problem in the development processing is judged. When the judgment is denied, the procedure proceeds to step **909**, in which liquid immersion state data is acquired, and in step **911**, the liquid-immersion-related parameters are optimized so that a pattern defect portion disappears. Meanwhile, when the judgment is affirmed, the processing conditions of the development processing are optimized so that the pattern defect portion disappears.

(8) Optimization of Processing Conditions of Liquid Immersion Exposure (No. 5)

[0284] Next, the case will be described where optimization of processing conditions of liquid immersion exposure (No. 5) is performed. Herein, as is shown in FIG. **41**, the processing conditions are optimized based on the difference between measurement and/or inspection results before an exposure processing and measurement and/or inspection results after a development processing. In this case, host **600** selects the subitem (selection): focus pre-measurement in the main item: wafer measurement and/or inspection processing (B) and the subitem (selection): pattern line width measurement in the main item: wafer measurement and/or inspection processing (E), and creates processing procedures.

[0285] FIG. **41** shows a flowchart of the analytical processing. As is shown in FIG. **41**, first, in step **951**, the judgment is made of whether or not a result of inspection (B) is normal and a result of inspection (E) is abnormal. When the judgment is denied, the processing is finished. In step **953**, data of processing state of a development processing in C/D **110** of track **200**B is acquired. In the next step, step **955**, based on the data of processing state of the development processing, the development processing is checked.

[0286] In the next step, step **957**, whether or not there is any problem in the development processing is judged, and when the judgment is affirmed, the procedure proceeds to step **959**, and the processing conditions of the development processing are optimized. When the judgment is denied, the procedure proceeds to step **961**, in which data of processing state of a PEB processing is acquired from C/D **110** of track **200**B. In step **963**, the processing state of the PEB processing is checked. In step **965**, whether or not there is any problem in the PEB processing is judged. When the judgment is affirmed, the procedure proceeds to step **967**, in which the processing conditions of PEB are optimized. When the judgment is denied, the procedure proceeds to step **969**, in which control trace data of various control errors such as an exposure dose, synchronous accuracy, focus, a lens and the like is acquired from exposure apparatus **101**.

[0287] In the next step, step **971**, the degree of correlation between data of inspection result of the portion where a line width is abnormal in inspection (E) and the trace data is computed. In step **973**, whether or not the degree of correlation exceeds a threshold is judged. When the judgment is affirmed, the procedure proceeds to step **974**, in which control parameters related to the trace data that has the high degree of correlation are optimized. For this optimization, the CD table group is used. Meanwhile, when the judgment is denied, a liquid immersion state defect during exposure is judged to occur due to bubbles, particles or the like, and the procedure proceeds to step **975**, in which data of liquid immersion monitoring results is acquired from exposure apparatus **101**. In step **977**, the liquid-immersion-related parameters are optimized.

(9) Optimization of Processing Conditions of Liquid, Immersion Exposure (No. 6)

[0288] Next, the case will be described where optimization of processing conditions of liquid immersion exposure (No. 6) is performed. In this case, host **600** selects the subitem (selection): focus pre-measurement in the main item: wafer measurement and/or inspection processing (B) and the subitem (selection): pattern line width measurement in the main item: wafer measurement and/or inspection processing (F), and creates processing procedures.

[0289] FIG. **42** shows a flowchart of a processing of analytical apparatus **170** that performs this optimization. As is shown in FIG. **42**, first, in step **1001**, the judgment is made of whether or not a result of inspection (B) is normal and a result of inspection (F) is abnormal. When the judgment is denied, the processing is finished because the optimization does not have to be performed in particular. Further, in the case the judgment is affirmed, the procedure proceeds to step **1003**, in which data of processing state of etching apparatus **930** is acquired. In step **1005**, the processing state of etching apparatus **930** is checked. In step **1007**, whether or not there is any problem in the etching apparatus is judged. When the judgment is affirmed, the procedure proceeds to step **1009**, in which the etching conditions are optimized so that abnormality of pattern line width is solved. When the judgment is denied, the procedure proceeds to step **1011**. Since the processings from steps **1011** to **1037** are the same as steps **953** to **977** in FIG. **41**, the detailed description will be omitted.

(10) Optimization of Processing Conditions of Liquid Immersion Exposure (No. 7)

[0290] Next, the case will be described where optimization of processing conditions of liquid immersion exposure (No. 7) is performed. In this case, host **600** selects the subitem

(selection): pattern defect inspection in the main item: wafer measurement and/or inspection processing (E) (defect inspection (E)) and the subitem (selection): pattern defect inspection in the main item: wafer measurement and/or inspection processing (F) (defect inspection (F)), and creates processing procedures. As is shown in FIG. **43**, first, in step **1051**, the judgment is made of whether a result of inspection (E) is normal and a result of inspection (F) is abnormal. When the judgment is denied, the processing is finished.

[0291] In step **1053**, data of processing state of an etching processing is acquired. In step **1055**, the processing state of etching apparatus **930** is checked. In step **1057**, whether or not there is any problem in the processing state of etching is judged. When the judgment is denied, deterioration in etching resistance caused by liquid that infiltrates resist is judged to be a factor, and the procedure proceeds to step **1061**, in which liquid immersion data is acquired from exposure apparatus **101**, and then in step **1063**, the liquid immersion-related-parameters are optimized. On the other hand, the etching processing is judged to have a problem and the judgment in step **1057** is affirmed, the procedure proceeds to step **1059**, in which the processing conditions of etching apparatus **940** are optimized.

[0292] Incidentally, the liquid-immersion-related parameters include the processing conditions of the liquid removal processing, as is described earlier.

(11) Optimization of Pattern-Line-Width-Related Processing Conditions

[0293] Next, the case will be described where optimization of pattern-line-width-related processing conditions is performed. In this case, host **600** selects the subitem (selection): wafer film inspection in the main item: wafer measurement and/or inspection processing (A) and the subitem (selection): pattern line width measurement in the main item: wafer measurement and/or inspection processing (E) or wafer measurement and/or inspection processing (F), and creates processing procedures.

[0294] FIG. **44** shows a flowchart of this analytical processing. As is shown in FIG. **44**, first, in step **1101**, the judgment is made of whether or not a result of inspection (A) is normal and a result of inspection (E) or inspection (F) is abnormal. When the judgment is denied, the processing is finished, and when the judgment is affirmed, the procedure proceeds to step **1103**. In step **1103**, the degree of correlation between data of inspection (A) and data of inspection (E) or inspection (F) is computed. In step **1105**, whether or not the degree of correlation exceeds a threshold is judged. When the judgment is denied, the processing is finished, and when the judgment is affirmed, the procedure proceeds to step **1107**.

[0295] In step **1107**, the judgment is made of whether or not film formation/coating conditions are set to be optimized. Only in the case the judgment is affirmed, the film formation/coating conditions are optimized in step **1109**. In step **1111**, whether or not to optimize control parameters is judged. Only in the case the judgment is affirmed, the control trace data of control errors of an exposure dose, synchronous accuracy, focus, a lens and the like is acquired in step **1113**, and the control parameters are optimized in step **1115**.

(12) Optimization of Pattern-Overlay-Accuracy-Related Processing Conditions (No. 1)

[0296] Next, the case will be described where optimization of pattern-overlay-accuracy-related processing conditions (No. 1) is performed. In this case, host **600** selects the subitem (selection): alignment pre-measurement in the main item: wafer measurement and/or inspection processing (B) and the subitem (selection): overlay error measurement in the main item: wafer measurement and/or inspection processing (E) or wafer measurement and/or inspection processing (F), and creates processing procedures.

[0297] FIG. **45** shows a flowchart of this analytical processing. As is shown in FIG. **45**, first, in step **1151**, the judgment is made of whether or not a result of inspection (B) is normal and a result of inspection (E) or inspection (F) is abnormal. When the judgment is denied, the processing is finished, and when the judgment is affirmed, the nonlinear correction parameters used to correct a nonlinear component of shot array out of the alignment-related parameters are optimized.

(13) Optimization of Pattern-Overlay-Accuracy-Related Processing Conditions (No. 2)

[0298] Next, the case will be described where optimization of pattern-overlay-accuracy-related processing conditions (No. 2) is performed. In this case, host **600** selects the subitem (selection): alignment pre-measurement in the main item: wafer measurement and/or inspection processing (B) and the subitem (selection): overlay error measurement in the main item: wafer measurement and/or inspection processing (E) or wafer measurement and/or inspection processing (F), and creates processing procedures.

[0299] FIG. **46** shows a flowchart of this analytical processing. As is shown in FIG. **46**, first, in step **1201**, the judgment is made of whether or not a result of inspection (B) is normal and a result of inspection (E) or inspection (F) is abnormal. When the judgment is denied, the processing is finished, and when the judgment is affirmed, the degree of correlation between inspection (B) and inspection (E) or inspection (F) is computed in step **1203**. In step **1205**, whether or not the degree of correlation exceeds a threshold is judged. When the judgment is denied, the processing is finished, and when the judgment is affirmed, the procedure proceeds to step **1207**, in which the alignment-related parameters are optimized.

[0300] The optimization processings in (1) to (13) described above can be combined as needed. It is effective to combine the processing procedures related to the same system parameters, for example, to combine the optimization related to alignment in (1) and the optimization of overlay error in (13), or the like. However, the optimization in (1) to (13) may be performed in a predetermined order. The procedures can be freely designed in host **600** such as being designed to perform the optimization in (13) after completing the optimization in (1). Since the ultimate purpose of the process is to form a device pattern on wafer W with good accuracy, the processing procedures with which the purpose can be achieved earlier are preferable. For example, the optimization processing that seems to be most effective can preferentially be executed, or the processing of optimizing the processing condition that greatly affects the yield in particular can preferentially be executed.

[0301] Incidentally, in the optimization in (1) to (13), two types of measurement and/or inspection results and the optimization results are to be complied as a database in step **413** of FIG. **27**. The database can be used in the succeeding processes as the knowledge that has been obtained beforehand. For example, when the similar measurement and/or inspection results are obtained, optimization of parameters can be more efficiently performed by searching which opti-

mization of parameter is effective or not effective and optimizing the parameter according to the searching results. In such a database, the effectiveness of optimization of such a parameter may be analyzable for all wafers, or in the case wafers are processed per lot, the effectiveness may be verifiable with respect to each wafer in a lot.

[0302] Further, when referring to such a database, it is also possible that the fluctuation in the processing state of a processing apparatus is sensed beforehand by detecting the tendency and regularity (e.g. periodicity) of two types of measurement and/or inspection results, and the processing contents of the processing apparatus are adjusted in advance so that occurrence of abnormality is anticipated and prevented. Such regularity can be expressed by, for example, a time function. For example, a long-term fluctuation such as focus fluctuation of a projection optical system of an exposure apparatus is expressed in a function that uses the time, the environment (the temperature and humidity) within the plant and the like as variables, referring to the database (trace data in exposure apparatuses **100** and **101**). In the case the function has the regularity, a best focus position that is a target value of focus control can be finely adjusted based on the function, and as a consequence, occurrence of abnormality (such as line width abnormality) in the measurement and/or inspection results can be anticipated and prevented. Besides, the alignment-related parameters can also be adjusted so that highly accurate overlay can be realized, by taking into consideration the regularity of measurement results of overlay error, the regularity of mark waveform data and the like. Further, since abnormality that occurs in the measurement and/or inspection at the latter stage can be predicted to some extent from the regularity of the measurement and/or inspection at the former stage, the measurement and/or inspection at the latter stage can be strictly executed.

SUMMARY

[0303] As is described in detail above, according to the embodiment, two types of measurement and/or inspection result data of measurement and/or inspection processings (e.g. film thickness data and mark waveform data, or appearance inspection data before and after the liquid immersion exposure processing) that are included in a series of processes are collected, the collected two types of measurement and/or inspection result data are compositely combined and analyzed, processing conditions under which processing results to wafer W are favorable are specified by performing optimization based on the analytical results, and the processing conditions (e.g. liquid-immersion-related parameters, control system parameters, and alignment-related parameters of exposure apparatus **100**, **101**) are optimized, and therefore, more efficient optimization of the processing conditions can be performed than the case where the processing conditions are optimized using only one type of measurement and/or inspection results data.

[0304] Further, in the embodiment, in analytical apparatus **170**, the processing whose processing conditions are optimized is decided based on the correlation between two types of measurement and/or inspection result data. In this manner, in the case there is the correlation between two types of measurement and/or inspection results, the processing that is effective for optimizing the processing conditions can be specified from among a plurality of processings. For example, in the case there is the correlation between film thickness data and mark waveform data, the film formation/resist coating processing can be specified as the processing that is effective for optimizing the processing conditions.

[0305] Further, in the embodiment, in analytical apparatus **170**, the processing conditions are optimized based on data related to at least one of the correlation between two types of measurement and/or inspection results and the total of two types of measurement and/or inspection results. Since the processing state of wafer W can be analyzed in detail using the correlation and/or the total of two types of measurement and/or inspection results or the like, more efficient optimization of the processing conditions can be performed than the case where the processing conditions are optimized based on a single measurement and/or inspection result. For example, by analyzing the surface shape of wafer W based on the correlation and/or the total of film thickness data and focus pre-measurement data, efficient optimization of focus-related parameters can be performed.

[0306] Further, according to the embodiment, as two types of measurement and/or inspection results, measurement and/or inspection results in the measurement and/or inspection processing that is performed before and after a specific processing (e.g. exposure processing) out of a plurality of processings are used. Further, in analytical apparatus **170**, the processing conditions are optimized based on whether or not there is the correlation between two types of measurement and/or inspection results (existence/nonexistence of the correlation between film thickness data and mark waveform data), whether or not an individual measurement and/or inspection result is favorable (a result of anterior inspection is normal and a result of posterior inspection is abnormal), and the like. In this manner, by analyzing the correlation or the difference between the measurement and/or inspection results before and after a certain processing, analysis with respect to each processing can be performed when the processings of plural stages including at least a specific processing are analyzed. Further, analysis of the etching processing or the like can be performed based on the change in measurement and/or inspection results (e.g. difference between a pattern line width after the development processing and a pattern line width after the etching processing).

[0307] Further, in the embodiment, in the case abnormality is not detected in an anterior measurement and/or inspection processing that is performed before a specific processing (such as the exposure processing, the PEB processing, the development processing, or the etching processing) and abnormality is detected in a posterior measurement and/or inspection processing after the specific processing, analytical apparatus **170** optimizes processing conditions of a substrate processing that is performed prior to the posterior measurement and/or inspection processing.

[0308] In this case, in the case abnormality is not detected in an anterior measurement and/or inspection processing that is performed before a specific processing and abnormality is detected in a posterior measurement and/or inspections processing after the specific processing, and also there is the correlation between measurement and/or inspection result data of the anterior measurement and/or inspection processing and measurement and/or inspection result data of the posterior measurement and/or inspection processing, analytical apparatus **170** optimizes processing conditions of the anterior measurement and/or inspection processing. This is because in the case there is the correlation between measurement and/or inspection processings before and after a certain processing and abnormality is detected only in the latter mea-

surement and/or inspection processing, it is considered that abnormality can be detected in the former measurement and/or inspection processing.

[0309] Further, according to the embodiment, in the case abnormality is not detected in an anterior measurement and/or inspection processing before a specific processing and abnormality is detected in a posterior measurement and/or inspection processing after the specific processing, analytical apparatus **170** acquires data related to processing state of the processing that has been performed before the posterior measurement and/or inspection processing (e.g. trace data of exposure apparatus **100**, **101**), and optimizes processing conditions based on the acquired data. Thus, based on the processing state of the processing before the posterior measurement and/or inspection processing including the specific processing that has a high possibility of being a cause of abnormality in the posterior measurement and/or inspection processing, whether or not the processing is the cause of abnormality can efficiently be identified.

[0310] Further, according to the embodiment, it is possible to analyze data related to processing state of a specific processing and optimize its processing conditions. That is, by analyzing a factor in the order of proximity to the measurement and/or inspection processing that has the highest possibility of being a factor of abnormality, it becomes possible to identify the factor of abnormality earlier.

[0311] However, it is also possible to further optimize processing conditions of a substrate processing that is performed after the. That is, even if abnormality is detected in the posterior measurement and/or inspection processing and a factor of the abnormality exists in the processing other than the posterior measurement and/or inspection processing, in the case the abnormality can be covered by the subsequent processing to some extent, processing conditions of the subsequent processing that is performed after the posterior measurement and/or inspection processing may be optimized so as to cover the abnormality. For example, in the case the entire line width of a device pattern is thin because of an exposure dose or focus in exposure apparatus **100** or **101**, processing conditions of the development processing or the etching processing can be optimized so that the line width of a device pattern (e.g. a pattern that is formed by a positive resist portion that remains after development) by a formed resist image or etching image (image formed after etching) becomes thick, for example, the processing time can be shortened.

[0312] Further, according to the embodiment, while a series of processes are performed to a plurality of wafers W, a relation between two types of measurement and/or inspection result data and information on optimization results of processing conditions is registered in a database. By referring to the database, the processing conditions that have the high, correlativity with two types of measurement and/or inspection results can be grasped in advance. Analytical apparatus **170** can preferentially optimize the processing conditions having the high correlativity based on the database.

[0313] Further, according to the embodiment, while a series of processes are performed to a plurality of wafers, the regularity of data related to measurement and/or inspection results is extracted. Then, when optimizing processing conditions, the extracted regularity is taken into consideration. Thus, optimization of the processing conditions can be performed.

[0314] In the embodiment, the optimization processing of several specific processing conditions has been described.

[0315] For example, in the embodiment, in the case there is the correlation between film thickness data of films that are formed on wafer W by the film formation/resist coating processing and waveform data of the wafer marks on wafer W, at least one of a measurement condition of the wafer marks in the alignment pre-measurement and a film formation/coating condition can be optimized so that the measurement results of the wafer marks on wafer W are not affected by the thickness of films.

[0316] Further, in the embodiment, in the case there is the correlation between film thickness data of films on wafer W and surface shape data of the exposed surface of wafer W, a film formation/coating condition or focus-related parameters (e.g. a selection state of a focus sensor) can be optimized.

[0317] Further, in the embodiment, in the case a foreign substance is not detected in appearance inspection (B) on wafer W before the exposure processing and a foreign substance is detected in appearance inspection (C) on wafer W after the exposure processing, and also there is the correlation between these inspection data, an inspection condition of foreign substances on wafer W before the exposure processing can be optimized.

[0318] Further, in the embodiment, in the case a result of appearance inspection of films formed on wafer W by the film formation processing is normal and a result of appearance inspection of the films on wafer W after the exposure processing is abnormal, it is possible to acquire trace data of control error of the exposure processing and optimize a processing condition of at least one of the exposure processing and the liquid removable processing based on the acquired trace data.

[0319] Further, in the case a result of appearance inspection of wafer W before the PEB processing is normal and a result of appearance inspection of wafer W after the PEB processing is abnormal, data of processing state of the PEB processing is acquired. Then, based on the acquired data of processing state, the PEB processing is checked. In the case the judgment is made as a result of this check that a factor of abnormality in appearance inspection of wafer W is not the PEB processing, at least one of a processing condition of the foreign substance inspection processing of wafer W before the PEB processing, a processing condition of the exposure processing and a processing condition of the liquid removal processing can be optimized.

[0320] Further, in the embodiment, in the case a result of appearance inspection before the PEB processing is normal and a result of pattern defect inspection after the development processing is abnormal, data of processing state of the development processing and the postbake processing is acquired. Then, in the case the judgment is made that neither the development processing nor the postbake processing is a factor of abnormality in the appearance inspection result based on the acquired data, at least one of a processing condition of the foreign substance inspection processing of the wafer before and after postbake processing, a processing condition of the exposure processing and a processing condition of the liquid removal processing can be optimized.

[0321] Further, in the embodiment, in the case shot flatness of the exposed surface of wafer W before the exposure processing is normal and a measurement result of a pattern line width of wafer W after the development processing or the etching processing is abnormal, data of processing state of at least one of the development processing, the postbake processing and the exposure processing is acquired and ana-

lyzed, and in the case the judgment is made that none of the etching processing, the postbake processing and the exposure processing is a factor of abnormality of the pattern line width, at least one of a processing condition of the exposure processing and a processing condition of the liquid removal processing can be optimized.

[0322] Further, in the embodiment, in the case a measurement result of a pattern line width on wafer W after the development processing is normal and a measurement result of a pattern line width on wafer W after the etching processing is abnormal, a processing state of the etching processing is analyzed, and in the case the judgment is made that the etching processing is not a factor of abnormality of a pattern line width, at least one of a processing condition of the exposure processing and a processing condition of the liquid removal processing can be optimized.

[0323] Further, in the embodiment, based on the correlativity between a change in inspection result of films on wafer W and a measurement result of variation in a pattern line width after the development processing or the etching processing, at least one of a film formation/coating condition and a processing condition of the exposure processing can be optimized.

[0324] Further, in the embodiment, in the case a result of alignment pre-measurement before the exposure processing is normal and a measurement result of overlay error of a pattern on wafer W after the development processing or the etching processing is abnormal, a processing condition of wafer alignment is optimized, and alignment-related parameters can be optimized based on the correlativity between an alignment pre-measurement result used for alignment of wafer W before the exposure processing and overlay error data of a pattern on wafer W after the development processing or the etching processing.

[0325] Host **600** can execute these optimization processing procedures in combination. In this case, host **600** can judge whether to perform liquid immersion exposure or dry exposure, and based on the judgment result, change the processing procedures.

[0326] Further, in the embodiment, since a processing content of at least part of a plurality of processings is adjusted in accordance with data related to whether the exposure processing is performed by liquid immersion exposure or dry exposure, relevant processing conditions can be appropriately adjusted in accordance with the exposure that has been performed to a wafer, and the adjustment results can be notified to a relevant processing apparatus.

[0327] In this case, in the adjustment process, at least one of an inspection item, inspection sensitivity and an inspection condition of the inspection processing can be switched depending on liquid immersion exposure or dry exposure. For example, in the case the exposure processing is performed by liquid immersion exposure, at least one of a defect inspection to a pattern defect peculiar to liquid immersion exposure, an abnormal inspection of abnormality of wafer W due to liquid used in liquid immersion exposure, and a remaining liquid inspection of liquid that adheres on wafer W after liquid immersion exposure is added as an inspection item of the inspection processing.

[0328] Further, in the embodiment, the pattern defect peculiar to liquid immersion exposure includes a pattern defect due to a stain adhering to an optical element of the projection optical system that comes into contact with liquid, bubbles or a foreign substance in liquid, and the appearance inspection of wafer W includes an inspection related to a watermark, a stain due to elution of material such as a resist film formed on wafer W into liquid, and peeling of a resist film or the like on wafer W, and the remaining liquid inspection includes a foreign substance inspection in the remaining liquid on wafer W.

[0329] Further, in the case the exposure processing is performed by liquid immersion exposure, the inspection sensitivity of the inspection processing is set slightly higher than that of dry exposure.

[0330] The inspection conditions of the inspection processing include at least one of the wavelength of illumination light that illuminates wafer W during the inspection, a detection method, a detection optical system, and a detection algorithm. For example, in the case the exposure processing is performed by liquid immersion exposure, shortening of the wavelength of illumination light, selection of a bright field out of bright and dark fields, selection of an electron beam detection method out of an optical detection method and the electron beam detection method, selection of a confocal system, and selection of an image comparison algorithm or a feature extraction algorithm out of the image comparison algorithm, a design data comparison algorithm and the feature extraction algorithm as a detection method are performed.

[0331] Further, in the embodiment, analytical apparatus **170** computes the correlativity between data of monitoring results of a liquid immersion portion during liquid immersion exposure and data of inspection results of the inspection processing. Then, based on the computed correlativity, at least one of an exposure condition in the exposure processing and an inspection condition in the inspection processing is optimized.

[0332] Measurement and/or inspection instrument **120** increases the inspection frequency of the appearance inspection of the outer circumference of wafer W. This is because there is the high probability that abnormality occurs in the outer circumference of wafer W in liquid immersion exposure. Meanwhile, by reducing the inspection frequency accordingly for a portion where there is the low probability that abnormality occurs, the decrease in throughput can be prevented.

[0333] Further, in the embodiment, analytical apparatus **170** further computes the correlativity between a period of time when each point on wafer W is immersed in liquid (liquid immersion time) and data of inspection results of the inspection processing. Then, based on the correlativity, at least one of an exposure route on wafer W, a film formation condition to wafer W and a liquid removal condition on wafer W after liquid immersion exposure is adjusted.

[0334] Further, according to the embodiment, in the case the exposure processing is performed by liquid immersion exposure, an inspection processing of a topcoat film that protects a resist film coated o wafer W from liquid is added to the inspection contents.

[0335] Further, in the embodiment, data of inspection results of the inspection processing and the like is registered in a database, and based on the database, information on occurrence frequency of abnormality at each point in wafer W is computed. Then, measurement and/or inspection instrument **120** increases or decreases the inspection frequency at each point in wafer W based on the information on occurrence frequency of abnormality.

[0336] Incidentally, the process window may be changed between liquid immersion exposure and dry exposure. Since the depth of focus is different between dry exposure apparatus **100** and liquid immersion exposure apparatus **101**, even in the

case the same device pattern is transferred, the range of settable exposure dose and focus is different, and therefore, the process window is preferably controlled separately.

[0337] Incidentally, analytical apparatus **170** does not have to be independent, and may also be equipped in host **600**, exposure apparatuses **100** and **101**, track **200**, measurement and/or inspection instrument **120**, and each apparatus (**910**, **920**, **930** or **940**) of device manufacturing apparatus group **910**. By the analytical apparatus being equipped in the apparatuses described above, the exposure apparatus, the track, the measurement and/or inspection instrument, and the device manufacturing apparatus can have the ability to optimize the processing conditions by itself.

[0338] Incidentally, in the embodiment above, although the case of a transmissive type reticle R has been described, reticle R is not limited to the transmissive type but may be a reflective type.

[0339] The unit that monitors a liquid immersion state is not limited to the one described above. Any unit can be employed as far as the unit can observe a liquid immersion state of a liquid immersion area corresponding to exposure area IA.

[0340] Further, in the embodiment above, the case has been described where light source for illumination **15** is installed in the area adjacent to the liquid immersion area for illuminating the liquid immersion area. However, the present invention is not limited to this, and instead of light source for illumination **15**, for example, a light-emitting device may also be arranged on base material **261**, or when a line sensor that has the sensitivity to exposure light EL is used as a line sensor of liquid immersion monitor **260**, the liquid immersion area may also be illuminated using exposure light EL.

[0341] Further, in the embodiment above, measurement and/or inspection instrument **120** is placed inline outside the track within exposure cell **700**, but measurement and/or inspection instrument **120** may be placed inline within track **200**, or placed offline outside exposure cell **700**.

[0342] Further, in the embodiment above, measurement and/or inspection instruments that perform the measurement and/or inspection processings performed at the respective stages, that is, a measurement and/or inspection instrument that performs a appearance inspection of wafer W that has been exposed by liquid immersion exposure, a measurement and/or inspection instrument that performs an appearance inspection of wafer W to which the PEB processing has been performed, a measurement and/or inspection instrument that performs a pattern inspection of wafer W to which the development processing has been performed, and the like may also be different measurement and/or inspection instruments respectively.

[0343] Further, in the embodiment above, removal unit T may also perform the processing not only to wafer W after the exposure processing but also to wafer W before the exposure processing. That is, removal unit T may also be used for removing foreign substances such as particles adhering to wafer W before exposure processing.

[0344] Further, in the embodiment above, the case has been described where an object that is subject to exposure in exposure apparatus **100** or exposure apparatus main section S is a semiconductor wafer for manufacturing a semiconductor. However, the present invention is not limited to this, and for example, the object may be a glass substrate for a display device, a ceramic wafer for a thin film magnetic head, an original plate (synthetic silica glass, silicon wafer) of a mask or a reticle used in an exposure apparatus, or the like. In other words, exposure apparatus **100** or exposure apparatus mains section S is not limited to an exposure apparatus for manufacturing semiconductor devices, but may be exposure apparatuses such as an exposure apparatus for manufacturing liquid crystal display devices, an exposure apparatus for manufacturing displays, an exposure apparatus for manufacturing thin film magnetic heads, an exposure apparatus for manufacturing imaging devices, or an exposure apparatus for manufacturing reticles or masks.

[0345] Moreover, the shape of an object that is subject to exposure in exposure apparatus **100** or exposure apparatus main section S is not limited to a circular shape, but may be, for example, a rectangular shape. In this case, base material **261** of liquid immersion monitor **260** that has also a rectangular shape is used.

[0346] Further, in the embodiment above, exposure apparatus **100** or exposure apparatus main section S may be a scanning exposure apparatus (so-called scanning stepper) that exposes a pattern that is formed on reticle R on wafer W while synchronously moving reticle R and wafer W in a scanning direction, or a projection exposure apparatus by a step-and-repeat method that exposes a pattern formed on reticle R in one time in a state where reticle R and wafer W are made static and sequentially performs step movement of wafer W. Moreover, exposure apparatus **100** or exposure apparatus main section S may be an exposure apparatus by a step-and-stitch method.

[0347] Further, exposure apparatus **100** or exposure apparatus main section S may be a twin-stage-type exposure apparatus that is equipped with a plurality of wafer stages (e.g. refer to Kokai (Japanese Unexamined Patent Application Publication) Nos. 10-163099 and 10-214783 (the corresponding U.S. Pat. No. 6,590,634), and Kohyo (published Japanese translation of International Publication for Patent Application) No. 2000-505958 (the corresponding U.S. Pat. No. 5,969,441)). Besides, various processing apparatuses can have a tandem configuration that is equipped with two processing sections so as to null the dead time.

[0348] Incidentally, in exposure apparatus **100** or exposure apparatus main section S in the embodiment above, a light-transmissive type mask (reticle), which is a light-transmissive substrate on which a predetermined light-shielding pattern (or a phase pattern or a light attenuation pattern) is formed, is used. Instead of this mask, however, as is disclosed in, for example, U.S. Pat. No. 6,778,257, an electron mask (which is also called a variable shaped mask, and includes, for example, a DMD (Digital Micromirror Device) that is a type of a non-emission type image display device (which is also called a spatial light modulator) or the like) on which a light-transmitting pattern, a reflection pattern, or an light-emitting pattern is formed according to electronic data of the pattern that is to be exposed may also be used. Further, the exposure apparatus may also be an exposure apparatus that forms a device pattern on wafer W by forming the interference fringe on wafer W, as is disclosed in the pamphlet of International Publication No. 2001/035168.

[0349] Further, exposure apparatus main section S may be a liquid immersion exposure apparatus that performs exposure in a state where the entire surface of wafer W is immersed in liquid (e.g. refer to Kokai (Japanese Unexamined Patent Application Publication) Nos. 06-124873 and 10-303114, and the U.S. Pat. No. 5,825,043).

[0350] Incidentally, the above disclosures of the various publications (including the pamphlets of the International Publications) and the U.S. patent descriptions related to exposure apparatuses and the like that are cited in the embodiment and modified examples described above are each incorporated herein by reference.

[0351] Further, in the embodiment above, the local liquid immersion type exposure apparatus is exemplified, but part of the substrate processing method and the substrate processing system, for example, the substrate processing method and the substrate processing system that optimize the inspection conditions based on at least one of a film formation status of films that are formed by the film forming apparatus and a film formation condition of the film forming apparatus can also be applied to a non-liquid-immersion type exposure apparatus. Accordingly, the type of exposure apparatus is not limited to a liquid immersion type.

[0352] Further, in the embodiment above, the programs related to the present invention are each recorded in a flash memory, but may be recorded in another information recoding medium (such as CD, magnet-optical disk, DVD, memory card, USB memory, or diskette). Further, the programs related to the present invention may also be transferred to each flash memory via a network (such as LAN, intranet or internet).

[0353] While the above-described embodiment of the present invention is the presently preferred embodiment thereof, those skilled in the art of lithography systems will readily recognize that numerous additions, modifications, and substitutions may be made to the above-described embodiment without departing from the spirit and scope thereof. It is intended that all such modifications, additions, and substitutions fall within the scope of the present invention, which is best defined by the claims appended below.

What is claimed is:

1. A substrate processing method in which a plurality of substrate processings that include an exposure processing of forming a pattern on a substrate by exposing the substrate and an inspection processing of inspecting the substrate afterward are performed, the method comprising:

an acquisition process of acquiring information as to whether the exposure processing is performed by liquid immersion exposure or dry exposure; and

an adjustment process of adjusting a processing content of at least part of the plurality of substrate processings in accordance with the acquired information; and

a transmission process of transmitting the adjustment result to an apparatus that performs a relevant processing.

2. The substrate processing method according to claim **1**, wherein

in the adjustment process, at least one of an inspection item, inspection sensitivity and an inspection condition of the inspection processing is switched depending on liquid immersion exposure or dry exposure.

3. The substrate processing method according to claim **2**, wherein

in the case the exposure processing is performed by liquid immersion exposure, at least one of a defect inspection with respect to a pattern defect peculiar to liquid immersion exposure, an abnormality inspection of abnormality of the substrate due to liquid used for liquid immersion exposure, and a remaining liquid inspection of liquid that adheres on the substrate after liquid immersion exposure is added as an inspection item of the inspection processing.

4. The substrate processing method according to claim **3**, wherein

the pattern defect peculiar to liquid immersion exposure includes a stain adhering to an optical element of a projection optical system that comes into contact with the liquid, or a pattern defect due to a bubble or a foreign substance in the liquid,

the abnormality inspection of abnormality of the substrate due to the liquid includes an inspection related to a watermark, a stain due to infiltrating of a material of a film formed on the substrate into the liquid and peeling of a film on the substrate, and

the remaining liquid inspection includes a foreign substance inspection of a foreign substance in remaining liquid on the substrate.

5. The substrate processing method according to claim **2**, wherein

in the case the exposure processing is performed by liquid immersion exposure, the inspection sensitivity of the inspection processing is set slightly higher than that of dry exposure.

6. The substrate processing method according to claim **2**, wherein

an inspection condition of the inspection processing includes at least one of a wavelength of illumination light that illuminates the substrate during the inspection, a detection method, a detection optical system and a detection algorithm.

7. The substrate processing method according to claim **6**, wherein

in the case the exposure processing is performed by liquid immersion exposure, an inspection condition of the inspection processing includes at least one of shortening of a wavelength of the illumination light, selection of a bright field out of bright and dark fields, selection of an electron beam detection method out of an optical detection method and the electron beam detection method, selection of a confocal system, and selection of an image comparison algorithm out of the image comparison algorithm, a design data comparison algorithm and a feature extraction algorithm as a detection algorithm.

8. The substrate processing method according to claim **1**, wherein

the adjustment process includes

a computation process of computing correlativity between information on a monitoring result of a liquid immersion portion during the liquid immersion exposure and information on an inspection result of the inspection processing; and

an optimization process of optimizing at least one of an exposure condition in the exposure processing and an inspection condition in the inspection processing, based on the computed correlativity.

9. The substrate processing method according to claim **8**, wherein

in the optimization process, at least one of inspection frequency and inspection sensitivity of a portion having the high correlativity on the substrate is increased.

10. The substrate processing method according to claim **8**, wherein

in the computation process, correlativity between information on a period of time when each point on the substrate is immersed in liquid and information on an inspection result of the inspection processing is further computed, and

in the optimization process, at least one of an exposure route on the substrate, a film formation condition to the substrate, a liquid removal condition on the substrate after liquid immersion exposure is adjusted based on the correlativity.

11. The substrate processing method according to claim **1**, wherein

in the adjustment process, information on a permissible range of a correction amount used to correct an exposure dose and focus that are set is switched.

12. The substrate processing method according to claim **1**, wherein

in the adjustment process, in the case the exposure processing is performed by the liquid immersion exposure, an inspection processing of a topcoat film that protects a resist film coated on the substrate from liquid is added to an inspection content.

13. The substrate processing method according to claim **1**, further comprising:

a storage process of storing information on a inspection result of the inspection processing, and

a computation process of computing information on occurrence frequency of abnormality at each point within the substrate based on the stored information, wherein

in the adjustment process, inspection frequency at each point within the substrate is increased or decreased based on the computed information on occurrence frequency.

14. A substrate processing apparatus that performs a substrate processing according to transmitted information using the substrate processing method according to claim **1**.

15. An exposure apparatus that performs exposure to a substrate according to transmitted information using the substrate processing method according to claim **1**.

16. A measurement and/or inspection apparatus that performs measurement and/or inspection of a substrate according to transmitted information using the substrate processing method according to claim **1**.

17. A program that makes a computer execute a plurality of substrate processings that include an exposure processing of forming a pattern on a substrate by exposing the substrate and an inspection processing of inspecting the substrate afterward, the program making the computer execute:

an acquisition procedure of acquiring information as to whether the exposure processing is performed by liquid immersion exposure or dry exposure;

an adjustment procedure of adjusting of a processing content of at least part of the plurality of substrate processings in accordance with the acquired information; and

a transmission procedure of transmitting the adjustment result to an apparatus that performs a relevant processing.

18. The program according to claim **17**, wherein

in the adjustment procedure, at least one of an inspection item, inspection sensitivity, an inspection condition of the inspection processing is switched depending on liquid immersion exposure or dry exposure.

19. The program according to claim **18**, wherein

in the case the exposure processing is performed by liquid immersion exposure, the inspection sensitivity of the inspection processing is set slightly higher than that of dry exposure.

20. The program according to claim **18**, wherein

the inspection condition of the inspection processing includes at least one of a wavelength of illumination light that illuminates the substrate during the inspection, a detection method, a detection optical system, and a detection algorithm.

21. The program according to claim **20**, wherein

in the case the exposure processing is performed by liquid immersion exposure, an inspection condition of the inspection processing includes at least one of shortening of a wavelength of the illumination light, selection of a bright field out of bright and dark fields, selection of an electron beam detection method out of an optical detection method and the electron beam detection method, selection of a confocal system, and selection of an image comparison algorithm out of the image comparison algorithm, a design data comparison algorithm and a feature extraction algorithm as a detection algorithm.

22. The program according to claim **17**, wherein

in the case the exposure processing is performed by liquid immersion exposure, at least one of a defect inspection with respect to a pattern defect peculiar to liquid immersion exposure, an abnormality inspection of abnormality of the substrate due to liquid used in liquid immersion exposure and a remaining liquid inspection of remaining liquid that adheres on the substrate after liquid immersion exposure is added as an inspection item of the inspection processing.

23. The program according to claim **22**, wherein

the pattern defect peculiar to liquid immersion exposure includes a stain adhering to an optical element of a projection optical system that comes into contact with the liquid, or a pattern defect due to a bubble or a foreign substance in the liquid,

the abnormality inspection of abnormality of the substrate due to the liquid includes an inspection related to a watermark, a stain due to infiltrating of a material of a film formed on the substrate into the liquid and peeling of a film on the substrate, and

the remaining liquid inspection includes a foreign substance inspection of a foreign substance in remaining liquid on the substrate.

24. The program according to claim **17**, wherein

the adjustment procedure includes

a computation procedure of computing correlativity between information on a monitoring result of a liquid immersion portion during the liquid immersion exposure and information on an inspection result of the inspection processing; and

an optimization procedure of optimizing at least one of an exposure condition in the exposure processing and an inspection condition in the inspection processing based on the computed correlativity.

25. The program according to claim **24**, wherein

in the optimization procedure, at least one of inspection frequency and inspection sensitivity of a portion having the high correlation on the substrate is increased.

26. The program according to claim **24**, wherein

in the computation procedure, correlativity between information on a period of time when each point on the substrate is immersed in liquid and information on an inspection result of the inspection processing is further computed, and

in the optimization procedure, at least one of an exposure route on the substrate, a film formation condition to the substrate, a liquid removal condition on the substrate after liquid immersion exposure is adjusted.

27. The program according to claim **17**, wherein

in the adjustment procedure, information on a permissible range of a correction amount used to correct an exposure dose and focus that are set is switched.

28. The program according to claim **17**, wherein

in the adjustment procedure, in the case the exposure processing is performed by the liquid immersion exposure, an inspection processing of a topcoat film that protects a resist film coated on the substrate from liquid is added to an inspection content.

29. The program according to claim **17**, further making the computer execute:

a storage procedure of storing information on a inspection result of the inspection processing, and

a computation procedure of computing information on occurrence frequency of abnormality at each point within the substrate based on the stored information, wherein

in the adjustment procedure, inspection frequency at each point within the substrate is increased or decreased based on the computed information on occurrence frequency.

30. A computer-readable information recording medium in which the program according to claim **17** is recorded.

31. A program that makes a computer system execute a processing process of a specific processing in which the specific processing that is unnecessary for a substrate that is subject to a dry exposure processing of irradiating exposure light on the substrate without liquid is executed to a substrate that is subject to a liquid immersion exposure processing of exposing the substrate with exposure light via liquid, the program making the computer system execute:

a procedure of changing whether or not to execute the specific processing in the processing process to a substrate based on information that shows whether the substrate is subject to the liquid immersion exposure processing or the dry exposure processing.

32. The program according to claim **31**, wherein

the specific processing is an inspection processing of a substrate subject to the liquid immersion exposure processing or a measurement processing related to a substrate subject to the liquid immersion exposure processing.

33. The program according to claim **32**, wherein

the inspection processing includes an inspection of a water repellent film that is formed on the substrate.

34. The program according to claim **32**, wherein

the inspection processing includes an inspection in which liquid that remains on the substrate is detected after a processing of removing liquid on the substrate.

35. The program according to claim **31**, wherein

the specific processing includes a film formation processing of forming a water repellent film on a substrate subject to the liquid immersion exposure processing.

36. A computer-readable information recording medium in which a program that makes a computer system execute a processing process of a specific processing in which the specific processing that is unnecessary for a substrate that is subject to a dry exposure processing of irradiating exposure light to the substrate without liquid is executed to a substrate that is subject to a liquid immersion exposure processing of exposing the substrate with exposure light via liquid is recorded, wherein

the program is a program that makes the computer system execute a procedure of changing whether or not to execute the specific processing in the processing process to a substrate based on information that shows whether the substrate is subject to the liquid immersion exposure processing or the dry exposure processing.

37. The information recording medium according to claim **36**, wherein

the specific processing is an inspection processing of a substrate subject to the liquid immersion exposure processing or a measurement processing related to a substrate subject to the liquid immersion exposure processing.

38. The information recording medium according to claim **37**, wherein

the inspection processing includes an inspection of a water repellent film that is formed on the substrate.

39. The information recording medium according to claim **37**, wherein

the inspection processing includes an inspection in which liquid that remains on the substrate is detected after a processing of removing liquid on the substrate.

40. The information recording medium according to claim **36**, wherein

the specific processing includes a film formation processing of forming a water repellent film on a substrate subject to the liquid immersion exposure processing.

41. A measurement and/or inspection system that implements at least one of a measurement processing and an inspection processing to a substrate that is subject to one of a liquid immersion exposure processing of exposing the substrate with exposure light via liquid and a dry exposure processing of irradiating exposure light on the substrate without liquid, the system comprising:

a specific measurement and/or inspection section that executes a specific measurement and/or inspection processing that is unnecessary for a substrate that is subject to the dry exposure processing to a substrate that is subject to the liquid immersion exposure processing, wherein

whether or not the specific measurement and/or inspection section executes the specific measurement and/or inspection processing is changed, in accordance with information that shows whether a substrate is subject to the liquid immersion exposure processing or the dry exposure processing.

42. The measurement and/or inspection system according to claim **41**, wherein

the measurement and/or inspection processing includes an inspection of a water repellent film that is formed on the substrate.

43. The measurement and/or inspection system according to claim **41**, wherein

the measurement and/or inspection processing includes an inspection in which liquid that remains on the substrate is detected after a processing of removing liquid on the substrate.

44. A processing apparatus that executes a specific processing that is unnecessary for a substrate that is subject to a dry exposure processing of irradiating exposure light to the substrate without liquid to a substrate that is subject to a liquid immersion exposure processing of exposing the substrate with exposure light via liquid, wherein

whether or not to execute the specific processing to a substrate is changed in accordance with information that shows whether the substrate is subject to the liquid immersion exposure processing or the dry exposure processing.

45. The processing apparatus according to claim **44**, wherein

the specific processing is an inspection processing of a substrate subject to the liquid immersion exposure processing or a measurement processing related to a substrate subject to the liquid immersion exposure processing.

46. The processing apparatus according to claim **45**, wherein

the inspection processing includes an inspection of a water repellent film that is formed on the substrate.

47. The processing apparatus according to claim **45**, wherein

the inspection processing includes an inspection in which liquid that remains on the substrate is detected after a processing of removing liquid on the substrate.

48. The processing apparatus according to claim **44**, wherein

the specific processing includes a film formation processing of forming a water repellent film on a substrate subject to the liquid immersion exposure processing.

49. A computer system that controls a processing process of a specific processing in which the specific processing that is unnecessary for a substrate that is subject to a dry exposure processing of irradiating exposure light to the substrate without liquid is executed to a substrate that is subject to a liquid immersion exposure processing of exposing the substrate with exposure light via liquid, wherein

whether or not to execute the specific processing in the processing process to a substrate is changed in accordance with information that shows whether the substrate is subject to the liquid immersion exposure processing or the dry exposure processing.

50. The computer system according to claim **49**, wherein

the specific processing is an inspection processing of a substrate subject to the liquid immersion exposure processing or a measurement processing related to a substrate subject to the liquid immersion exposure processing.

51. The computer system according to claim **50**, wherein

the inspection processing includes an inspection of a water repellent film that is formed on the substrate.

52. The computer system according to claim **50**, wherein

the inspection processing includes an inspection in which liquid that remains on the substrate is detected after a processing of removing liquid on the substrate.

53. The computer system according to claim **49**, wherein the specific processing includes a film formation processing of forming a water repellent film on a substrate subject to the liquid immersion exposure processing.

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