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(54) **COLOR IDENTIFYING DEVICE FOR IDENTIFYING COLORS OF REACTION SURFACES PRODUCED BY CHEMICAL REACTION AND GAS IDENTIFYING DEVICE**

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(57) **ABSTRACT**

A color identifying device includes a mount block, a color detector, a lens and a color identifier. A reactive board having a plurality of surfaces to be measured in respective predetermined positions is mounted in the mount block. The color detector has a plurality of color measuring areas corresponding respectively to the reaction surfaces of the reactive board mounted in the mount block. The lens forms images of the surfaces of the reactive board mounted in the mount block on the respective color measuring areas. The color identifier identifies the colors of the surfaces based on output signals from the corresponding color measuring areas.

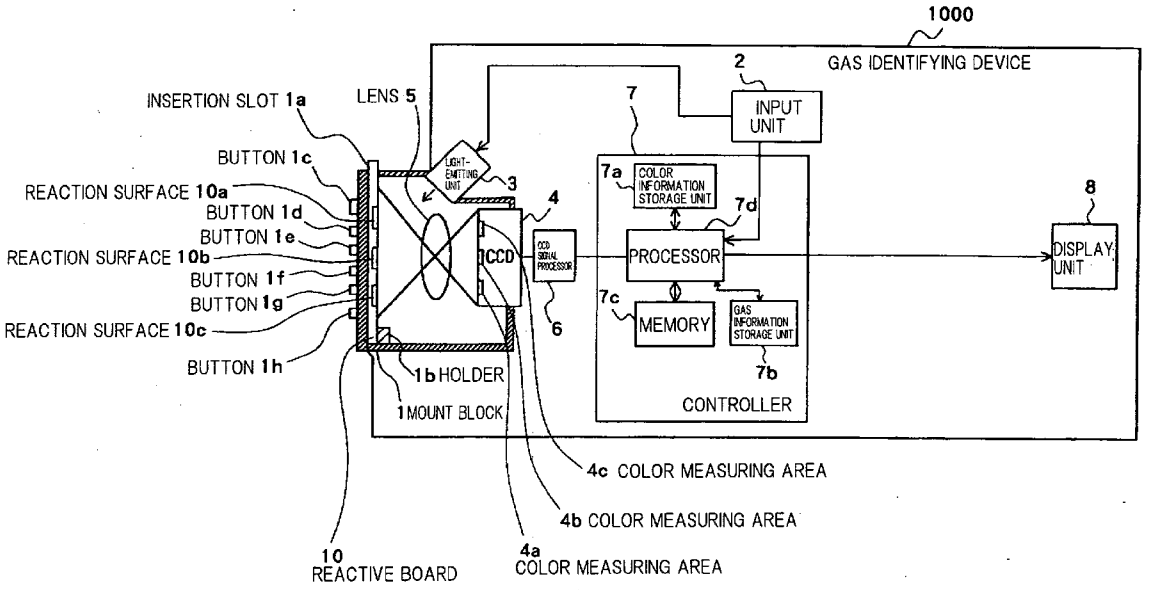


Fig. 1

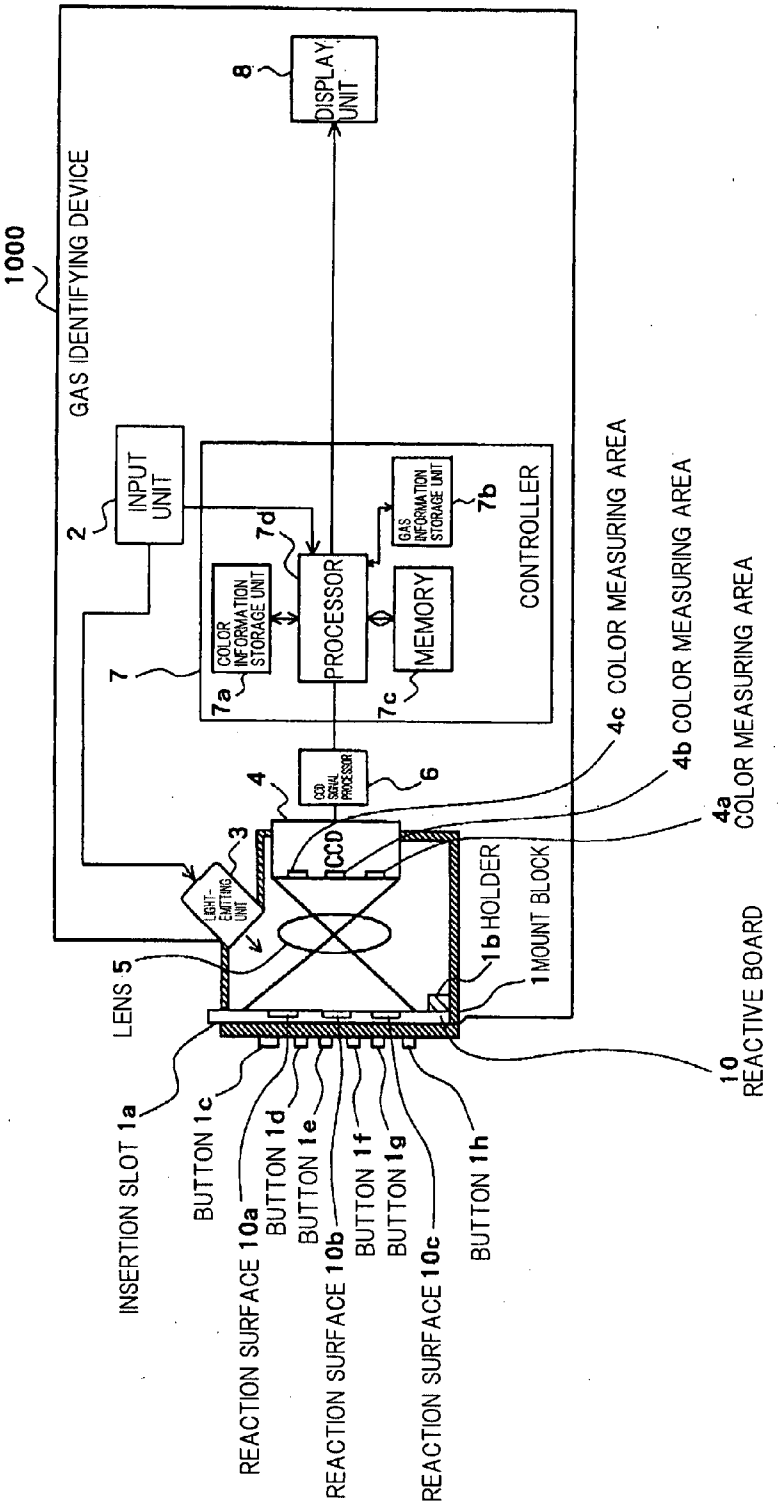

1000
GAS IDENTIFYING DEVICE
8
DISPLAY UNIT
2
INPUT UNIT
7
CONTROLLER
7d
PROCESSOR
7a
COLOR INFORMATION STORAGE UNIT
7c
MEMORY
7b
GAS INFORMATION STORAGE UNIT
4
CCD SIGNAL PROCESSOR
6
3
CCD
LIGHT-EMITTING UNIT
4c COLOR MEASURING AREA
4b COLOR MEASURING AREA
4a COLOR MEASURING AREA
LENS 5
1b HOLDER
1 MOUNT BLOCK
10 REACTIVE BOARD
INSERTION SLOT 1a
BUTTON 1c
BUTTON 1d
BUTTON 1e
BUTTON 1f
BUTTON 1g
BUTTON 1h
REACTION SURFACE 10a
REACTION SURFACE 10b
REACTION SURFACE 10c

Fig. 2

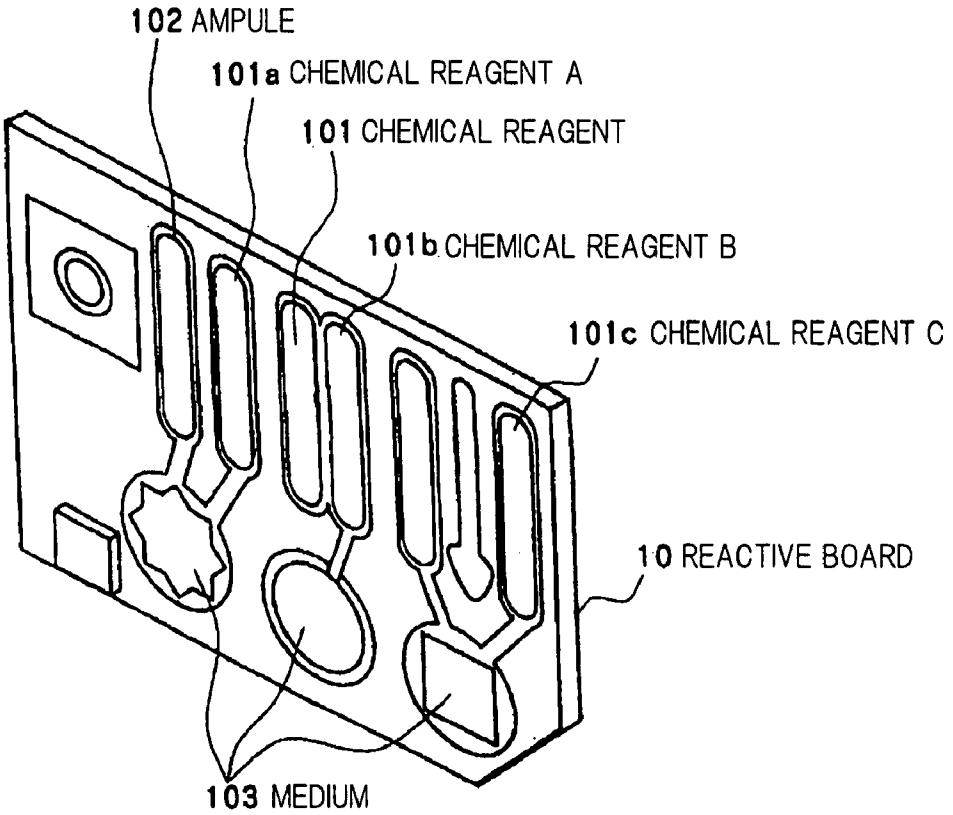

102 AMPULE
101a CHEMICAL REAGENT A
101 CHEMICAL REAGENT
101b CHEMICAL REAGENT B
101c CHEMICAL REAGENT C
10 REACTIVE BOARD
103 MEDIUM

Fig. 3

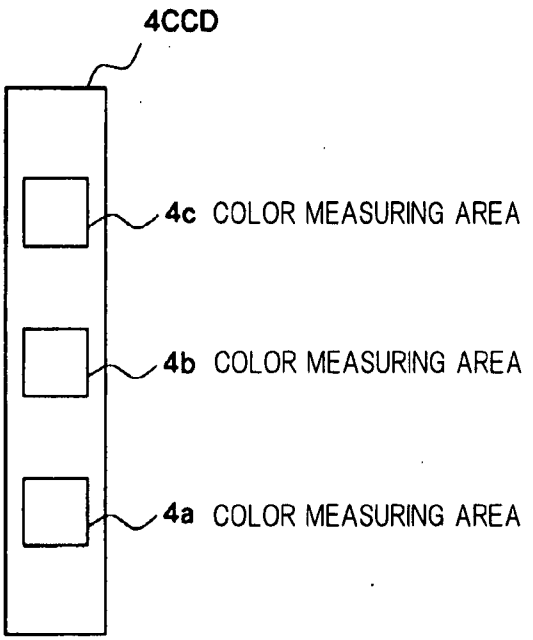

4CCD
4c COLOR MEASURING AREA
4b COLOR MEASURING AREA
4a COLOR MEASURING AREA

Fig. 4

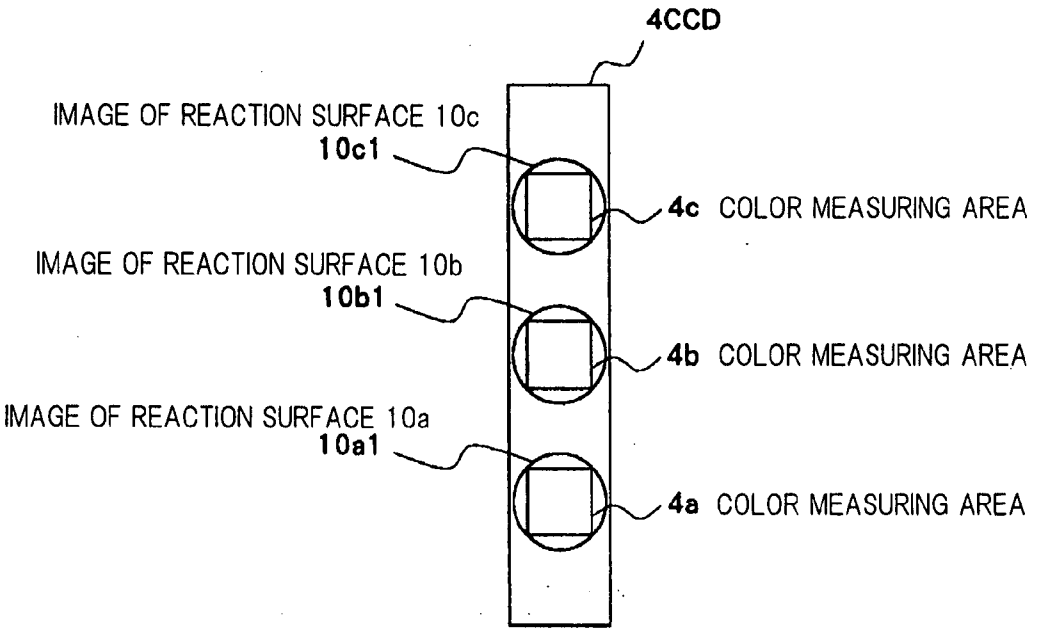

4CCD
IMAGE OF REACTION SURFACE 10c
10c1
4c COLOR MEASURING AREA
IMAGE OF REACTION SURFACE 10b
10b1
4b COLOR MEASURING AREA
IMAGE OF REACTION SURFACE 10a
10a1
4a COLOR MEASURING AREA

Fig. 5

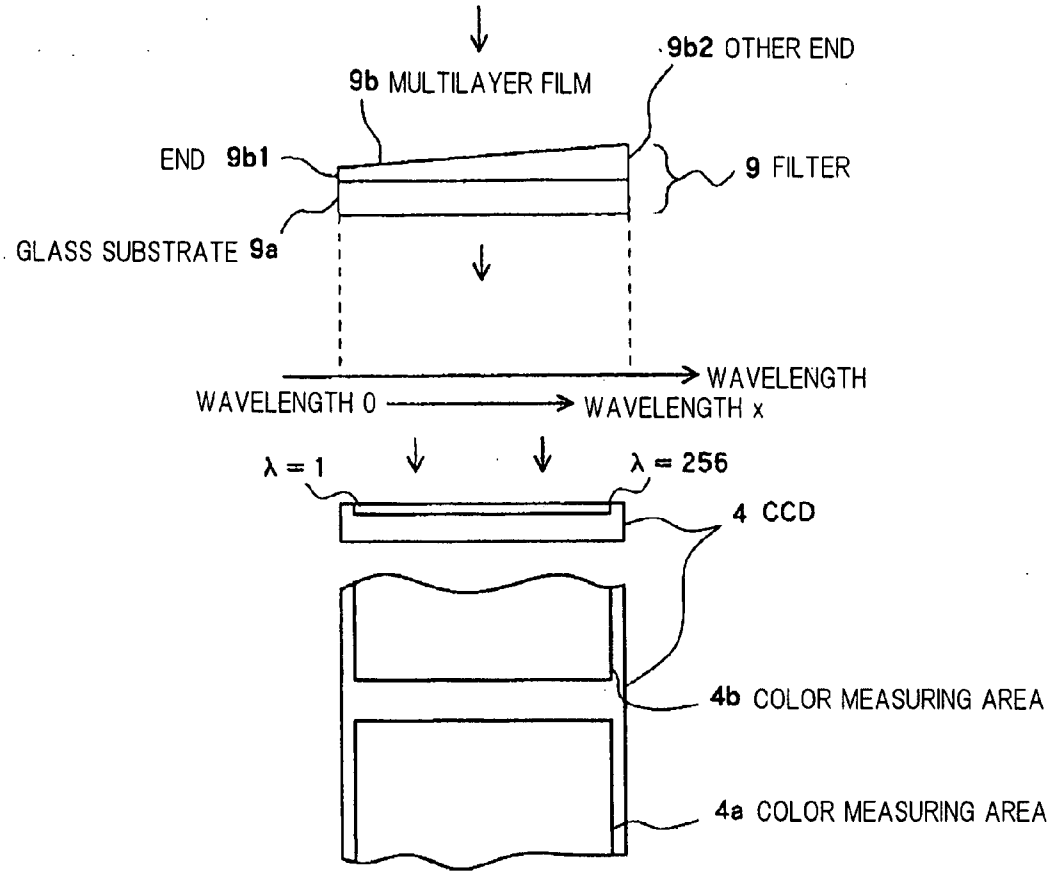

9b2 OTHER END
9b MULTILAYER FILM
END 9b1
9 FILTER
GLASS SUBSTRATE 9a
WAVELENGTH
WAVELENGTH 0
WAVELENGTH x
λ = 1
λ = 256
4 CCD
4b COLOR MEASURING AREA
4a COLOR MEASURING AREA

Fig. 6

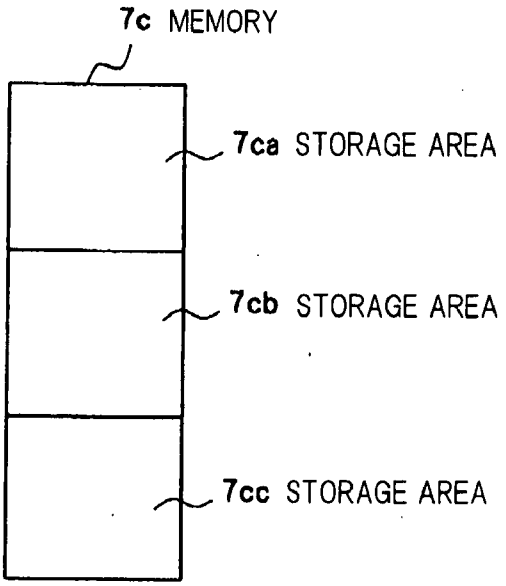

7c MEMORY
7ca STORAGE AREA
7cb STORAGE AREA
7cc STORAGE AREA

Fig. 7

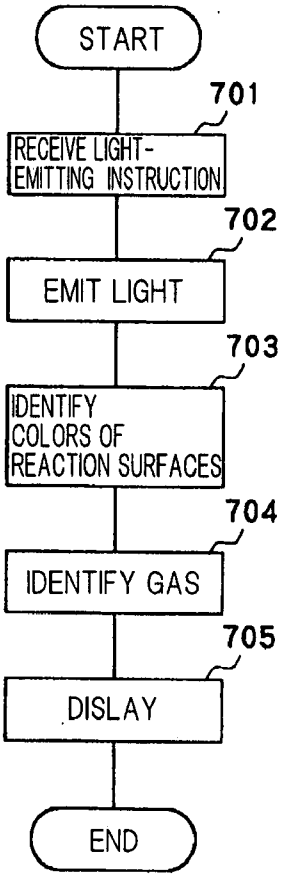

START
701
RECEIVE LIGHT-EMITTING INSTRUCTION
702
EMIT LIGHT
703
IDENTIFY COLORS OF REACTION SURFACES
704
IDENTIFY GAS
705
DISLAY
END

Fig. 8

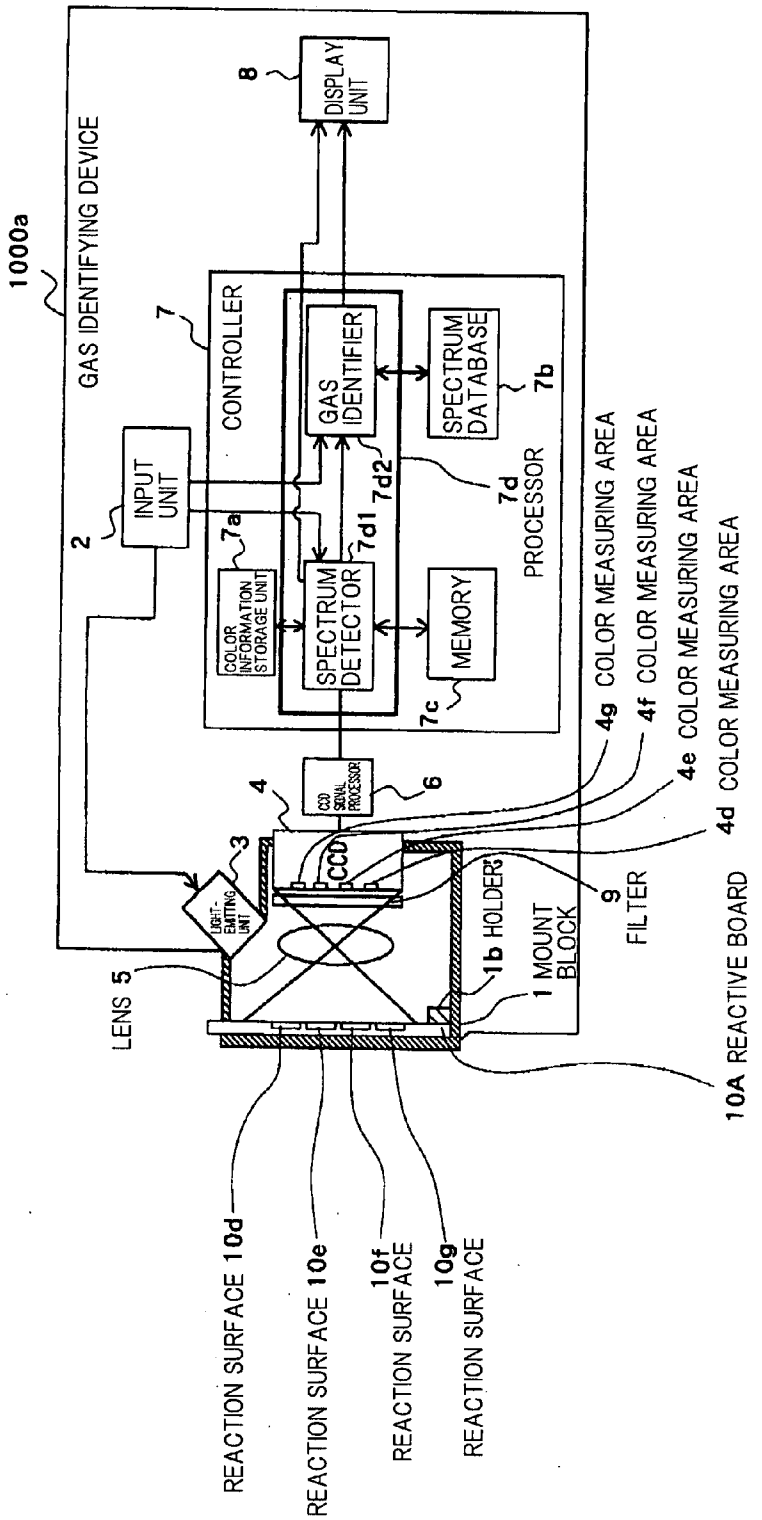

1000a
GAS IDENTIFYING DEVICE
8
DISPLAY UNIT
7
CONTROLLER
GAS IDENTIFIER
SPECTRUM DATABASE
7b
2
INPUT UNIT
7a
7d1
7d2
7d
PROCESSOR
COLOR INFORMATION STORAGE UNIT
SPECTRUM DETECTOR
MEMORY
7c
4
CCD SIGNAL PROCESSOR
6
3
CCD
LIGHT-EMITTING UNIT
LENS 5
1b HOLDER
1 MOUNT BLOCK
9
FILTER
4g COLOR MEASURING AREA
4f COLOR MEASURING AREA
4e COLOR MEASURING AREA
4d COLOR MEASURING AREA
10A REACTIVE BOARD
REACTION SURFACE 10d
REACTION SURFACE 10e
10f
REACTION SURFACE
10g
REACTION SURFACE

Fig. 9

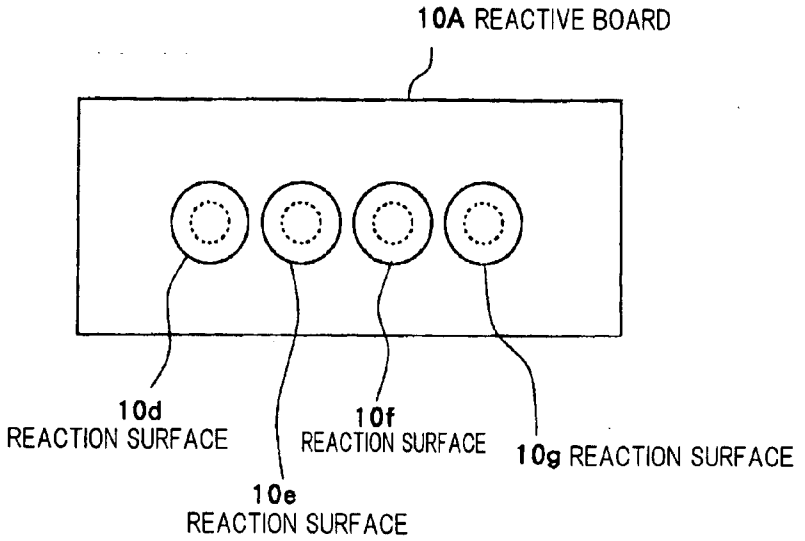

10A REACTIVE BOARD
10d
REACTION SURFACE
10e
REACTION SURFACE
10f
REACTION SURFACE
10g REACTION SURFACE

Fig. 10

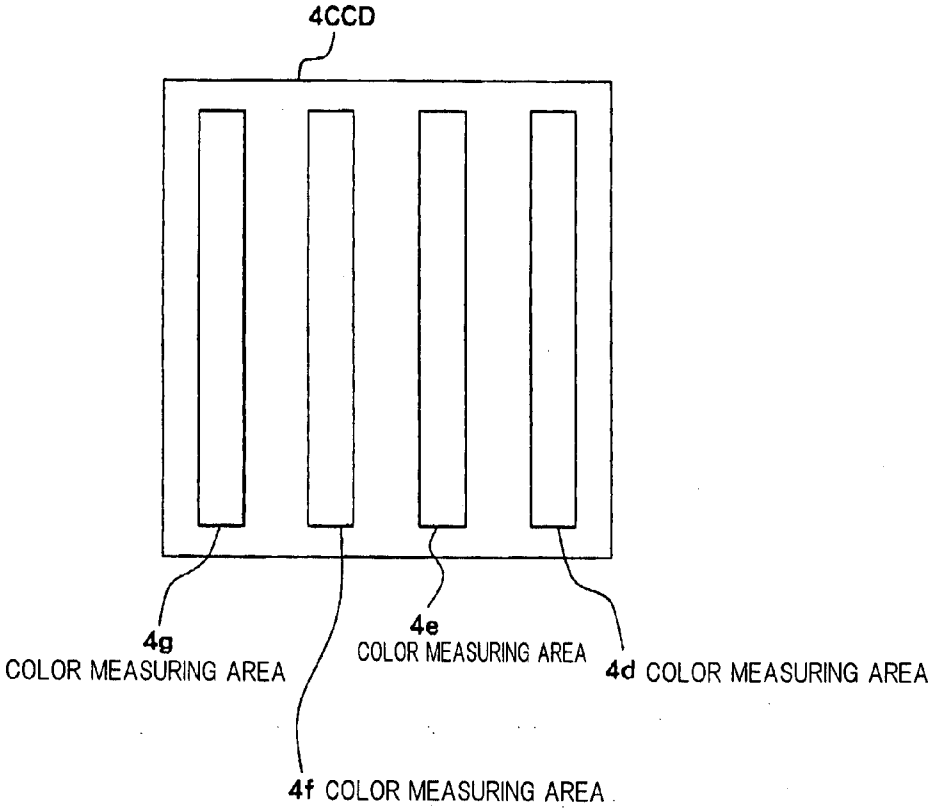

4CCD
4g
COLOR MEASURING AREA
4e
COLOR MEASURING AREA
4d COLOR MEASURING AREA
4f COLOR MEASURING AREA

Fig. 11A

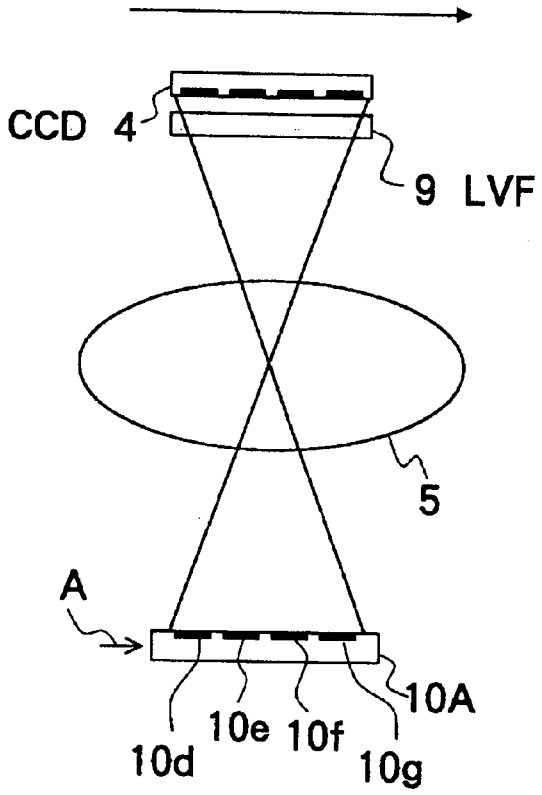


Fig. 11B

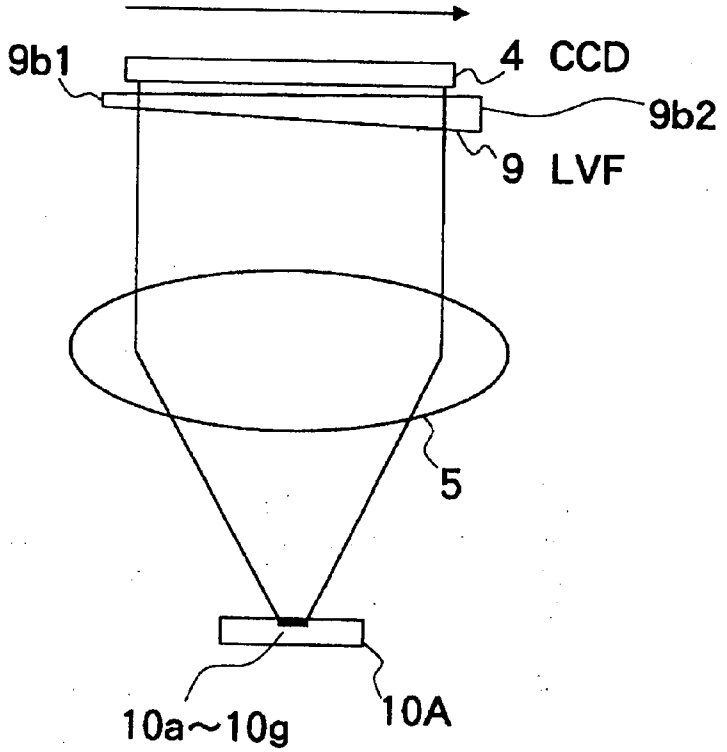


Fig. 12

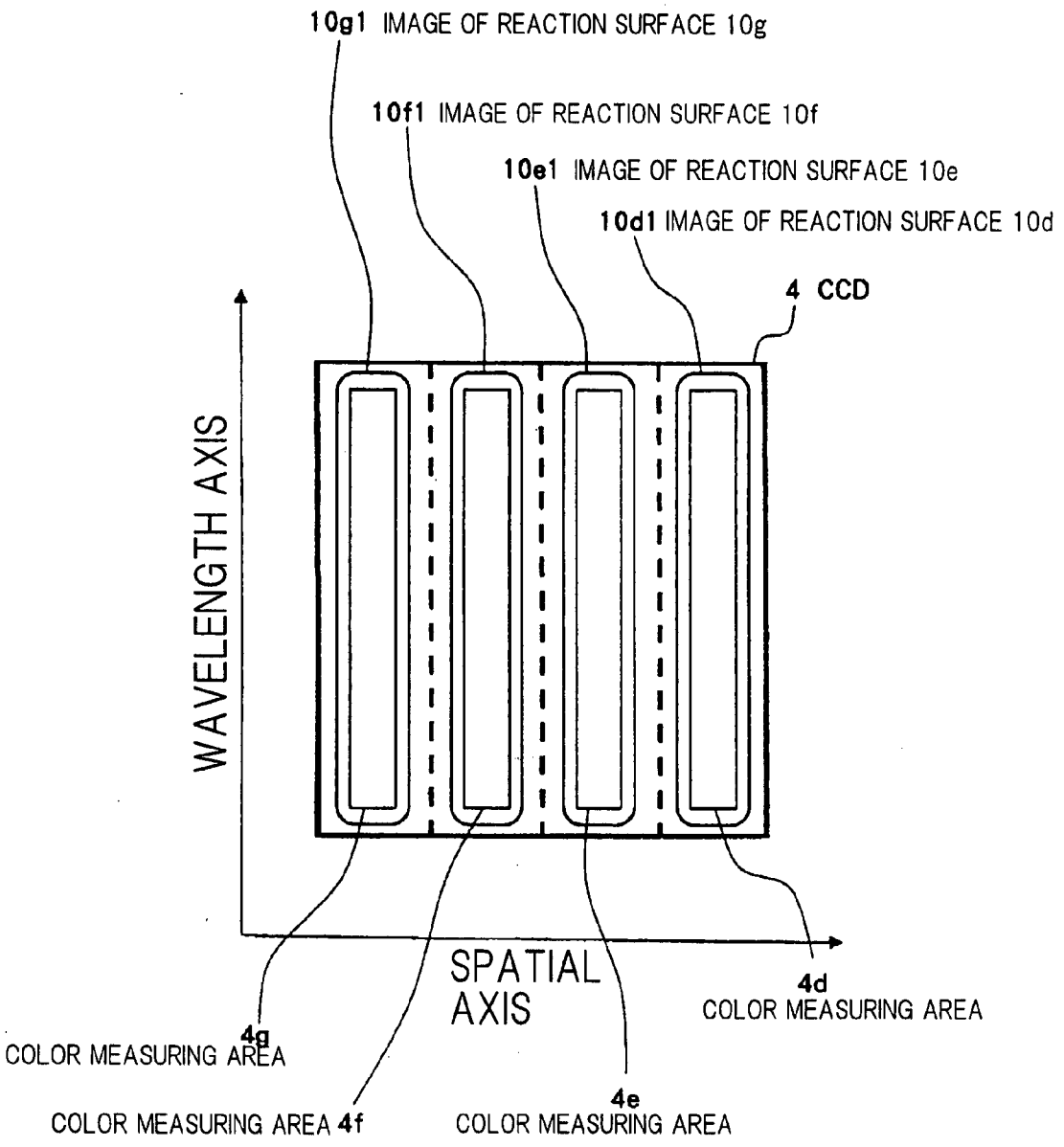

10g1 IMAGE OF REACTION SURFACE 10g
10f1 IMAGE OF REACTION SURFACE 10f
10e1 IMAGE OF REACTION SURFACE 10e
10d1 IMAGE OF REACTION SURFACE 10d
4 CCD
WAVELENGTH AXIS
SPATIAL AXIS
4g COLOR MEASURING AREA
COLOR MEASURING AREA 4f
4e COLOR MEASURING AREA
4d COLOR MEASURING AREA

Fig. 13

7b SPECTRUM DATABASE

7b1 CHEMICAL REAGENT NAMES	7b2 GAS IDENTIFYING INFORMATION	7b3 COLOR INFORMATION (SPECTRUM INFORMATION)	
		λ	INTENSITY
A	a	1	aaa
		2	bbb
		3	ccc
		.	.
		.	.
		.	.
		256	nnn
B	b	1	aba
		2	cdc
		.	.
		.	.
		.	.
		256	aaa
C	c	1	bbb
		2	ddd
		.	
		.	
		.	
		256	eee

Fig. 14

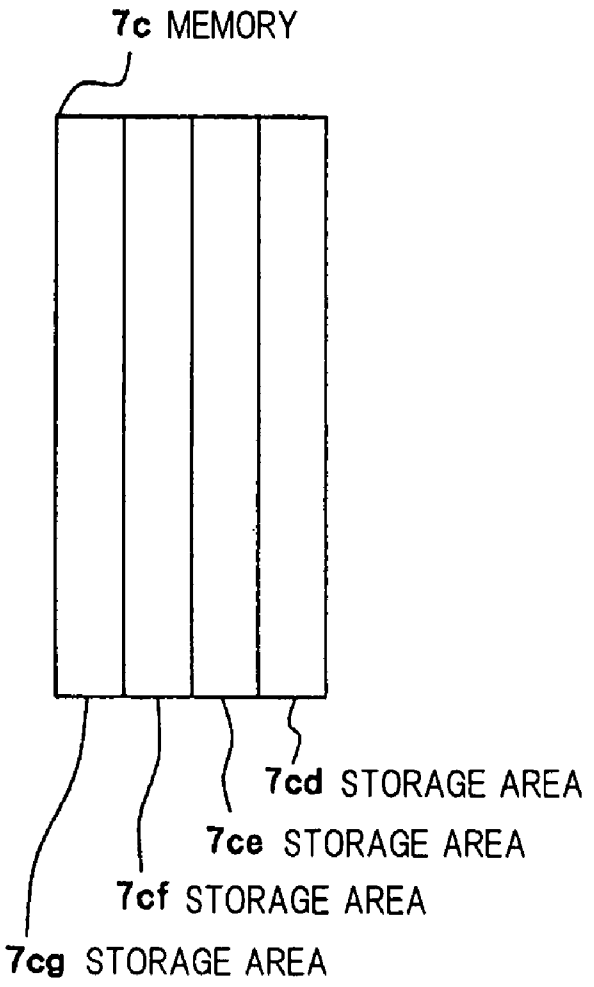

7c MEMORY
7cd STORAGE AREA
7ce STORAGE AREA
7cf STORAGE AREA
7cg STORAGE AREA

Fig. 15

7cd STORAGE AREA

λ	DETECTED VALUE					∧ (BAND)
	S0	S1	SX	S	Sb(∧)	
1	•	•	•	•	•	|
2	•	•	•	•		
3	•	•	•	•		
4	•	•	•	•		
• • •	• • •	• • •	• • •	• • •	• • •	
256	•	•	•	•	•	64

Binning = 4

Fig. 16

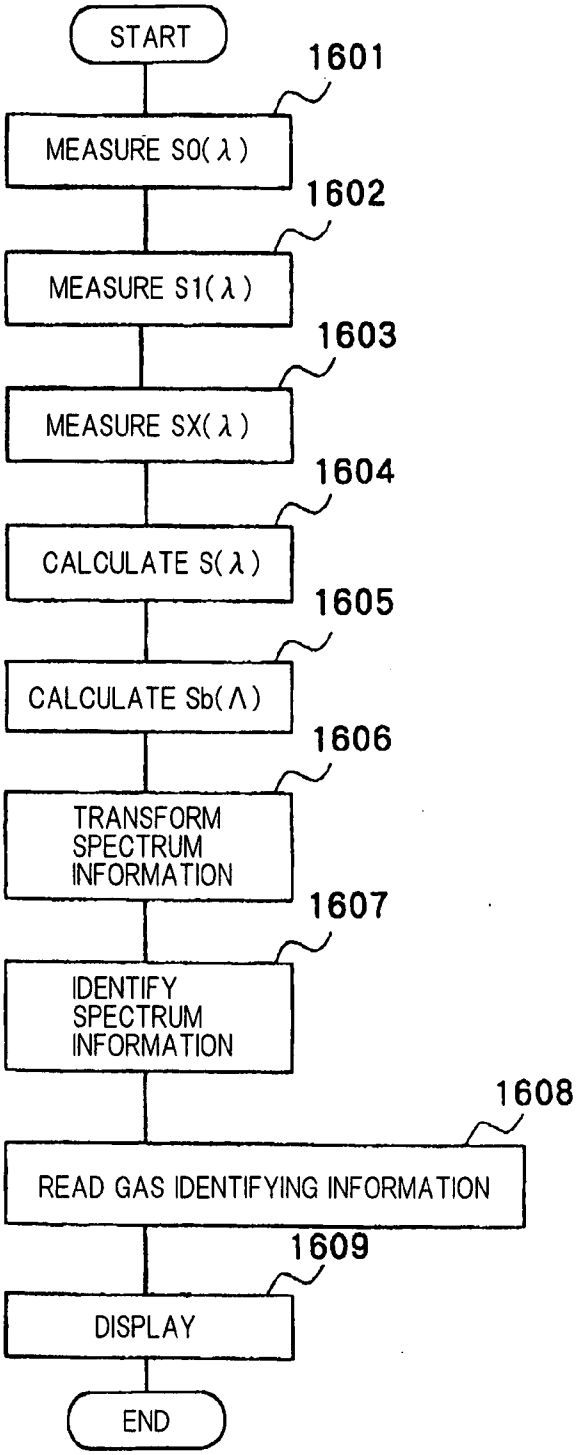

START
1601
MEASURE S0(λ)
1602
MEASURE S1(λ)
1603
MEASURE SX(λ)
1604
CALCULATE S(λ)
1605
CALCULATE Sb(Λ)
1606
TRANSFORM SPECTRUM INFORMATION
1607
IDENTIFY SPECTRUM INFORMATION
1608
READ GAS IDENTIFYING INFORMATION
1609
DISPLAY
END

Fig. 17a

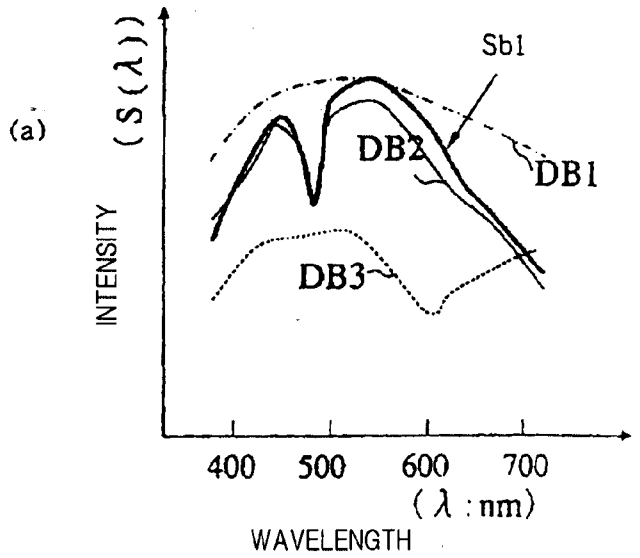


Fig. 17b

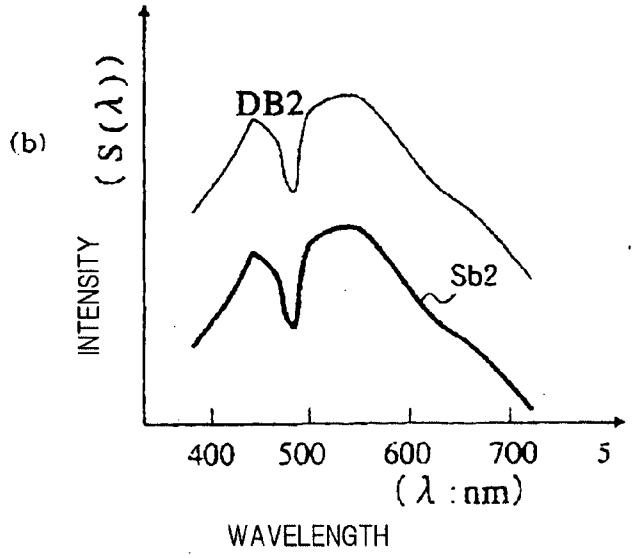


Fig. 17c

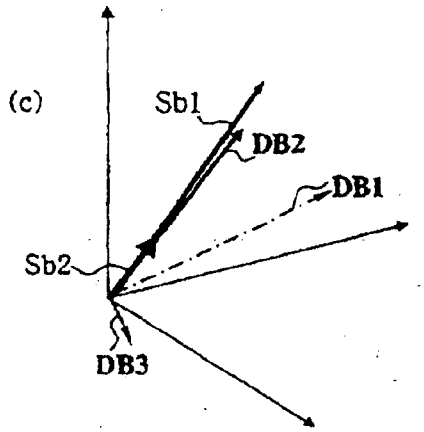


Fig. 18

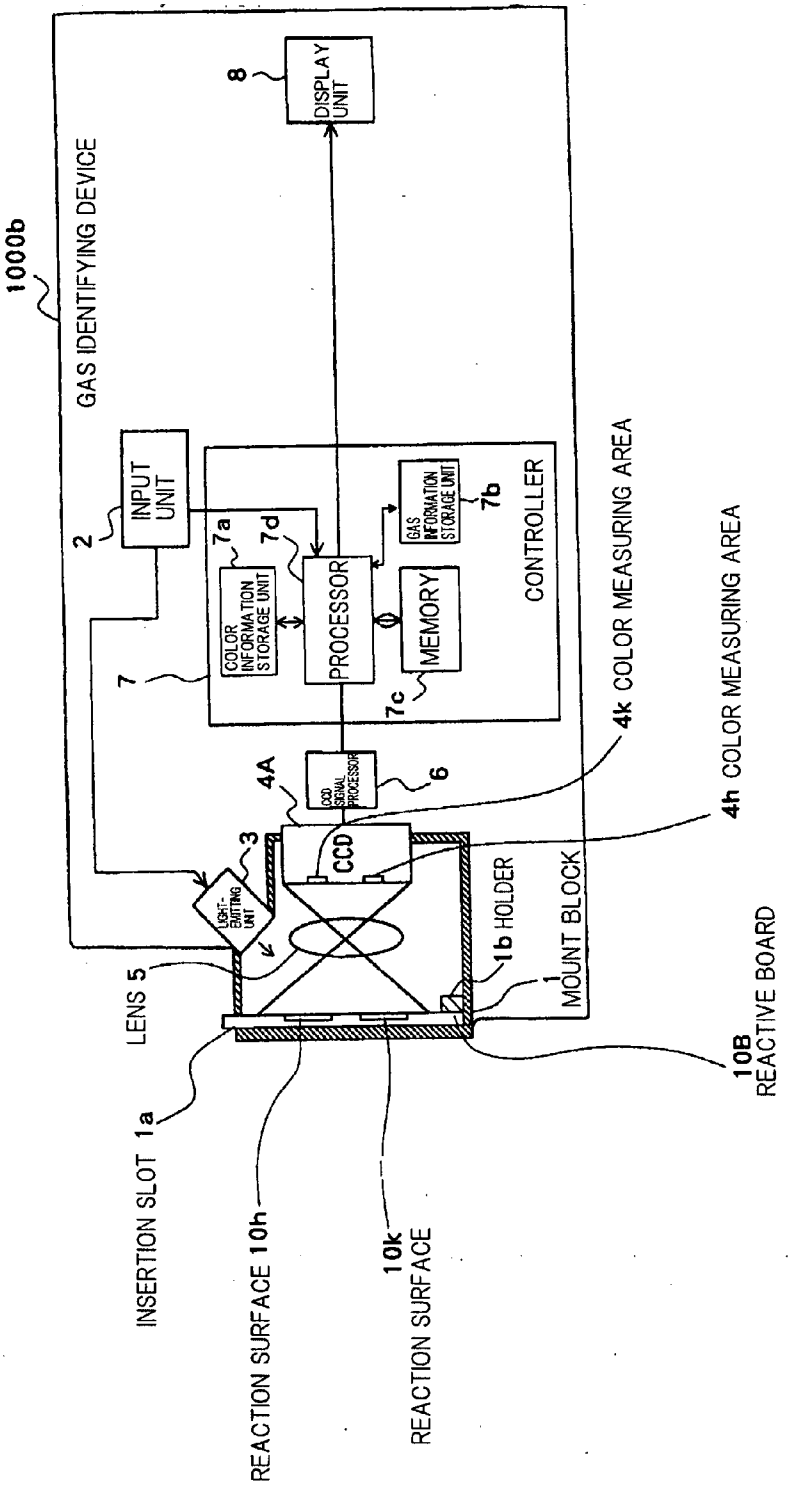

1000b
GAS IDENTIFYING DEVICE
8
DISPLAY UNIT
2
INPUT UNIT
7a
7d
7b
GAS INFORMATION STORAGE UNIT
COLOR INFORMATION STORAGE UNIT
PROCESSOR
MEMORY
CONTROLLER
7
7c
4k COLOR MEASURING AREA
4A
CCD SIGNAL PROCESSOR
6
4h COLOR MEASURING AREA
3
CCD
LIGHT-EMITTING UNIT
1b HOLDER
1 MOUNT BLOCK
LENS 5
10B REACTIVE BOARD
INSERTION SLOT 1a
REACTION SURFACE 10h
10k
REACTION SURFACE

Fig. 19

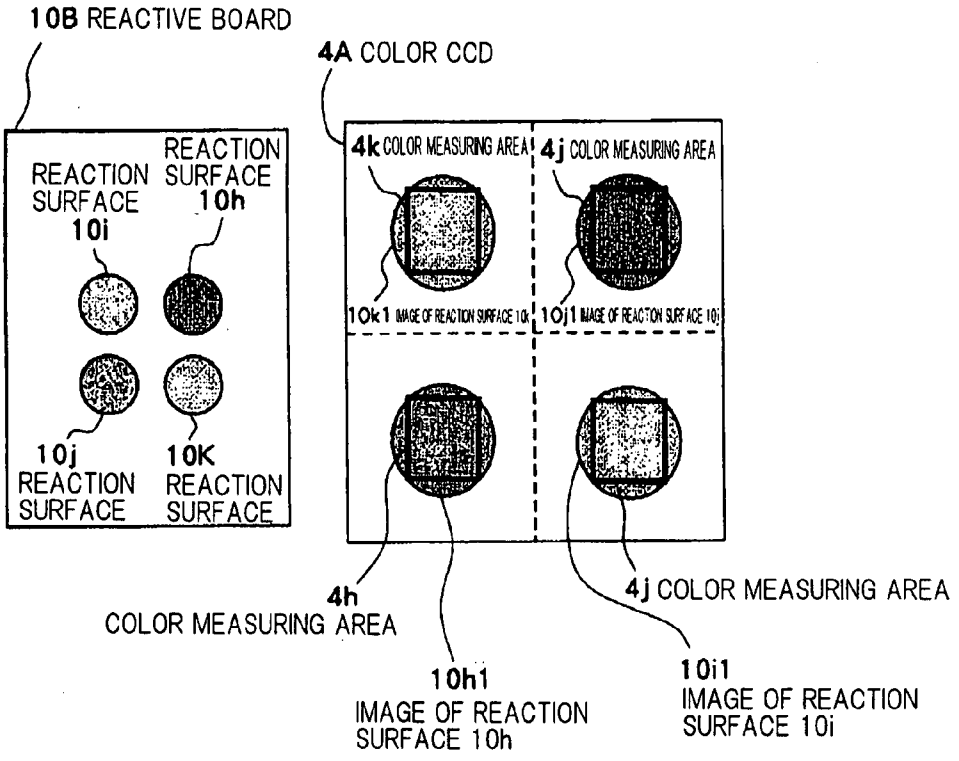
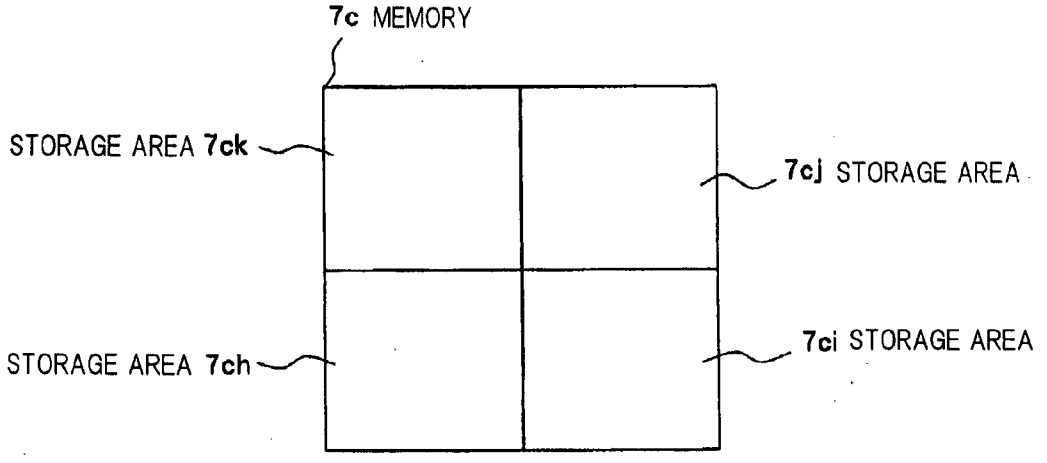

10B REACTIVE BOARD
4A COLOR CCD
REACTION SURFACE 10i
REACTION SURFACE 10h
10j REACTION SURFACE
10K REACTION SURFACE
4k COLOR MEASURING AREA
4j COLOR MEASURING AREA
10k1 IMAGE OF REACTION SURFACE 10k
10j1 IMAGE OF REACTION SURFACE 10j
4h COLOR MEASURING AREA
4j COLOR MEASURING AREA
10h1 IMAGE OF REACTION SURFACE 10h
10i1 IMAGE OF REACTION SURFACE 10i

Fig. 20


7c MEMORY
STORAGE AREA 7ck
7cj STORAGE AREA
STORAGE AREA 7ch
7ci STORAGE AREA

COLOR IDENTIFYING DEVICE FOR IDENTIFYING COLORS OF REACTION SURFACES PRODUCED BY CHEMICAL REACTION AND GAS IDENTIFYING DEVICE

[0001] This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2006-078809 filed on Mar. 22, 2006, the content of which is incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a color identifying device and a gas identifying device, and more particularly to a color identifying device for identifying colors of reaction surfaces which are produced by a chemical reaction and a gas identifying device.

[0004] 2. Description of the Related Art

[0005] There have heretofore been known gas detecting devices for causing a chemical reaction between a gas such as a toxic gas and chemical reagents to change the colors of the chemical reagents. For example, U.S. Pat. No. 6,228,657B1 discloses an M256 chemical agent detection kit.

[0006] The gas detecting device includes a plurality of ampules containing respective chemical reagents of different types and a plurality of mediums (reaction surfaces). When the ampules are crushed, the chemical reagents contained therein flow into the mediums.

[0007] The chemical reagents, as they flow into the mediums, chemically react with a gas that is held in contact with the mediums. The chemical reaction causes the chemical reagents to change their colors, and the mediums also change their colors depending on the color changes of the chemical reagents.

[0008] The user of the gas detecting device introduces different chemical reagents into the respective mediums, and recognizes the concentration of the gas based on the color changes of the mediums.

[0009] There are also known color identifying devices in the art. The user can objectively determine the colors of the mediums (chemical reagents) of the gas detecting device by using a color identifying device to identify the colors of the mediums.

[0010] One known color identifying device has three photodetectors and three optical filters associated respectively with the photodetectors.

[0011] If it is assumed that the photodetectors produce respective outputs X, Y, Z, then the color identifying device calculates values $x=X/(X+Y+Z)$, $y=Y/(X+Y+Z)$, and $z=Z/(X+Y+Z)$. Of these values x, y, z, two, e.g., the values x and y, are plotted on a chromaticity diagram, and a color is determined from the position of the values on the chromaticity diagram.

[0012] U.S. Pat. No. 6,228,657B1 also reveals a reader device for outputting a signal depending on the color of a measuring surface (medium) using three photodiodes or a single color CCD sensitive to the colors of R, G, B (red, green, and blue).

[0013] The conventional color identifying device can measure the color of one medium only in one measuring cycle. If the user uses the conventional color identifying device to measure the colors of a plurality of mediums, then the user have to measure the colors of the mediums separately.

[0014] If the reader device revealed in U.S. Pat. No. 6,228,657B1 is used to measure the colors of a plurality of measuring surfaces at a time, the reader device needs to have three photodiodes or a single color CCD for each of the measuring surfaces. Consequently, as the number of measuring surfaces to be measured at a time increases, the number of photodiodes or color CCDs used also increases, resulting in an increased number of parts of the reader device.

SUMMARY OF THE INVENTION

[0015] It is an object of the present invention to provide a color identifying device and a gas identifying device which are capable of measuring the colors of a plurality of measuring surfaces at a time without the need for a number of parts commensurate with the number of measuring surfaces.

[0016] To achieve the above object, a color identifying device according to the present invention has a mount block, a color detector, a lens, and a color identifier.

[0017] A board to be measured which has a plurality of surfaces to be measured in predetermined positions, respectively, is mounted in the mount block.

[0018] The color detector has a plurality of color measuring areas corresponding respectively to said surfaces while said board is mounted in said mount block.

[0019] The lens forms respective images of said surfaces of said board mounted on said mount block, respectively on said color measuring areas corresponding respectively to said surfaces.

[0020] The color identifier identifies colors of said surfaces which correspond respectively to said color measuring areas, based on output signals from said color measuring areas corresponding respectively to said surfaces.

[0021] With the above arrangement, when the user places the board to be measured in the mount block, the colors of the surfaces to be measured are measured. The number of parts of the color identifying device is prevented from increasing in a manner to be commensurate with the number of reaction surfaces.

[0022] The output signals from said color measuring areas should preferably represent spectrums of the colors of said surfaces which correspond respectively to said color measuring areas.

[0023] The colors of the surfaces can thus be identified based on the spectrums of the colors. Therefore, the colors of the surfaces can be identified with high accuracy.

[0024] The output signals from said color measuring areas should preferably represent three components of the colors of said surfaces which correspond respectively to said color measuring areas.

[0025] Specifically, said output signals from said color measuring areas should preferably represent red, green, and blue components of the colors of said surfaces which correspond respectively to said color measuring areas.

[0026] The colors of the surfaces can thus be identified based on the three components, e.g., the red, green, and blue components, of the colors of said surfaces. Therefore, the colors of the surfaces can be identified with high accuracy.

[0027] According to the present invention, a gas identifying device has a mount block, a color detector, a lens, and a gas identifier.

[0028] A reactive board having a plurality of reaction surfaces disposed in predetermined positions, respectively, is mounted in a mount block. The reaction surfaces have colors variable by chemical reactions between a gas to be identified and chemical reagents.

[0029] The color detector has a plurality of color measuring areas corresponding respectively to said reaction surfaces while said board is mounted on said mount block.

[0030] The lens forms respective images of said reaction surfaces of said board mounted on said mount block, respectively on said color measuring areas corresponding respectively to said surfaces.

[0031] The gas identifier identifies said gas based on output signals from said color measuring areas corresponding respectively to said surfaces.

[0032] With the above arrangement, when the user places the reactive board in the mount block, the gas to be identified is identified based on the colors of the reaction surfaces. The number of parts of the gas identifying device is prevented from increasing in a manner to be commensurate with the number of reaction surfaces.

[0033] The output signals from said color measuring areas should preferably represent spectrums of the colors of said reaction surfaces which correspond respectively to said color measuring areas.

[0034] The colors of the reaction surfaces can thus be identified based on the spectrums of the colors. Therefore, the colors of the reaction surfaces can be identified with high accuracy.

[0035] The output signals from said color measuring areas should preferably represent three components of the colors of said reaction surfaces which correspond respectively to said color measuring areas.

[0036] Specifically, said output signals from said color measuring areas should preferably represent red, green, and blue components of the colors of said reaction surfaces which correspond respectively to said color measuring areas.

[0037] The colors of the reaction surfaces can thus be identified based on the three components, e.g., the red, green, and blue components, of the colors of said reaction surfaces. Therefore, the colors of the reaction surfaces can be identified with high accuracy.

[0038] The above and other objects, features, and advantages of the present invention will become apparent from the following description with reference to the accompanying drawings which illustrate an example of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039] FIG. **1** is a block diagram of a gas identifying device according to the present invention;

[0040] FIG. **2** is a perspective view of a reactive board of the gas identifying device shown in FIG. **1**;

[0041] FIG. **3** is a view showing a CCD of the gas identifying device shown in FIG. **1**;

[0042] FIG. **4** is a view showing the CCD with images formed thereon;

[0043] FIG. **5** is a view showing a CCD with a linear variable filter (LVF);

[0044] FIG. **6** is a view showing a memory of the gas identifying device shown in FIG. **1**;

[0045] FIG. **7** is a flowchart of an operation sequence of the gas identifying device shown in FIG. **1**;

[0046] FIG. **8** is a block diagram of a gas identifying device according to a first embodiment of the present invention;

[0047] FIG. **9** is a view of a reactive board of the gas identifying device shown in FIG. **8**;

[0048] FIG. **10** is a view showing a CCD of the gas identifying device shown in FIG. **8**;

[0049] FIGS. **11**A and **11**B are views showing the relationship of the reactive board mounted in a mount block, a lens, a filter, and the CCD;

[0050] FIG. **12** is a view showing the CCD on which the images of reaction surfaces are formed by the lens;

[0051] FIG. **13** is a diagram showing an example of data stored in a spectrum database of the gas identifying device shown in FIG. **8**;

[0052] FIG. **14** is a view showing a memory of the gas identifying device shown in FIG. **8**;

[0053] FIG. **15** is a diagram showing an example of spectral data representative of color changes of a reaction surface which are stored in the memory;

[0054] FIG. **16** is a flowchart of an operation sequence of the gas identifying device shown in FIG. **8**;

[0055] FIG. **17***a* through **17***c* are diagrams illustrative of a method of identifying spectral information;

[0056] FIG. **18** is a block diagram of a gas identifying device according to a second embodiment of the present invention;

[0057] FIG. **19** is a view of a reactive board and a color CCD of the gas identifying device shown in FIG. **18**; and

[0058] FIG. **20** is a view showing a memory of the gas identifying device shown in FIG. **18**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0059] FIG. **1** shows in block form gas identifying device **1000** according to the present invention.

[0060] As shown in FIG. **1**, gas identifying device **1000** comprises mount block **1**, input unit **2**, light-emitting unit **3**, CCD **4**, lens **5**, CCD signal processor **6** including an ADC (analog-to-digital converter), controller **7**, and display unit **8**.

[0061] Controller **7** comprises color information storage unit **7***a*, gas information storage unit **7***b*, memory **7***c*, and processor **7***d*.

[0062] Reactive board **10**, which is an example of a board to be measured, is mounted in mount block **1**.

[0063] Reactive board **10** has a plurality of reaction surfaces (surfaces to be measured) **10***a*, **10***b* and **10***c*. Each of reaction surfaces **10***a*, **10***b* and **10***c* is disposed in a predetermined position on reactive board **10**.

[0064] FIG. **2** shows reactive board **10** in perspective.

[0065] As shown in FIG. **2**, reactive board **10** has a plurality of chemical reagents **101** which are different from each other, a plurality of ampules **102**, and a plurality of mediums **103**. Ampules **102** contain chemical reagents **101**, respectively, which are of different types. Mediums **103** are respective sheets of paper. When ampules **102** are crushed, chemical reagents contained therein flow into mediums **103**. Mediums **103** provide reaction surfaces (surfaces to be measured) **10***a*, **10***b* and **10***c*.

[0066] Reactive board **10** includes chemical reagent **101***a* titled "A", chemical reagent **101***b* titled "B", and chemical reagent **101***c* titled "C".

[0067] When each chemical reagent **101** flows into medium **103**, it chemically reacts with a gas, e.g., a gas to be identified, that is held in contact with medium **103**. Chemical reagent **101** and medium **103** change their colors due to the chemical reaction with the gas. The M256 chemical agent detection kit disclosed in U.S. Pat. No. 6,228,657B1, for example, may be used as reactive board **10**.

[0068] In FIG. **1**, gas identifying device **1000** identifies the gas to be identified based on the colors of chemical reagents **101** which have chemically reacted with the gas on reactive board **10**. Stated otherwise, gas identifying device **1000** identifies the gas to be identified based on the colors of the reaction surfaces where the chemical reaction has occurred.

[0069] Mount block **1** has insertion slot **1***a*, holder **1***b*, and a plurality of buttons **1***c* through **1***h*.

[0070] Reactive board **10** is inserted through insertion slot **1***a* into mount block **1** and is held in mount block **1** by holder **1***b*.

[0071] When reactive board **10** is held in mount block **1** by holder **1***b*, buttons **1***c* through **1***c* on mount block **1** are aligned respectively with ampules **102** on reactive board **10**. When the user presses one of buttons **1***c* through **1***h*, the pressed button pushes and crushes the ampule that is aligned therewith.

[0072] Input unit **2** is an operation switch for receiving an input action of the user, which may represent an instruction to emit light from light-emitting unit **3**, for example.

[0073] When input unit **2** receives a light-emitting instruction, input unit **2** transmits the light-emitting instruction to light-emitting unit **3** and processor **7***d*.

[0074] In response to the light-emitting instruction, light-emitting unit **3** emits and applies light to reaction surfaces **10***a* through **10***c*. Light-emitting unit **3** preferably, but not necessarily, comprises a halogen lamp or an incandescent lamp.

[0075] Reaction surfaces **10***a* through **10***c* reflect the light applied from light-emitting unit **3**. If a reaction surface contains chemical reagent **101** that has chemically reacted with the gas to be identified, then the light reflected by the reaction surface exhibits the color of chemical reagent **101** that has chemically reacted with the gas to be identified.

[0076] Mount block **1** prevents other lights that are different from the light emitted from light-emitting unit **3** from irradiating reactive board **10**.

[0077] CCD **4** is an example of color detector used in gas identifying device **1000**. The color detector may comprise another device such as a CMOS sensor, for example, rather than a CCD.

[0078] FIG. **3** shows CCD **4** by way of example. Those parts of CCD **4** shown in FIG. **3** which are identical to those shown in FIG. **1** are denoted by identical reference characters.

[0079] As shown in FIG. **3**, CCD **4** has a plurality of color measuring areas **4***a*, **4***b* and **4***c* corresponding respectively to reaction surfaces **10***a*, **10***b* and **10***c* of reactive board **10** mounted in mount block **1**. Specifically, color measuring area **4***a* corresponds to reaction surface **10***a*, color measuring area **4***b* to reaction surface **10***b*, and color measuring area **4***c* to reaction surface **10***c*. Each of color measuring areas **4***a*, **4***b* and **4***c* comprises an array of photodetectors.

[0080] As shown in FIG. **1**, lens **5** forms images of reaction surfaces **10***a* through **10***c* of reactive board **10** mounted in mount block **1** on respective color measuring areas **4***a* through **4***c*.

[0081] FIG. **4** shows CCD **4** on which the images of reaction surfaces **10***a* through **10***c* are formed by lens **5**. Those parts of CCD **4** shown in FIG. **4** which are identical to those shown in FIG. **1** are denoted by identical reference characters.

[0082] In FIG. **4**, image **10***a***1** of reaction surface **10***a* is formed on color measuring area **4***a*, image **10***b***1** of reaction surface **10***b* on color measuring area **4***b*, and image **10***c***1** of reaction surface **10***c* on color measuring area **4***c*.

[0083] If CCD **4** comprises a color CCD, then an output signal from color measuring area **4***a* varies depending on the color of reaction surface **10***a*, an output signal from color measuring area **4***b* varies depending on the color of reaction surface **10***b*, and an output signal from color measuring area **4***c* varies depending on the color of reaction surface **10***c*.

[0084] If CCD **4** comprises a CCD having a linear variable filter (LVF) on its detecting surface, then an output signal from color measuring area **4***a* varies depending on the color of reaction surface **10***a* (the spectrum of the color), an output signal from color measuring area **4***b* varies depending on the color of reaction surface **10***b* (the spectrum of the color), and an output signal from color measuring area **4***c* varies depending on the color of reaction surface **10***c* (the spectrum of the color).

[0085] FIG. **5** shows a CCD with a linear variable filter (hereinafter referred to as "filter" or "LVF"). Those parts of the CCD shown in FIG. **5** which are identical to those shown in FIG. **1** are denoted by identical reference characters.

[0086] As shown in FIG. **5**, filter **9** comprises glass substrate **9***a* and multilayer film **9***b* disposed on glass substrate **9***a*. Multilayer film **9***b* is progressively thicker from end **9***b***1** to other end **9***b***2**. Therefore, the wavelength of light passing through filter **9** gradually varies from end **9***b***1** to other end **9***b***2**.

[0087] According to the present invention, filter **9** passes light in a wavelength range from 380 to 720 nm. However, filter **9** may pass light in a different wavelength range rather than the wavelength range from 380 to 7-20 nm.

[0088] As shown in FIG. **1**, CCD signal processor **6** converts an analog output signal from CCD **4** into a digital signal.

[0089] Controller **7** identifies the colors of reaction surfaces **10***a* through **10***c* corresponding respectively to color measuring areas **4***a* through **4***c* based on the output signals from color measuring areas **4***a* through **4***c*. Specifically, controller **7** identifies the color of reaction surface **10***a* based on the output signal from color measuring area **4***a*, the color of reaction surface **10***b* based on the output signal from color measuring area **4***b*, and the color of reaction surface **10***c* based on the output signal from color measuring area **4***c*.

[0090] Controller **7** also identifies the gas to be identified based on the output signals from color measuring areas **4***a* through **4***c* which correspond respectively to reaction surfaces **10***a* through **10***c*.

[0091] As described above, controller **7** comprises color information storage unit **7***a*, gas information storage unit **7***b*, memory **7***c*, and processor **7***d*.

[0092] Color information storage unit **7***a* stores color feature information representing features of colors and color

identifying information for identifying colors having features represented by the color feature information, in association with each other.

[0093] Gas information storage unit **7***b* stores gas identifying information for identifying gases and color information about the colors of chemical reagents, which have chemically reacted with gas identified by the gas identifying information, in association with each other.

[0094] Memory **7***c* stores the output signals from color measuring areas **4***a* through **4***c*.

[0095] FIG. **6** shows memory **7***c* by way of example. As shown in FIG. **6**, memory **7***c* has a plurality of storage areas **7***ca*, **7***cb* and **7***cc*.

[0096] Processor **7***d* shown in FIG. **1** stores the output signal of color measuring area **4***a* in storage area **7***ca*, the output signal of color measuring area **4***b* in storage area **7***cb*, and the output signal of color measuring area **4***c* in storage area **7***cc*.

[0097] Processor **7***d* generates color feature information representing the features of the colors of reaction surfaces **10***a* through **10***c* based on the output signals from color measuring areas **4***a* through **4***c* which correspond to respective reaction surfaces **10***a* through **10***c*. Processor **7***d* reads the color identifying information associated with the generated color feature information from color information storage unit **7***a*. Processor **7***d* then outputs the color identifying information as representing the colors of reaction surfaces **10***a* through **10***c* to display unit **8**.

[0098] Processor **7***d* also generate color information about the colors of reaction surfaces **10***a* through **10***c* based on the output signals from color measuring areas **4***a* through **4***c* which correspond to respective reaction surfaces **10***a* through **10***c*. Processor **7***d* identifies color information representing a most similar color to the color identified by the generated color information from the color information stored in gas information storage unit **7***b*, for the every generated color information. Processor **7***d* reads the gas identifying information associated with the identified color information from gas information storage unit **7***b*. Processor **7***d* outputs the read gas identifying information as representing the gas to be identified to display unit **8**.

[0099] Display unit **8** displays the information received from processor **7***d*.

[0100] Operation of gas identifying device **1000** will be described below with reference to FIG. **7** which is a flowchart of an operation sequence of gas identifying device **1000**.

[0101] The user inserts reactive board **10** through insertion slot **1***a* into mount block **1** until reactive board **10** is held in place by holder **1***b*.

[0102] Then, the user presses buttons **1***c* through **1***h* to crush ampules **102** on reactive board **10**. As a result, chemical reagents **101** in ampules **102** are discharged and brought into contact with the gas to be identified on reaction surfaces **10***a* through **10***c*.

[0103] The user enters a light-emitting instruction into input unit **2**, which executes step **701** shown in FIG. **7**.

[0104] In step **701**, input unit **2** receives the light-emitting instruction and supplies the light-emitting instruction to light-emitting unit **3** and processor **7**. When light-emitting unit **3** receives the light-emitting instruction, it executes step **702**.

[0105] In step **702**, light-emitting unit **3** applies light to reactive board **10**.

[0106] Reaction surfaces **10***a* through **10***c* of reactive board **10** reflect the light applied by light-emitting unit **3**. The reflected light takes on the color (reflected intensity) of chemical reagent **101** which has reacted with the gas to be identified. More specifically, the reflected light takes on the color (reflected intensity) of medium **103** including chemical reagent **101** which has reacted with the gas to be identified.

[0107] Lens **5** forms respective images of reaction surfaces **10***a* through **10***c* of reactive board **10** mounted in mount block **1** respectively on color measuring areas **4***a* through **4***c* which correspond to respective reaction surfaces **10***a* through **10***c*.

[0108] CCD signal processor **6** converts analog output signals from color measuring areas **4***a* through **4***c*, i.e., analog output signals from the photodetectors of color measuring areas **4***a* through **4***c*, into digital signals. CCD signal processor **6** transmits the digital signals to processor **7***d*.

[0109] When processor **7***d* receives the light-emitting instruction from input unit **2**, processor **7***d* executes step **703**.

[0110] In step **703**, processor **7***d* identifies the colors of reaction surfaces **10***a* through **10***c* corresponding to color measuring areas **4***a* through **4***c*, based on the output signals from color measuring areas **4***a* through **4***c*.

[0111] Specifically, processor **7***d* stores the output signal from color measuring area **4***a* into storage area **7***ca*, the output signal from color measuring area **4***b* into storage area **7***cb*, and the output signal from color measuring area **4***c* into storage area **7***cc*. Thereafter, processor **7***d* generates color feature information representing the feature of the color of reaction surface **10***a* based on the output signal from color measuring area **4***a* which is stored in storage area **7***ca*. Processor **7***d* reads the color identifying information associated with the color feature information from color information storage unit **7***a*. Processor **7***d* then outputs the read color identifying information as representing the color of reaction surface **10***a* to display unit **8**.

[0112] Thereafter, processor **7***d* generates color feature information representing the feature of the color of reaction surface **10***b* based on the output signal from color measuring area **4***b* which is stored in storage area **7***cb*. Processor **7***d* reads the color identifying information associated with the color feature information from color information storage unit **7***a*. Processor **7***d* then outputs the read color identifying information as representing the color of reaction surface **10***b* to display unit **8**.

[0113] Thereafter, processor **7***d* generates color feature information representing the feature of the color of reaction surface **10***c* based on the output signal from color measuring area **4***c* which is stored in storage area **7***cc*. Processor **7***d* reads the color identifying information associated with the color feature information from color information storage unit **7***a*. Processor **7***d* then outputs the read color identifying information as representing the color of reaction surface **10***c* to display unit **8**.

[0114] After having identified the colors of reaction surfaces **10***a* through **10***c*, processor **7***d* executes step **704**.

[0115] In step **704**, processor **7***d* identifies the gas to be identified based on the output signals from color measuring areas **4***a* through **4***c*.

[0116] Specifically, processor **7***d* generates color information about the color of reaction surface **10***a* based on the output signal from color measuring area **4***a* which is stored

in storage area **7***ca*. Processor **7***d* identifies color information that represents a color which is most similar to the generated color information from the color information stored in gas information storage unit **7***b*. *Processor* **7***d* reads the gas identifying information associated with the identified color information from gas information storage unit **7***b*. Processor **7***d* outputs the read gas identifying information as representing the gas to be identified to display unit **8**.

[0117] Then, processor **7***d* generates color information about the color of reaction surface **10***b* based on the output signal from color measuring area **4***b* which is stored in storage area **7***cb*. Processor **7***d* identifies color information that represents a color which is most similar to the generated color information from the color information stored in gas information storage unit **7***b*. Processor **7***d* reads the gas identifying information associated with the identified color information from gas information storage unit **7***b*. Processor **7***d* outputs the read gas identifying information as representing the gas to be identified to display unit **8**.

[0118] Then, processor **7***d* generates color information about the color of reaction surface **10***c* based on the output signal from color measuring area **4***c* which is stored in storage area **7***cc*. Processor **7***d* identifies color information that represents a color which is most similar to the generated color information from the color information stored in gas information storage unit **7***b*. Processor **7***d* reads the gas identifying information associated with the identified color information from gas information storage unit **7***b*. Processor **7***d* outputs the read gas identifying information as representing the gas to be identified to display unit **8**.

[0119] When display unit **8** receives the information from processor **7***d*, display unit **8** executes step **705**.

[0120] In step **705**, display unit **8** displays the colors of reaction surfaces **10***a* through **10***c* and the gas to be identified which has chemically reacted on reaction surfaces **10***a* through **10***c*, based on the information received from processor **7***d*.

[0121] According to the present invention, lens **5** forms the respective images of reaction surfaces **10***a* through **10***c* of reactive board **10** mounted in mount block **1** on respective color measuring areas **4***a* through **4***c* corresponding to reaction surfaces **10***a* through **10***c*. Controller **7** identifies the colors of reaction surfaces **10***a* through **10***c* which correspond respectively to color measuring areas **4***a* through **4***c* of CCD **4**, based on the output signals from color measuring areas **4***a* through **4***c* corresponding to reaction surfaces **10***a* through **10***c*.

[0122] Therefore, when the user places reactive board **10** into mount block **1**, the colors of reaction surfaces **10***a* through **10***c* of reactive board **10** are measured. The number of parts of color identifying device **1000** is prevented from increasing in a manner to be commensurate with the number of reaction surfaces.

[0123] According to the present invention, controller **7** identifies the gas to be identified based on the output signals from color measuring areas **4***a* through **4***c* corresponding to reaction surfaces **10***a* through **10***c*.

[0124] Therefore, when the user places reactive board **10** into mount block **1**, the gas to be identified is identified based on the colors of reaction surfaces **10***a* through **10***c* of reactive board **10**. The number of parts of color identifying device **1000** is prevented from increasing in a manner to be commensurate with the number of reaction surfaces.

EMBODIMENTS

[0125] Specific embodiments of the present invention will be described below.

[0126] FIG. **8** shows in block form gas identifying device **1000***a* according to a first embodiment of the present invention. As shown in FIG. **8**, gas identifying device **1000***a* identifies the colors of reaction surfaces and a gas to be identified based on the spectrums of the colors of the reaction surfaces. Those parts of gas identifying device **1000***a* shown in FIG. **8** which are identical to those shown in FIGS. **1** and **5** are denoted by identical reference characters.

[0127] As shown in FIG. **8**, gas identifying device **1000***a* includes mount block **1**, input unit **2**, light-emitting unit **3**, CCD **4**, lens **5**, CCD signal processor **6**, controller **7**, display unit **8** and filter **9**. Controller **7** comprises color information storage unit **7***a*, spectrum database **7***b* as an example of gas information storage unit, memory **7***c*, and processor **7***d*. Processor **7***d* comprises spectrum detector **7***d***1** and gas identifier **7***d***2**.

[0128] Reactive board **10**A, which is an example of a board to be measured, is mounted in mount block **1**.

[0129] FIG. **9** shows reactive board **10**A. As shown in FIG. **9**, reactive board **10**A has a plurality of reaction surfaces (surfaces to be measured) **10***d*, **10***e*, **10***f*, **10***g*. Each of reaction surfaces **10***d*, **10***e*, **10***f* and **10***g* is disposed in a predetermined position on reactive board **10**A. In FIG. **9**, the ampules are omitted from illustration.

[0130] For example, each of reaction surfaces **10***d*, **10***e*, **10***f* and **10***g* has a diameter of 2.5 mm and includes a central area having a diameter of 1.5 mm. Adjacent two of reaction surfaces **10***d*, **10***e*, **10***f* and **10***g* are spaced from each other by a distance of 0.5 mm. The distance from reaction surface **10***d* to reaction surface **10***g* is 11.5 mm.

[0131] FIG. **10** shows CCD **4**. As shown in FIG. **10**, CCD **4** has a plurality of color measuring areas **4***d*, **4***e*, **4***f* and **4***g* corresponding respectively to reaction surfaces **10***d*, **10***e*, **10***f* and **10***g* of reactive board **10**A mounted in mount block **1**. Specifically, color measuring area **4***d* corresponds to reaction surface **10***d*, color measuring area **4***e* to reaction surface **10***e*, color measuring area **4***f* to reaction surface **10***f*, and color measuring area **4***g* to reaction surface **10***g*. Each of color measuring areas **4***d*, **4***e*, **4***f* and **4***g* comprises an array of photodetectors.

[0132] For example, CCD **4** has 512×512 photodetectors (pixels) spaced at a pitch of 24×24 μm. CCD **4** has a chip size of 12.288×12.288 mm. However, CCD **4** is not limited to these details and may have different specifications and dimensions.

[0133] For the sake of brevity, it is assumed in the description which follows that each color measuring area of CCD **4** comprises a linear array of 256 photodetectors λ (λ=1 through 256) in the longitudinal direction, i.e., in the vertical direction in FIG. **10**.

[0134] FIGS. **11**A and **11**B show the relationship of reactive board **10**A mounted in mount block **1**, lens **5**, filter (LVF) **9** and CCD **4**. Those parts in FIGS. **11**A and **11**B which are identical to those shown in FIGS. **8** and **9** are denoted by identical reference characters. FIG. **11**B is a view as viewed in the direction of the arrow A in FIG. **11**A.

[0135] In FIGS. **11**A and **11**B, lens **5** comprises a cylindrical lens.

[0136] As shown in FIG. **11**A, cylindrical lens **5** forms the respective images of reaction surfaces **10***d*-**10***g* through filter (LVF) **9** as unchanged images on CCD **4** in the direction indicated by the arrow A in which reaction surfaces **10***d* through **10***g* are arrayed. As shown in FIG. **11**B, cylindrical lens **5** forms the respective images of reaction surfaces **10***d*-**10***g* through filter (LVF) **9** as expanded images on CCD **4** in a direction perpendicular to the direction indicated by the arrow A in which reaction surfaces **10***d* through **10***g* are arrayed.

[0137] The images expanded by cylindrical lens **5** fall on filter **9**. The wavelengths of the images (light rays) that pass through the filter **9** vary gradually from one end **9***b***1** to other end **9***b***2** of filter **9**.

[0138] FIG. **12** shows CCD **4** on which the images of reaction surfaces **10***d* through **10***g* are formed by cylindrical lens **5**. Those parts shown in FIG. **12** which are identical to those shown in FIG. **10** are denoted by identical reference characters.

[0139] As shown in FIG. **12**, image **10***d***1** of reaction surface **10***d* is formed on color measuring area **4***d*, image **10***e***1** of reaction surface **10***e* on color measuring area **4***e*, image **10***f***1** of reaction surface **10***f* on color measuring area **4***f*, and image **10***g***1** of reaction surface **10***g* on color measuring area **4***g*.

[0140] More specifically, image **10***d***1** of reaction surface **10***d* that has passed through filter **9** represents the spectrum of the color of reaction surface **10***d*. Image **10***e***1** of reaction surface **10***e* that has passed through filter **9** represents the spectrum of the color of reaction surface **10***e*. Image **10***f***1** of reaction surface **10***f* that has passed through filter **9** represents the spectrum of the color of reaction surface **10***f*. Image **10***g***1** of reaction surface **10***g* that has passed through filter **9** represents the spectrum of the color of reaction surface **10***g*.

[0141] Therefore, 256 photodetectors λ of color measuring areas **4***d* through **4***g* detect light in different wavelengths, and color measuring areas **4***d* through **4***g* successively produce output signals depending on the intensities of the light detected by photodetectors λ.

[0142] As shown in FIG. **8**, input unit **2** receives a dark current measuring instruction, a light-emitting instruction and a binning instruction.

[0143] When input unit **2** receives a dark current measuring instruction, input unit **2** supplies the dark current measuring instruction to spectrum detector **7***d***1**. When input unit **2** receives a light-emitting instruction, input unit **2** transmits the light-emitting instruction to light-emitting unit **3** and spectrum detector **7***d***1**.

[0144] When input unit **2** receives a binning instruction, input unit **2** transmits the binning instruction to spectrum detector **7***d***1** and gas identifier **7***d***2**. Instead, a predetermined binning instruction may be set in controller **7**.

[0145] Color information storage unit **7***a* stores the names of colors in association with the spectrums of the colors.

[0146] Spectrum database **7***b* stores gas identifying information for identifying gases in association with color information about the colors of chemical reagents that have chemically reacted with gases identified by the gas identifying information.

[0147] For example, spectrum database **7***b* stores color change information as color information. The color change information represents a change from the color of medium **103** before chemical reagent **101** flows into medium **103** to the color of medium **103** after chemical reagent **101** flows into medium **103** and chemically reacts therewith.

[0148] In the first embodiment, spectrum database **7***b* stores spectrum information as color change information. The spectrum information represents a spectrum showing a change of the color of medium **103** which is caused when a gas identified by gas identifying information and chemical reagent **101** chemically react with each other.

[0149] In the first embodiment, spectrum database **7***b* stores color information based on an output signal that is produced by CCD **4** when CCD **4** detects the color of chemical reagent **101** (medium **103**) which has chemically reacted with a gas identified by gas identifying information.

[0150] FIG. **13** shows an example of data stored in spectrum database **7***b*.

[0151] As shown in FIG. **13**, spectrum database **7***b* stores chemical reagent names **7***b***1**, gas identifying information **7***b***2** and color information **7***b***3** in association with each other.

[0152] In spectrum database **7***b*, for example, chemical reagent "A", gas identifying information "a" and the spectrum of the color of chemical reagent "A" which has chemically reacted with a gas represented by gas identifying information "a" (specifically, a color change of medium **103**) are associated with each other.

[0153] As shown in FIG. **8**, spectrum detector **7***d***1** detects spectrums representing color changes of reaction surfaces **10***d* through **10***g* based on an output signal from CCD signal processor **6**.

[0154] Memory **7***c* stores the spectrums representing color changes of reaction surfaces **10***d* through **10***g* which are detected by spectrum detector **7***d***1**.

[0155] FIG. **14** shows memory **7***c* by way of example. As shown in FIG. **14**, memory **7***c* has a plurality of storage areas **7***cd*, **7***ce*, **7***cf* and **7***cg*. Storage area **7***cd* corresponds to reaction surface **10***d* and color measuring area **4***d*. Storage area **7***ce* corresponds to reaction surface **10***e* and color measuring area **4***e*. Storage area **7***cf* corresponds to reaction surface **10***f* and color measuring area **4***f*. Storage area **7***cg* corresponds to reaction surface **10***g* and color measuring area **4***g*.

[0156] Storage area **7***cd* stores an output signal from color measuring area **4***d*. Storage area **7***ce* stores an output signal from color measuring area **4***e*. Storage area **7***cf* stores an output signal from color measuring area **4***f*. Storage area **7***cg* stores an output signal from color measuring area **4***g*.

[0157] FIG. **15** shows by way of example spectrums representative of color changes of reaction surface **10***d* which are stored in storage area **7***cd*. Spectrums representative of color changes of other reaction surfaces **7***ce*, **7***cf* and **7***cg* are stored in other storage areas **7***ce*, **7***cf* and **7***cg*.

[0158] In FIG. **15**, storage area **7***cd* stores the names of the photodetectors (λ) of color measuring area **4***d* corresponding to reaction surface **10***d*, output values S**0**, S**1**, SX thereof, relative intensity (spectral data) S, binning relative intensity (spectral data) Sb, and band value Λ, in association with each other.

[0159] Output values S**0**, S**1**, SX, relative intensity S, binning relative intensity Sb, and band value Λ shown in FIG. **15** will be described below. A processing sequence with respect to reaction surface **10***d*, color measuring area **4***d* and storage area **7***cd* only will be described below. A similar

processing sequence is also performed with respect to other reaction surfaces, other color measuring areas, and other storage areas.

[0160] When input unit **2** receives a dark current measuring instruction before chemical reagent **101** flows into medium **103**, input unit **2** supplies the dark current measuring instruction to spectrum detector **7***d***1**.

[0161] When spectrum detector **7***d***1** receives the dark current measuring instruction from input unit **2**, spectrum detector **7***d***1** measures output values **S0**(λ) of the photodetectors (λ) of color measuring area **4***d* at the time light-emitting unit **3** is not energized. Spectrum detector **7***d***1** stores measured output values **S0**(λ) into **S0** in storage area **7***cd*.

[0162] Then, when input unit **2** receives a light-emitting instruction before chemical reagent **101** flows into medium **103**, input unit **2** supplies the light-emitting instruction to light-emitting unit **3** and spectrum detector **7***d***1**.

[0163] When light-emitting unit **3** receives the light-emitting instruction from input unit **2**, light-emitting unit **3** applies light to reactive board **10**A.

[0164] Reaction surface **10***d* of reactive board **10**A reflects the light applied from light-emitting unit **3**. The reflected light takes on the color (reflected intensity) of reaction surface **10***d* before chemical reagent **101** flows into reaction surface **10***d*. The reflected light passes through filter **9** and is detected by photodetectors λ of color measuring area **4***d*. Therefore, an output signal from color measuring area **4***d* represents the spectrum of the reflected light.

[0165] When spectrum detector **7***d***1** receives the light-emitting instruction after it has received the dark current measuring instruction, spectrum detector **7***d***1** measures output signals from photodetectors λ of color measuring area **4***d*, i.e., output values S**1** (λ) representing the spectrum of the color of reaction surface **10***d* before chemical reagent **101** flows into reaction surface **10***d*. Spectrum detector **7***d***1** stores output values S**1** (λ) into S**1** in storage area **7***cd*.

[0166] Thereafter, when ampule **102** on reactive board **10**A are crushed, chemical reagent **101** contained in ampule **102** flows into reaction surface **10***d*. When chemical reagent **101** flows into reaction surface **10***d*, chemical reagent **101** chemically reacts with the gas to be identified which is held in contact with reaction surface **10***d*.

[0167] When input unit **2** receives a light-emitting instruction again after chemical reagent **101** has flowed into medium **103**, input unit **2** supplies the light-emitting instruction to light-emitting unit **3** and spectrum detector **7***d***1**.

[0168] When light-emitting unit **3** receives the light-emitting instruction from input unit **2**, light-emitting unit **3** emits and applies light to reactive board **10**A.

[0169] Reaction surface **10***d* reflects the light applied from light-emitting unit **3**. The reflected light takes on the color (reflected intensity) of chemical reagent **101** which has chemically reacted with the gas to be identified. Specifically, the reflected light takes on the color (reflected intensity) of reaction surface **10***d* including chemical reagent **101** which has chemically reacted with the gas to be identified.

[0170] The reflected light passes through filter **9** and is detected by photodetectors λ of color measuring area **4***d*. Therefore, an output signal from color measuring area **4***d* represents the spectrum of the reflected light.

[0171] When spectrum detector **7***d***1** receives the light-emitting instruction again from input unit **2**, spectrum detector **7***d***1** measures output signals from photodetectors λ of color measuring area **4***d*, i.e., output values SX(λ) representing the spectrum of the color of reaction surface **10***d* after chemical reagent **101** has flowed into reaction surface **10***d* and has chemically reacted with the gas to be identified. Spectrum detector **7***d***1** stores output values SX(λ) into SX in storage area **7***cd*.

[0172] After having stored output values SX(λ) into SX in storage area **7***cd*, spectrum detector **7***d***1** calculates relative intensity (S(λ)) according to the following equation:

$$S(\lambda)=(SX(\lambda)-S0(\lambda))/(S1(\lambda)-S0(\lambda))$$

[0173] If medium **103** has a stable quality, then output values S**0**(λ) and output values S**1** (λ) are measured once, and measured output values S**0**(λ) and measured output values S**1**(λ) may be used in subsequent cycles. This makes it possible to minimize the process of calculating output values S(λ).

[0174] Spectrum detector **7***d***1** stores output values S(λ) into S in storage area **7***cd*.

[0175] For storing color information into spectrum database **7***b*, the same process as described above is performed while the gas identified by the gas identifying information is being held in contact with medium **103**. Calculated output values S(λ) are stored into spectrum database **7***b* as color information associated with the gas identifying information.

[0176] After having stored output values S(λ) in storage area **7***cd*, spectrum detector **7***d***1** calculates binning relative intensity (spectral data) Sb(Λ) based on a binning instruction supplied from input unit **2**.

[0177] For example, if a binning instruction "4" is supplied from input unit **2**, then spectrum detector **7***d***1** calculates binning relative intensity Sb(Λ) based on a cluster of four output values S(λ). In the example shown in FIG. **15**, the sum of four output values S(**1**) through S(**4**) becomes binning relative intensity Sb(Λ=1), and the sum of four output values S(**253**) through S(**256**) becomes binning relative intensity Sb(Λ=64).

[0178] Spectrum detector **7***d***1** stores calculated binning relative intensities Sb(Λ) into Sb(Λ) in storage area **7***cd*. Thereafter, spectrum detector **7***d***1** supplies binning relative intensities Sb(Λ) to gas identifier **7***d***2**.

[0179] When spectrum detector **7***d***1** receives the binning instruction from input unit **2**, spectrum detector **7***d***1** calculates band (Λ) based on the binning instruction, and stores calculated band (Λ) into Λ in storage area **7***cd*.

[0180] Gas identifier **7***d***2** identifies spectrum information representing a spectrum which is most similar to the spectrum representing the color change of reaction surface **10***d* detected by spectrum detector **7***d***1**, from the spectrum information **7***b***3** stored in spectrum database **7***b*.

[0181] According to the first embodiment, gas identifier **7***d***2** identifies spectrum information which satisfies the two conditions 1 and 2 described below from spectrum information **7***b***3** stored in spectrum database **7***b*.

[0182] Condition 1: spectrum information having a spectrum waveform which is most similar to the waveform of the spectrum that represents the color change of the reaction surface.

[0183] Condition 2: spectrum information having a spectrum waveform whose coincidence with the waveform of the spectrum that represents the color change of the reaction surface is equal to or greater than a predetermined value.

[0184] Specifically, gas identifier **7***d***2** performs the following process:

[0185] Gas identifier **7***d***2** hypothetically places spectrum Sb(Λ) that represents the color change of the reaction surface which is detected by spectrum detector **7***d***1**, in a multidimensional space having coordinates A. Thus, spectrum Sb(Λ) is indicated as a vector in the multidimensional space.

[0186] Gas identifier **7***d***2** processes each of the spectrum information stored in spectrum database **7***b* based on the binning instruction supplied from input unit **2** to equalize the number of bands of each of the spectrum information to the number of bands of spectrum Sb(Λ).

[0187] For example, if a binning instruction "4" is supplied from input unit **2**, then gas identifier **7***d***2** brings the spectrum information of gases identified by gas identifying information **7***b***2** into clusters of four items of spectrum information to equalize the number of bands of each of the spectrum information stored in spectrum database **7***b* to the number of bands of spectrum Sb(Λ).

[0188] Gas identifier **7***d***2** hypothetically places each of the spectrum information which has the same number of bands as the number of bands of spectrum Sb(Λ), in the multidimensional space having coordinates Λ, as with spectrum Sb(Λ). Thus, each of the spectrum information is indicated as a vector in the multidimensional space.

[0189] Gas identifier **7***d***2** calculates the inner product of spectrum Sb(Λ) and each of the spectrum information. Based on the calculated inner product, gas identifier **7***d***2** selects the spectrum information whose angle formed with respect to spectrum Sb(Λ) is the smallest. This process is known in the art as spectral angle mapper (SAM).

[0190] The angle formed between the spectrum information and spectrum Sb(Λ) is smaller as their spectral waveforms are closer to each other. Stated otherwise, the angle formed between the spectrum information and spectrum Sb(Λ) is representative of the degree of coincidence between the spectrum information and spectrum Sb(Λ).

[0191] Then, gas identifier **7***d***2** determines whether or not the angle between spectrum Sb(Λ) and the selected spectrum information is equal to or smaller than a predetermined angle.

[0192] If the angle between spectrum Sb(Λ) and the selected spectrum information is equal to or smaller than the predetermined angle, then gas identifier **7***d***2** identifies the selected spectrum information as spectrum information representative of spectrum Sb(Λ).

[0193] Gas identifier **7***d***2** reads gas identifying information **7***b***2** associated with the identified gas information from spectrum database **7***b*.

[0194] Gas identifier **7***d***2** outputs read gas identifying information **7***b***2** as gas identifying information representing the gas to be identified to display unit **8**.

[0195] Operation of gas identifying device **1000***a* according to the first embodiment will be described below.

[0196] FIG. **16** is a flowchart of an operation sequence of gas identifying device **1000***a*. Operation of gas identifying device **1000***a* will be described below with reference to FIG. **16**.

[0197] It is assumed that the user has entered a binning instruction "binning=4" to input unit **2**. The binning instruction is not limited to "binning **4**", but may be of any of binning values.

[0198] The user inserts reactive board **10**A through insertion slot **1***a* into mount block **1** until reactive board **10**A is held in place by holder **1***b*. At this time, the ampules on reactive board **10**A have not been crushed yet. When reactive board **10**A is inserted into mount block **1**, external light should not enter mount block **1**.

[0199] Then, the user enters a dark current measuring instruction into input unit **2**. When input unit **2** receives the dark current measuring instruction, step **1601** is executed.

[0200] In step **1601**, the following process is performed:

[0201] Input unit **2** supplies the dark current measuring instruction to spectrum detector **7***d***1**.

[0202] When spectrum detector **7***d***1** receives the dark current measuring instruction, spectrum detector **7***d***1** measures output values S**0**(λ) of photodetectors λ of color measuring areas **4***d* through **4***g* when light-emitting unit **3** does not emit light.

[0203] Spectrum detector **7***d***1** stores measured output values S**0**(λ) into S**0** in storage areas **7***cd*, **7***ce*, **7***cf* and **7***cg* (memory **7***c*) which correspond respectively to color measuring areas **4***d* through **4***g*.

[0204] The process in step **1601** is now finished.

[0205] Then, the user enters a light-emitting instruction into input unit **2**. When input unit **2** receives the light-emitting instruction, step **1602** is executed.

[0206] In step **1602**, the following process is performed:

[0207] Input unit **2** supplies the light-emitting instruction to light-emitting unit **3** and spectrum detector **7***d***1**.

[0208] When light-emitting unit **3** receives the light-emitting instruction, light-emitting unit **3** applies light to reactive board **10**A.

[0209] Reaction surfaces **10***d* through **10***g* of reactive board **10**A reflect the light applied from light-emitting unit **3**. The reflected light takes on the colors (reflected intensities) of reaction surfaces **10***d* through **10***g* before chemical reagents **101** flow into reaction surfaces **10***d* through **10***g*. The reflected light passes through filter **9** and is detected by photodetectors λ of color measuring areas **4***d* through **4***g*. Therefore, output signals from color measuring areas **4***d* through **4***g* represent the spectrums of the reflected light which correspond to color measuring areas **4***d* through **4***g*.

[0210] When spectrum detector **7***d***1** receives the light-emitting instruction after it has received the dark current measuring instruction, spectrum detector **7***d***1** measures output signals from photodetectors λ of color measuring areas **4***d* through **4***g*, i.e., output values S**1** (λ) representing the spectrums of the colors of reaction surfaces **10***d* through **10***g* before chemical reagents **101** flow into reaction surfaces **10***d* through **10***g*. Spectrum detector **7***d***1** stores output values S**1** (λ) into S**1** in storage areas **7***cd* through **7***cg*(memory **7***c*) which correspond to color measuring areas **4***d* through **4***g*.

[0211] The process in step **1602** is now finished.

[0212] Then, the user presses buttons, not shown, on mount block **1** to crush ampules **102** on reactive board **10**A.

[0213] When ampules **102** are crushed, chemical reagents **101** contained in ampules **102** are discharged and flow into reaction surfaces **10***d* through **10***g*. When chemical reagents **101** flow into reaction surfaces **10***d* through **10***g*, they chemically react the gas to be identified which is held in contact with mediums **103**.

[0214] Then, the user enters a light-emitting instruction again into input unit **2**. When input unit **2** receives the light-emitting instruction again, step **1603** is executed.

[0215] In step **1603**, the following process is performed:

[0216] Input unit **2** supplies the light-emitting instruction to light-emitting unit **3** and spectrum detector **7***d***1**.

[0217] When light-emitting unit **3** receives the light-emitting instruction, light-emitting unit **3** applies light to reactive board **10**A.

[0218] Reaction surfaces **10***d* through **10***g* of reactive board **10**A reflect the light applied from light-emitting unit **3**. The reflected light takes on the colors (reflected intensities) of chemical reagents **101** which have chemically reacted with the gas to be identified. Specifically, the reflected light takes on the colors of reaction surfaces **10***d* through **10***g* containing chemical reagents **101** which have chemically reacted with the gas to be identified.

[0219] The reflected light passes through filter **9** and is detected by photodetectors λ of color measuring areas **4***d* through **4***g*. Therefore, output signals from color measuring areas **4***d* through **4***g* represent the spectrums of the reflected light from reactive surfaces **10***d* through **10***g* which correspond to color measuring areas **4***d* through **4***g*.

[0220] When spectrum detector **7***d***1** receives the light-emitting instruction again from input unit **2**, spectrum detector **7***d***1** measures output signals from photodetectors λ of color measuring areas **4***d* through **4***g*, i.e., output values SX(λ) representing the spectrums of the colors of reaction surfaces **10***d* through **10***g* after chemical reagents **101** have flowed into reaction surfaces **10***d* through **10***g*. Spectrum detector **7***d***1** stores output values SX(λ) into SX in storage areas **7***cd* through **7***cg* (memory **7***c*) which correspond to color measuring areas **4***d* through **4***g*.

[0221] The process in step **1603** is now finished.

[0222] After having stored output values SX(λ) into memory **7***c*, spectrum detector **7***d***1** executes step **1604**.

[0223] In step **1604**, spectrum detector **7***d***1** calculates relative intensities S(λ) with respect to the respective output values of color measuring areas **4***d* through **4***g* which are stored in respective storage areas **7***cd* through **7***cg* according to the following equation:

$$S(\lambda)=(SX(\lambda)-S0(\lambda))/(S1(\lambda)-S0(\lambda))$$

[0224] Spectrum detector **7***d***1** stores calculated relative intensities S(λ) into S in storage areas **7***cd* through **7***cg* (memory **7***c*) corresponding to relative intensities S(λ). After having stored calculated relative intensities S(λ) into memory **7***c*, spectrum detector **7***d***1** executes step **1605**.

[0225] In step **1605**, spectrum detector **7***d***1** calculates binning relative intensities (spectral data) Sb(Λ) with respect to the output values of color measuring areas **4***d* through **4***g* which are stored in storage areas **7***cd* through **7***cg*, based on a binning instruction supplied from input unit **2**.

[0226] Since a binning instruction "4" is supplied from input unit **2**, spectrum detector **7***d***1** calculates binning relative intensities Sb(Λ) for respective clusters of four relative intensities S(λ).

[0227] Spectrum detector **7***d***1** stores calculated binning relative intensities Sb(Λ) into Sb(Λ) in storage areas **7***cd* through **7***cg* corresponding to relative intensities S(Λ). Thereafter, spectrum detector **7***d***1** supplies binning relative intensities Sb(Λ) to gas identifier **7***d***2**.

[0228] When gas identifier **7***d***2** receives binning relative intensities Sb(Λ), gas identifier **7***d***2** executes steps **1606** and **1607** using SAM.

[0229] In steps **1606** and **1607**, gas identifier **7***d***2** identifies the spectrum information which satisfies two conditions 1 and 2 described below from spectrum information **7***b***3** stored in spectrum database **7***b*, with respect to respective output values of color measuring areas **4***d* through **4***g* which are stored in respective storage areas **7***cd* through **7***cg*.

[0230] Condition 1: spectrum information having a spectrum waveform which is most similar to the waveform of the spectrum that represents the color change of the reaction surface which is detected by spectrum detector **7***d***1**.

[0231] Condition 2: spectrum information having a spectrum waveform whose coincidence with the waveform of the spectrum that represents the color change of the reaction surface is equal to or greater than a predetermined value.

[0232] Specifically, gas identifier **7***d***2** performs the following process:

[0233] Gas identifier **7***d***2** executes step **1606**.

[0234] In step **1606**, gas identifier **7***d***2** performs the following process on each of the data of color measuring areas **4***d* through **4***g*:

[0235] Gas identifier **7***d***2** hypothetically places spectrum Sb(Λ) that represents the color change of the reaction surface which is detected by spectrum detector **7***d***1**, in a multidimensional space having coordinates Λ.

[0236] Gas identifier **7***d***2** processes each of the spectrum information stored in spectrum database **7***b* based on the binning instruction supplied from input unit **2** to equalize the number of bands of each of the spectrum information to the number of bands of spectrum Sb(Λ).

[0237] Since a binning instruction "4" is supplied from input unit **2**, gas identifier **7***d***2** brings the spectrum information of gases identified by gas identifying information **7***b***2** into clusters of four items of spectrum information to equalize the number of bands of each of the spectrum information stored in spectrum database **7***b* to the number of bands of spectrum Sb(Λ).

[0238] Gas identifier **7***d***2** hypothetically places each of the spectrum information which has the same number of bands as the number of bands of spectrum Sb(Λ), in the multidimensional space having coordinates Λ, as with spectrum Sb(Λ).

[0239] After having hypothetically placed each of the spectrum information in the multidimensional space having coordinates Λ, gas identifier **7***d***2** executes step **1607**.

[0240] In step **1607**, gas identifier **7***d***2** calculates the inner product of spectrum Sb(Λ) and each of the spectrum information. Based on the calculated inner product, gas identifier **7***d***2** selects the spectrum information whose angle formed with respect to spectrum Sb(Λ) is the smallest.

[0241] Then, gas identifier **7***d***2** determines whether or not the angle between spectrum Sb(Λ) and the selected spectrum information is equal to or smaller than a predetermined angle.

[0242] If the angle between spectrum Sb(Λ) and the selected spectrum information is equal to or smaller than the predetermined angle, then gas identifier **7***d***2** identifies the selected spectrum information as spectrum information representative of spectrum Sb(Λ).

[0243] FIGS. **17***a* through **17***c* are illustrative of a method of identifying spectral information using SAM.

[0244] In FIGS. **17***a* and **17***b*, DB**1** represents the spectral waveform of spectrum information associated with gas identifying information "a", DB**2** the spectral waveform of spectrum information associated with gas identifying information "b", and DB**3** the spectral waveform of spectrum information associated with gas identifying information "c".

[0245] In FIG. **17***a*, Sb**1** represents a measured spectrum. Measured spectrum Sb**1** has a waveform and an intensity

similar to spectral waveform DB2. In FIG. **17***b*, Sb2 represents a measured spectrum. Measured spectrum Sb2 has a waveform which is the same as spectral waveform DB2 and has an intensity which is different from spectral waveform DB2.

[0246] The degree of coincidence between spectral waveforms indicates the degree of coincidence between chemical reactions.

[0247] However, the degree of coincidence between intensities does not necessarily indicate the degree of coincidence between chemical reactions because the intensity varies depending on the ambient temperature and moisture and the concentration of the gas in chemical reactions.

[0248] Therefore, it is desirable to identify spectrum information corresponding to a measured spectrum by determining whether spectral waveforms coincide with each other or not.

[0249] According to the first embodiment, spectrum information is identified according to SAM. Consequently, spectrum information corresponding to a measured spectrum is identified based on the degree of coincidence between spectral waveforms.

[0250] FIG. **17***c* is illustrative of an example in which DB1, DB2, DB3, Sb1 and Sb2 are placed in one multidimensional space.

[0251] As shown in FIG. **17***c*, the angle between similar spectral waveforms Sb1 and DB2 is small, and the angle between similar spectral waveforms Sb2 and DB2 is also small.

[0252] According to the first embodiment, therefore, not only if spectral waveforms and intensities are similar to each other as shown in FIG. **17***a*, but also if spectral waveforms are similar to each other, but spectral intensities are different from each other, it is possible to identify spectrum information corresponding to a measured spectrum.

[0253] After having specified spectrum information representative of spectrum Sb(A), gas identifier **7***d***2** executes step **1608**.

[0254] In step **1608**, gas identifier **7***d***2** reads gas identifying information **7***b***2** associated with the identified spectrum information from spectrum database **7***b*.

[0255] Gas identifier **7***d***2** outputs read gas identifying information **7***b***2** to display unit **8**.

[0256] When display unit **8** receives gas identifying information **7***b***2** from gas identifier **7***d***2**, display unit **8** executes step **1609**.

[0257] In step **1609**, display unit **8** displays gas identifying information **7***b***2**.

[0258] In the present embodiment, processor **7***d* identifies the color of each reaction surface based on the spectrum of the color of the reaction surface. Therefore, it is possible to identify the color of each reaction surface with high accuracy.

[0259] In the present embodiment, processor **7***d* identifies the gas to be identified which has chemically reacted with the chemical reagents on the reaction surfaces, based on the spectrum of the color of each reaction surface.

[0260] Therefore, it is possible to identify the gas to be identified with high accuracy. In the present embodiment, spectrum database **7***b* and processor **7***d* may be modified as follows:

[0261] Spectrum database **7***b* stores gas identifying information and absorption lines obtained from the spectrums of the colors of chemical reagents **101** which have chemically reacted with gases identified by the gas identifying information, in association with each other.

[0262] Processor **7***d* identifies the absorption line of a substance that is generated by the chemical reaction between a gas to be identified and chemical reagent **101**, based on the color detected in the color measuring area. Processor **7***d* identifies an absorption line closest to the absorption line from absorption lines stored in spectrum database **7***b*. Processor **7***d* reads the gas identifying information associated with the identified absorption line as the gas identifying information representative of the gas to be identified, from spectrum database **7***b*.

[0263] It is thus possible to identify the gas to be identified based on the absorption line of the substance that is generated by the chemical reaction between the gas and the chemical reagent.

[0264] Color information may be stored in spectrum database **7***b* as follows:

[0265] The user introduces a plurality of chemical reagents into mediums **103** held in contact with a given gas in a predetermined sequence. Then, the user successively detects changes in the colors of mediums **103** using color measuring areas. Spectrum database **7***b* stores the color changes that are successively detected by the color measuring areas, as color information corresponding to the given gas (identifying information of the given gas).

[0266] Controller **7** identifies a gas to be identified as follows:

[0267] The user introduces a plurality of chemical reagents into reaction surfaces held in contact with a gas to be identified in the predetermined sequence, and successively detects changes in the colors of reaction surfaces using the color measuring areas.

[0268] Each time a color detecting area detects a change in the color of the reaction surface, processor **7***d* compares the detected color change with the color information stored in spectrum database **7***b*, and identifies the color information representing a color that is most similar to the color detected by the color detecting area, from the color information stored in spectrum database **7***b*. Processor **7***d* then reads the gas identifying information associated with the identified color information from spectrum database **7***b*.

[0269] The gas identifying device according to the first embodiment may be modified as follows:

[0270] CCD **4** detects light emitted from light-emitting unit **3** and transmitted through the reaction surfaces, rather than detecting light emitted from light-emitting unit **3** and reflected by the reaction surfaces.

[0271] The gas identifying device may be incorporated in the reader device disclosed in U.S. Pat. No. 6,228,657B1.

[0272] Colors may be identified using SAM.

[0273] A gas identifying device according to a second embodiment of the present invention will be described below.

[0274] FIG. **18** shows in block form gas identifying device **1000***b* according to the second embodiment. Gas identifying device **1000***b* identifies the colors of respective reaction surfaces and a gas to be identified, based on the ratio of components R, G, B of the colors of the reaction surfaces. Those parts of gas identifying device **1000***b* shown in FIG. **18** which are identical to those shown in FIG. **1** are denoted by identical reference characters.

[0275] As shown in FIG. **18**, gas identifying device **1000***b* comprises mount block **1**, input unit **2**, light-emitting unit **3**, color CCD **4**A, lens **5**, CCD signal processor **6**, controller **7** and display unit **8**.

[0276] Controller **7** comprises color information storage unit **7***a*, gas information storage unit **7***b*, memory **7***c* and processor **7***d*.

[0277] Reactive board **10**B, which is an example of a board to be measured, is mounted in mount block **1**.

[0278] FIG. **19** shows reactive board **10**B and color CCD **4**A.

[0279] As shown in FIG. **19**, reactive board **10**B has a matrix of reaction surfaces (surfaces to be measured) **10***h*, **10***i*, **10***j* and **10***k*. Each of reaction surfaces **10***h* through **10***k* is disposed in a predetermined position on reactive board **10**B. In FIG. **19**, the ampules are omitted from illustration.

[0280] Color CCD **4**A has a plurality of color measuring areas **4***h*, **4***i*, **4***j* and **4***k* corresponding respectively to reaction surfaces **10***h*, **10***i*, **10***j* and **10***k* of reactive board **10**B mounted in mount block **1**. Specifically, color measuring area **4***h* corresponds to reaction surface **10***h*, color measuring area **4***i* to reaction surface **10***i*, color measuring area **4***j* to reaction surface **10***j*, and color measuring area **4***k* to reaction surface **10***k*. Each of color measuring areas **4***h* through **4***k* comprises an array of photodetectors.

[0281] When reactive board **10**B is mounted in mount block **1** and held by holder **1***b*, lens **5** forms image **10***h***1** of reaction surface **10***h* on color measuring area **4***h*, image **10***i***1** of reaction surface **10***i* on color measuring area **4***i*, image **10***j***1** of reaction surface **10***j* on color measuring area **4***j*, and image **10***k***1** of reaction surface **10***k* on color measuring area **4***k* at the same time.

[0282] Therefore, an output signal from color measuring area **4***h* varies depending on the color of reaction surface **10***h*, an output signal from color measuring area **4***i* varies depending on the color of reaction surface **10***i*, an output signal from color measuring area **4***j* varies depending on the color of reaction surface **10***j*, and an output signal from color measuring area **4***k* varies depending on the color of reaction surface **10***k*.

[0283] As shown in FIG. **18**, color information storage unit **7***a* stores a chromaticity diagram. The chromaticity diagram has x and y coordinates. The x coordinates represent values R/(R+G+B), and the y coordinates values G/(R+G+B). R represents a red component of color, G a green component of color, and B a blue component of color. The chromaticity diagram is peculiar to the present invention. In other words, the chromaticity diagram may be a relative chromaticity diagram.

[0284] Gas information storage unit **7***b* stores gas identifying information for identifying gases and chromaticity diagram coordinates of the colors of chemical reagents that have chemically reacted with gases identified by the gas identifying information, in association with each other.

[0285] Memory **7***c* stores the output signals from color measuring areas **4***h* through **4***k*.

[0286] FIG. **20** shows memory **7***c* by way of example. As shown in FIG. **20**, memory **7***c* has a plurality of storage areas **7***ch*, **7***ci*, **7***cj* and **7***ck*.

[0287] As shown in FIG. **18**, processor **7***d* processes an output signal from CCD**4**A with respect to each of color measuring areas **4***h* through **4***k*.

[0288] Specifically, processor **7***d* stores the output signal from color measuring area **4***h* into storage area **7***ch*, the output signal from color measuring area **4***i* into storage area **7***ci*, the output signal from color measuring area **4***j* into storage area **7***cj*, and the output signal from color measuring area **4***k* into storage area **7***ck*.

[0289] Processor **7***d* integrates output values of components R, G, B of color measuring area **4***h* respectively. It is assumed that an integrated value of output values of component R is represented by R**1**, an integrated value of output values of component G by G**1**, and an integrated value of output values of component B by B**1**.

[0290] Processor **7***d* then calculates x=R**1**/(R**1**+G**1**+B**1**) and y=G**1**/(R**1**+G**1**+B**1**). Processor **7***d* applies calculated x and y to x and y coordinates of the chromaticity diagram stored in color information storage unit **7***a* to identify the color of reaction surface **10***h*.

[0291] Then, processor **7***d* identifies coordinates closest to the identified x and y coordinates of the chromaticity diagram, from the coordinates stored in gas information storage unit **7***b*. Processor **7***d* reads the gas identifying information associated with the identified coordinates from gas information storage unit **7***b*.

[0292] Then, processor **7***d* controls display unit **8** to display the color of reaction surface **10***h* and the gas identifying information.

[0293] Processor **7***d* also processes output signals from other color measuring areas **4***i*, **4***j* and **4***k* in the same manner as with color measuring area **4***h*.

[0294] Operation of gas identifying device **1000***b* according to the second embodiment will be described below.

[0295] Gas identifying device **1000***b* operates essentially according to the flowchart shown in FIG. **7**.

[0296] Therefore, steps **703** and **704** based on a feature of the second embodiment will mainly be described below.

[0297] In step **703**, processor **7***d* integrates respective output values of components R, G and B of color measuring area **4***h*, thereby calculating integrated values R**1**, G**1** and B**1**.

[0298] Processor **7***d* then calculates x=R**1**/(R**1**+G**1**+B**1**) and y=G**1**/(R**1**+G**1**+B**1**). Processor **7***d* applies calculated x and y to x and y coordinates of the chromaticity diagram stored in color information storage unit **7***a* to identify the color of reaction surface **10***h*. Processor **7***d* also processes output signals from other color measuring areas **4***i*, **4***j* and **4***k* in the same manner as with color measuring area **4***h*.

[0299] After having identified the colors of reaction surfaces **10***h* through **10***k*, processor **7***d* executes step **704**.

[0300] In step **704**, processor **7***d* identifies the coordinates closest to the coordinates obtained as representing the color of reaction surface **10***h* from the coordinates stored in gas information storage unit **7***b*. Processor **7***d* reads the gas identifying information associated with the identified coordinates from gas information storage unit **7***b*. Processor **7***d* also processes output signals from other color measuring areas **4***i*, **4***j* and **4***k* in the same manner as with color measuring area **4***h*.

[0301] According to the second embodiment, processor **7***d* identifies the colors of the reaction surfaces based on components R, G and B of the colors of the reaction surfaces. Therefore, the colors of the reaction surfaces can be identified with high accuracy.

[0302] According to the second embodiment, furthermore, processor **7***d* identifies a gas to be identified which has chemically reacted with the chemical reagents on the reaction surfaces, based on components R, G, B of the colors of

the reaction surfaces. Therefore, the gas to be identified can be identified with high accuracy.

[0303] While a preferred embodiment of the present invention has been described using specific terms, such description is for illustrative purposes only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following claims.

What is claimed is:

1. A color identifying device comprising:

a mount block for mounting a board to be measured which has a plurality of surfaces to be measured in predetermined positions, respectively;

a color detector having a plurality of color measuring areas corresponding respectively to said surfaces while said board is mounted on said mount block;

a lens for forming respective images of said surfaces of said board mounted on said mount block, respectively on said color measuring areas corresponding respectively to said surfaces; and

a color identifier for identifying colors of said surfaces which correspond respectively to said color measuring areas, based on output signals from said color measuring areas corresponding respectively to said surfaces.

2. The color identifying device according to claim **1**, wherein said output signals from said color measuring areas represent spectrums of the colors of said surfaces which correspond respectively to said color measuring areas.

3. The color identifying device according to claim **1**, wherein said output signals from said color measuring areas represent three components of the colors of said surfaces which correspond respectively to said color measuring areas.

4. The color identifying device according to claim **3**, wherein said output signals from said color measuring areas represent red, green and blue components of the colors of said surfaces which correspond respectively to said color measuring areas.

5. A gas identifying device comprising:

a mount block for mounting a reactive board having a plurality of reaction surfaces disposed in predetermined positions, respectively, said reaction surfaces having colors variable by chemical reactions between a gas to be identified and chemical reagents;

a color detector having a plurality of color measuring areas corresponding respectively to said reaction surfaces while said board is mounted on said mount block;

a lens for forming respective images of said reaction surfaces of said board mounted on said mount block, respectively on said color measuring areas corresponding respectively to said surfaces; and

a gas identifier for identifying said gas based on output signals from said color measuring areas corresponding respectively to said surfaces.

6. The gas identifying device according to claim **5**, wherein said output signals from said color measuring areas represent spectrums of the colors of said reaction surfaces which correspond respectively to said color measuring areas.

7. The gas identifying device according to claim **5**, wherein said output signals from said color measuring areas represent three components of the colors of said reaction surfaces which correspond respectively to said color measuring areas.

8. The gas identifying device according to claim **7**, wherein said output signals from said color measuring areas represent red, green and blue components of the colors of said reaction surfaces which correspond respectively to said color measuring areas.

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