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(54) **FOOD INSPECTION APPARATUS**

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(57) **ABSTRACT**

A food inspection apparatus configured to inspect food being conveyed by a conveyance mechanism includes an optical unit and a transparent window member. The optical unit is disposed above the conveyance mechanism and includes an imager. The imager is configured to image the conveyed food and acquire inspection information on the food. The transparent window member is disposed between the conveyance mechanism and the optical unit.

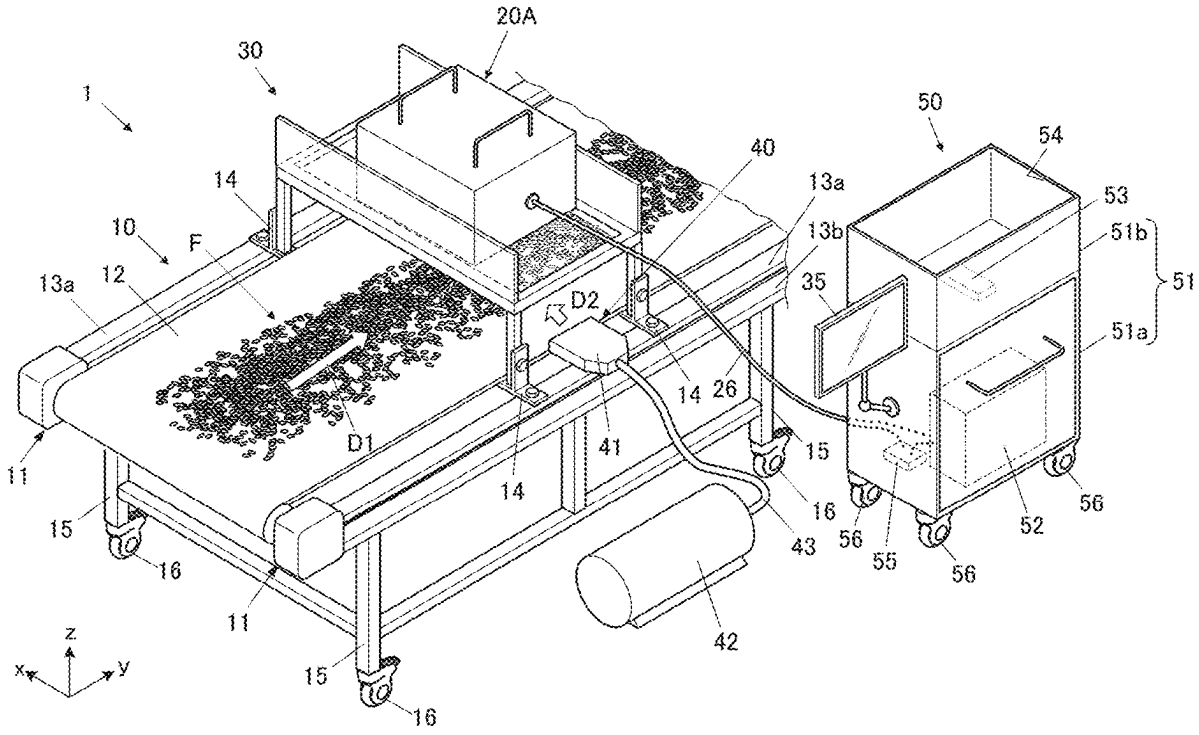
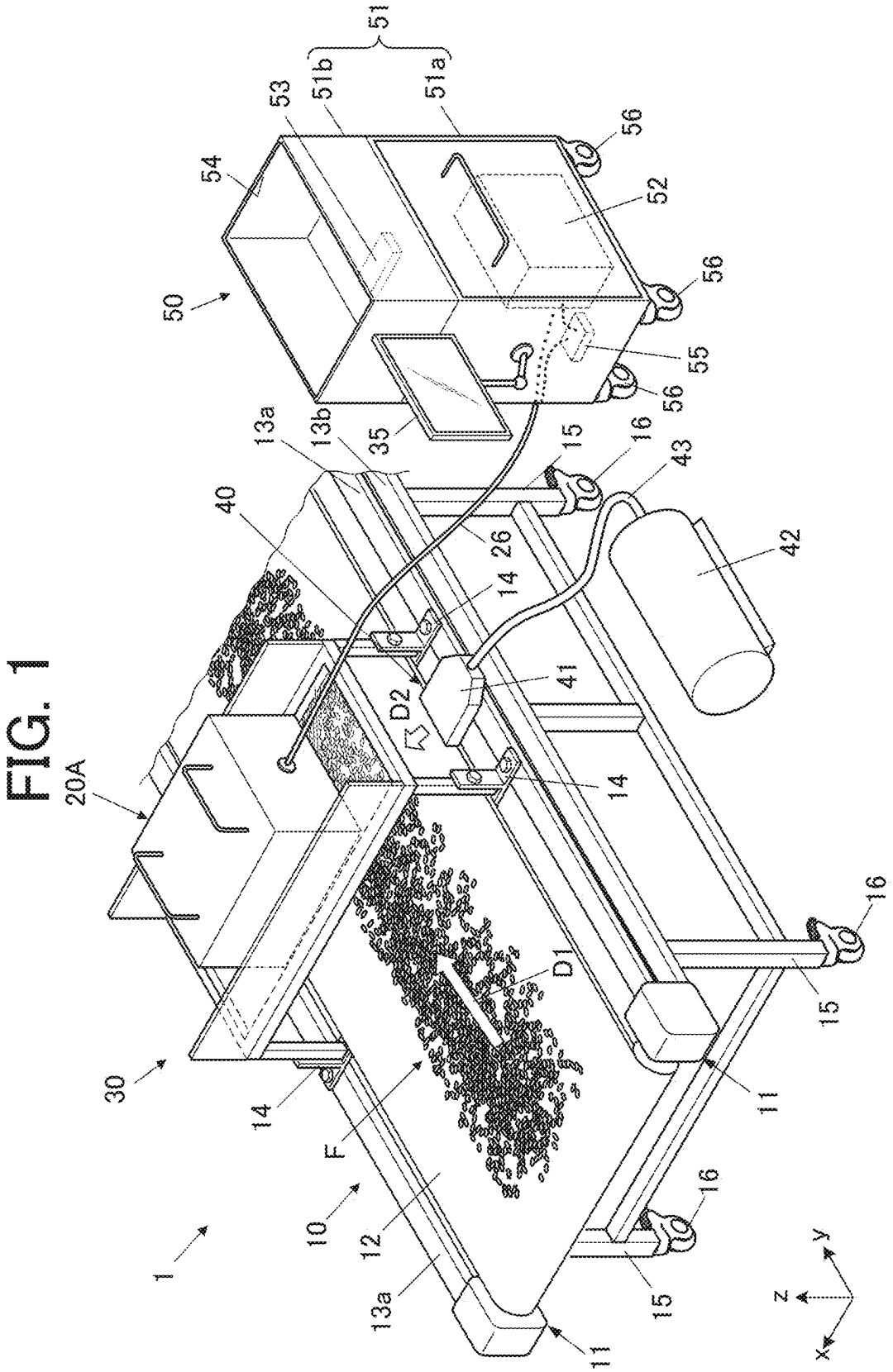


FIG. 1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D2
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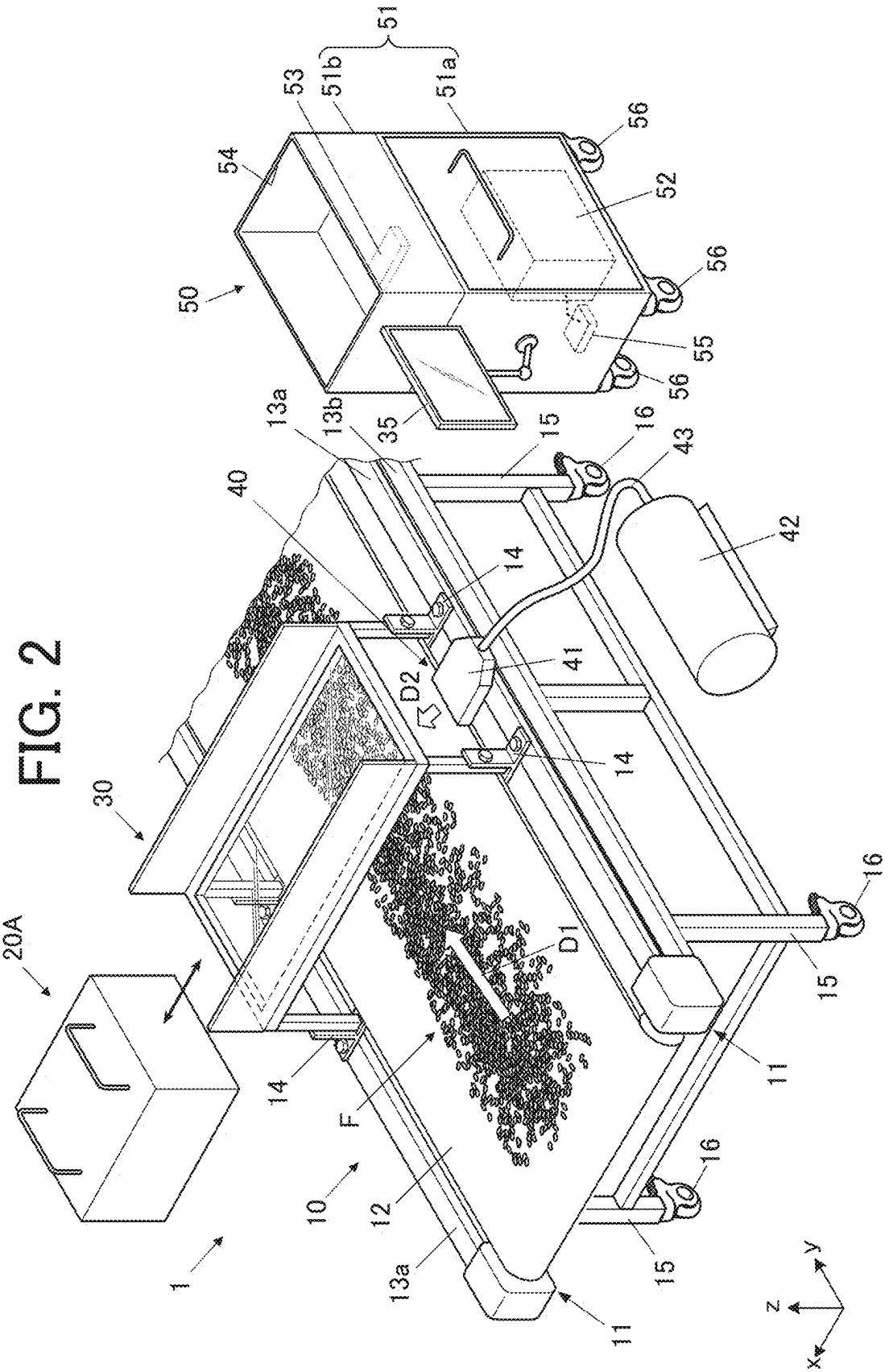
FIG. 2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D2
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FIG. 3

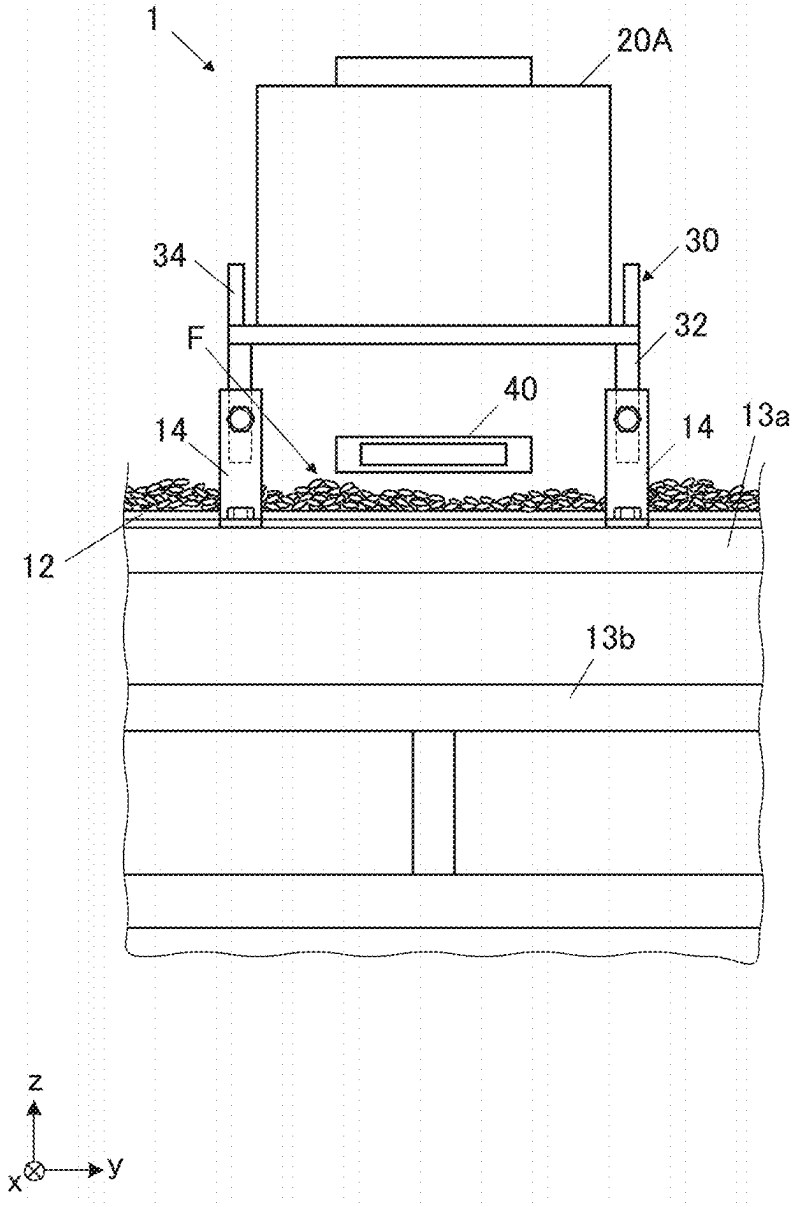


FIG. 4

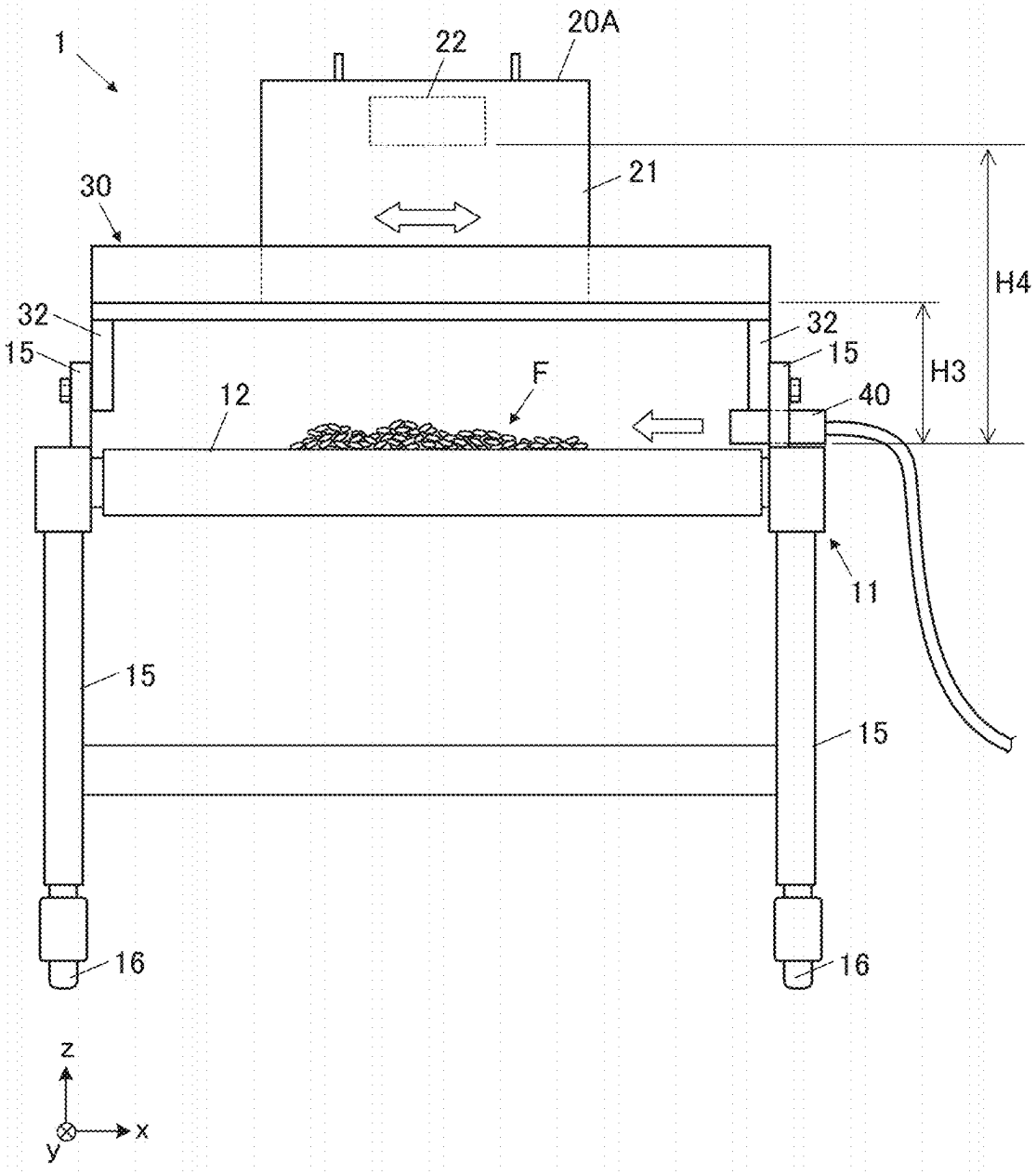


FIG. 5

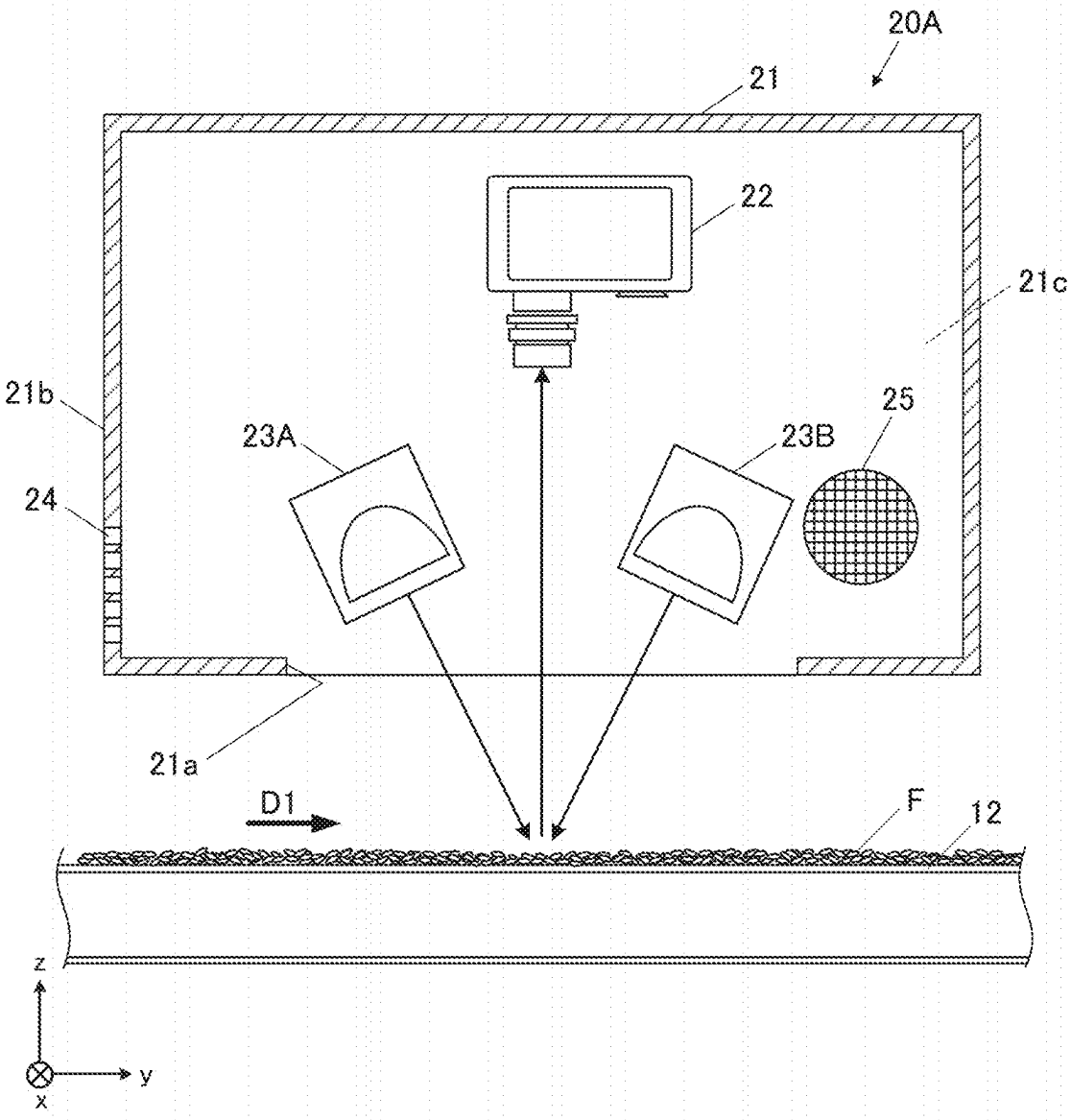


FIG. 6

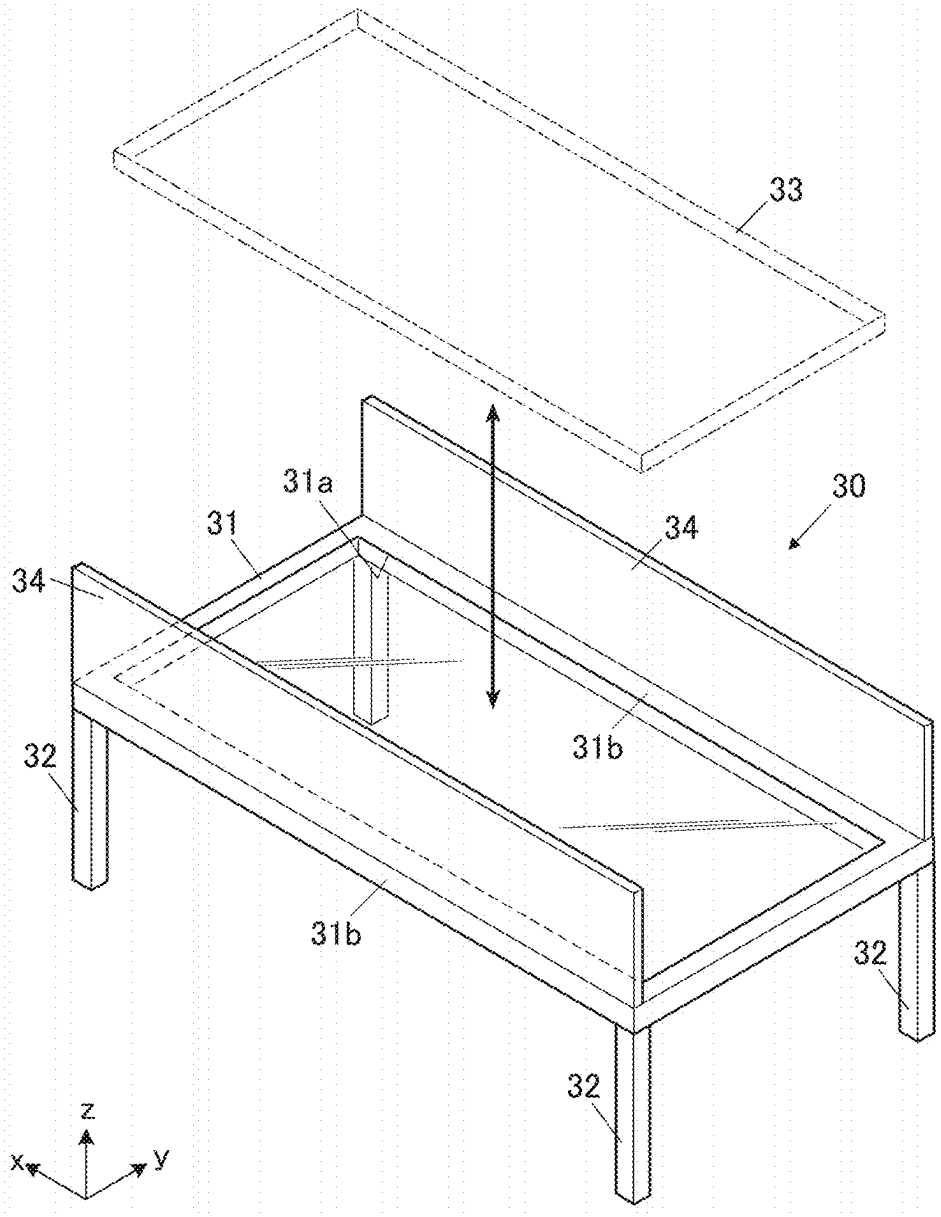


FIG. 7

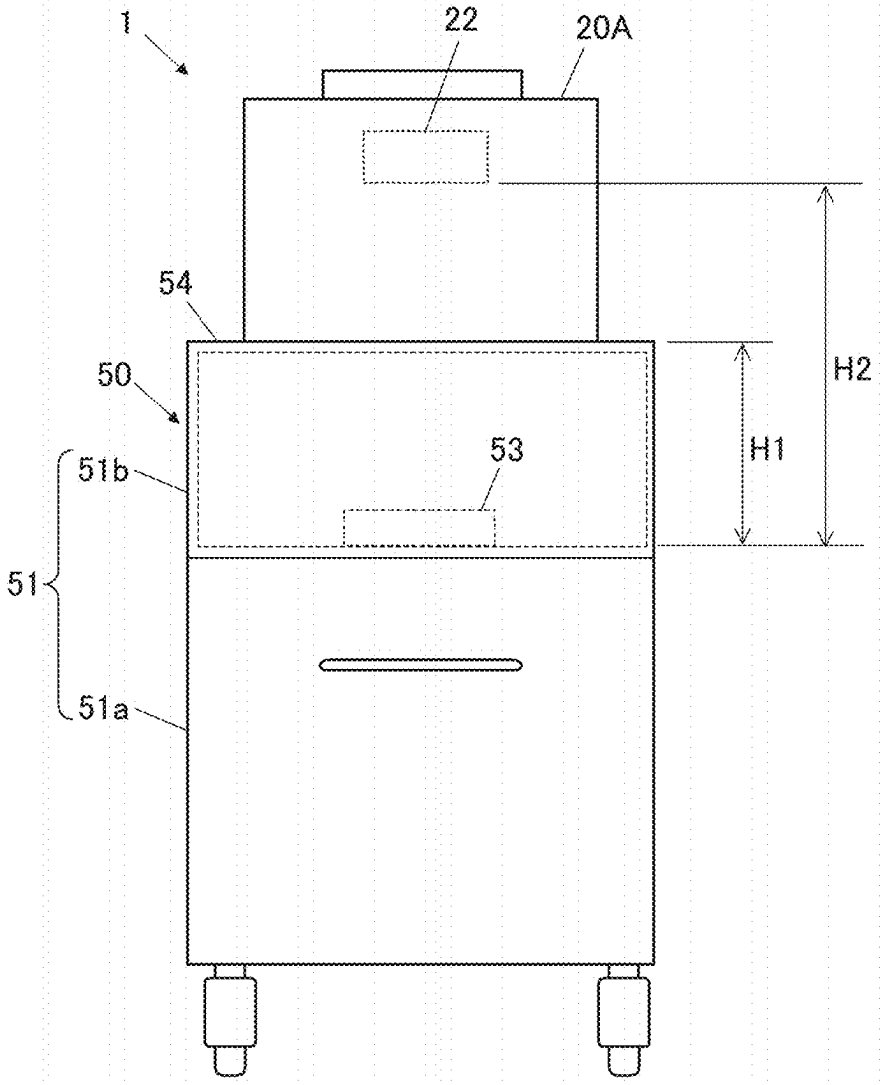
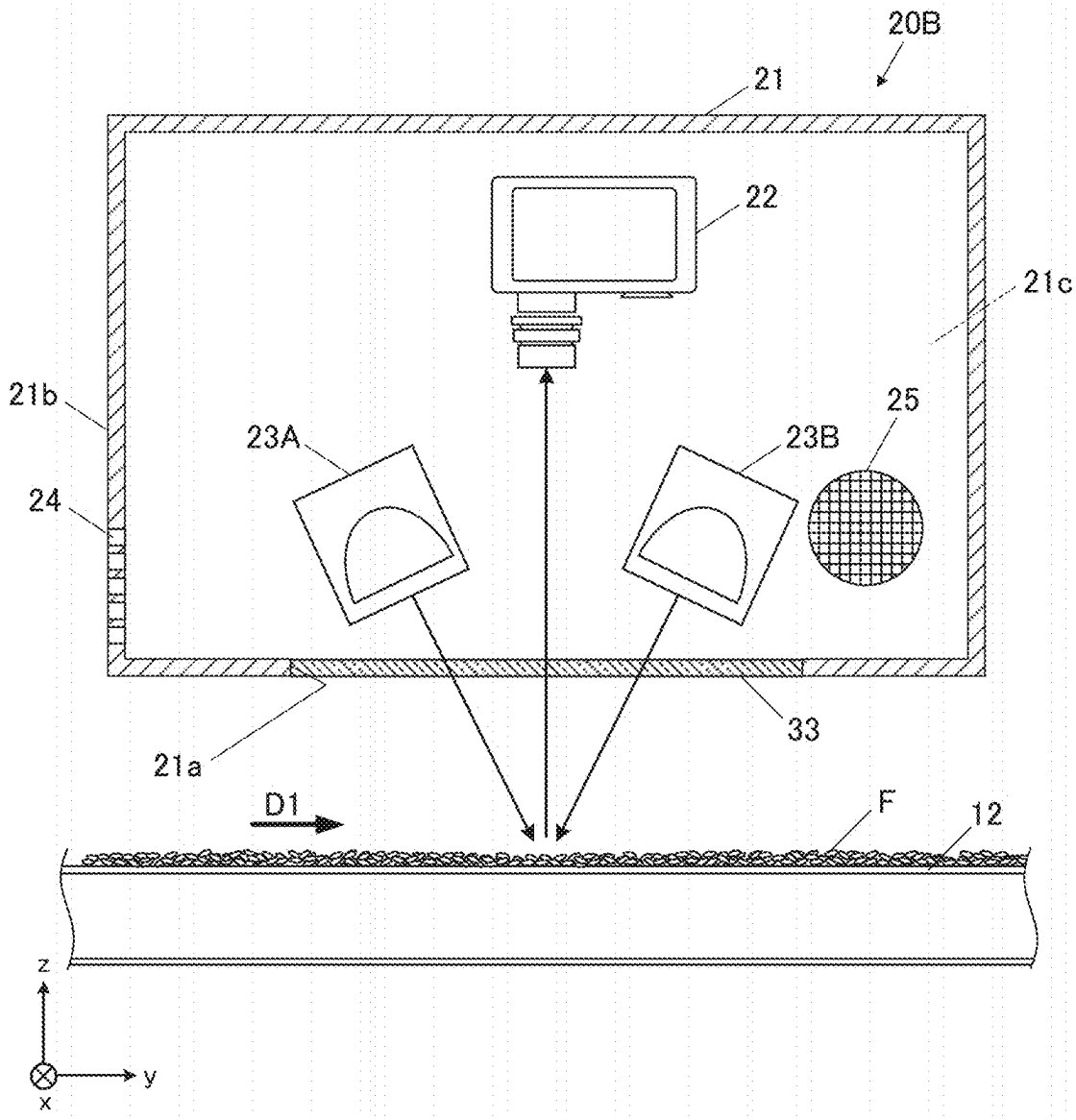


FIG. 8



FOOD INSPECTION APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The entire disclosure of Japanese Patent Application No. 2024-020538 filed on Feb. 14, 2024, is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

Technical Field

[0002] The present invention relates to a food inspection apparatus.

Description of Related Art

[0003] In food processing, the water content of food conveyed on a belt conveyor is inspected for stable quality control of food. To inspect the water content of food, an analytical apparatus, such as a multispectral camera, can be used that calculates the two-dimensional distribution of the water content of food in an evaluation area on the belt.

[0004] Japanese Unexamined Patent Publication No. H 6-109719 (A) discloses a quality evaluation method for calculating the water content of food, such as cooked rice. The quality evaluation method uses a near-infrared spectroscopic analyzer to calculate the water content in the cooked rice by multiple regression analysis of the wavelength of light reflected by the cooked rice. The near-infrared spectroscopic analyzer is disposed near the cooked rice outlet of the continuous rice cooker.

[0005] In the known art, the steam, oil splash, or the like from food conveyed by the conveyance device may stain the camera of the optical unit constituting the food inspection apparatus. Such stains prevent accurate inspections of the water content of food.

[0006] To deal with the above-described issue, an object of the present invention is to provide a food inspection apparatus capable of preventing contamination of an imager of an optical unit.

SUMMARY OF THE INVENTION

[0007] To achieve at least one of the abovementioned objects, according to an aspect of the present invention, there is provided a food inspection apparatus configured to inspect food being conveyed by a conveyance mechanism, the food inspection apparatus including: an optical unit that is disposed above the conveyance mechanism and that includes an imager, the imager being configured to image the conveyed food to acquire inspection information on the food; and a transparent window member disposed between the conveyance mechanism and the optical unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The advantages and features provided by one or more embodiments of the invention will become more fully understood from the detailed description given hereinafter and the appended drawings which are given by way of illustration only, and thus are not intended as a definition of the limits of the present invention, and wherein:

[0009] FIG. **1** is a perspective view of a schematic configuration of a food inspection apparatus after an optical unit is set on a conveyance mechanism according to the present embodiment as an example;

[0010] FIG. **2** is a perspective view of the schematic configuration of the food inspection apparatus before the optical unit is set on the conveyance mechanism according to the present embodiment as an example;

[0011] FIG. **3** is a side view of a schematic configuration of the food inspection apparatus after the optical unit is set on the conveyance mechanism according to the present embodiment as an example;

[0012] FIG. **4** is a front view of a schematic configuration of the food inspection apparatus after the optical unit is set on the conveyance mechanism according to the present embodiment as an example;

[0013] FIG. **5** is a diagram of the internal configuration of the optical unit according to the present embodiment as an example;

[0014] FIG. **6** is a diagram of the configuration of a stand according to the present embodiment;

[0015] FIG. **7** is a diagram for explaining the flow of obtaining reference information that is used in calibration of spectral data obtained by the imager according to the present embodiment; and

[0016] FIG. **8** is a diagram of the internal configuration of the optical unit of the food inspection apparatus according to a modification example.

DETAILED DESCRIPTION

[0017] Hereinafter, a food inspection apparatus according to a preferred embodiment of the present disclosure will be described in detail with reference to the drawings. However, the scope of the invention is not limited to the disclosed embodiments.

Configuration Example of Food Inspection Apparatus **1**

[0018] FIG. **1** is a perspective view of the schematic configuration of a food inspection apparatus **1** after an optical unit **20**A is set on a conveyance mechanism **10** according to the present embodiment as an example. FIG. **2** is a perspective view of the schematic configuration of the food inspection apparatus **1** after the optical unit **20**A is set on the conveyance mechanism **10** according to the present embodiment as an example. FIG. **3** is a side view of the schematic configuration of the food inspection apparatus **1** after the optical unit **20**A is set on the conveyance mechanism **10** according to the present embodiment as an example. FIG. **4** is a front view of the schematic configuration of the food inspection apparatus **1** after the optical unit **20**A is set on the conveyance mechanism **10** according to the present embodiment as an example.

[0019] In FIG. **1** and other figures, the width direction (left-right direction) of a belt **12** of the conveyance mechanism **10**, which are described later, is defined as the x-axis direction; and the extending direction (front-rear direction) of the belt **12** is defined as the y-axis direction. The up-down direction perpendicular to the x-axis direction and the y-axis direction of the belt **12** is defined as the z-axis direction. The extending direction of the belt **12** is the conveyance direction D**1** of the belt **12**. In FIG. **3** and FIG. **4**, the processing apparatus main body **50** is omitted for convenience.

[0020] The food inspection apparatus **1** is installed in a manufacturing line for manufacturing food F. The food inspection apparatus **1** performs quality inspection of the food F by imaging the conveyed food F and acquiring inspection information on the food F. Examples of the food F include cooked rice coated with a coating agent for frozen food, such as oil. The inspection information includes, for example, spectroscopic data on moisture absorption of the food F. As illustrated in FIG. **1**, the food inspection apparatus **1** includes the conveyance mechanism **10**, the optical unit **20**A, a stand **30**, a cooling mechanism **40**, and the processing apparatus main body **50**.

[0021] The conveyance mechanism **10** includes a drive section **11**, an endless belt **12**, and support members **13***a* and **13***b*. The drive section **11** moves the belt **12** along the conveyance direction D**1**. For example, the drive section **11** may be constituted of rollers, a motor, and so forth; and the motor may be driven to rotate the rollers to move the belt **12** in close contact with the rollers. For another example, the drive section **11** may be constituted of a chain, a gear, a motor, and the like; and the motor may be driven to rotate the gear engaging with the chain to move the belt **12**.

[0022] The belt **12** is stretched around the rollers disposed at a predetermined interval and is moved in the conveyance direction DI by the drive section **11**. The food F is placed on the top surface of the belt **12** so as to spread in a planar shape. As the belt **12** moves in the conveyance direction D**1**, the food F on the top surface of the belt **12** passes through an imaging area where the imager **22** performs imaging.

[0023] The support members **13***a* and **13***b* support the drive section **11** and the belt **12**. The support members **13***a* and **13***b* are disposed on the left and right sides of the belt **12** and extend in the conveyance direction D**1** of the belt **12**. Although not illustrated, the conveyance mechanism **10** may include rails and rollers that directly support the belt **12** in addition to the support members **13***a* and **13***b*. A leg **15** that supports the belt **12** and so forth is attached to the support member **13***b*. The support member **13***b* extends downward. To the lower ends of the support member **13***b*, casters **16** as an example of a transportation mechanism are attached. Thus, the conveyance mechanism **10** can be moved freely, and the position of the conveyance mechanism **10** in the manufacturing line can be changed easily. The conveyance mechanism **10** may be stationary.

[0024] To the upper top surfaces of the support members **13***a*, one ends of attaching brackets **14** are attached by fastening members, such as screws. The attaching brackets **14** are for attaching the stand **30**. To the other ends of the attaching brackets **14**, legs **32** of the stand **30** (described later) are attached by fastening members, such as screws. In the present embodiment, the attaching brackets **14** are attached to the left and right support members **13***a* at positions corresponding to the four legs **32** of the stand **30**. The attaching brackets **14** are an example of attachment members.

[0025] The optical unit **20**A is movably disposed above the belt **12**. Specifically, when the optical unit **20**A is placed on the stand **30**, the optical unit **20**A is movable in the left-right direction on the stand **30** so that the operator can manually move the optical unit **20**A to the position of the conveyed food F on the top surface of the belt **12**. A handle is attached to the top surface of the optical unit **20**A so that the operator can carry the optical unit **20**A. The position of the optical unit **20**A may not be manually adjusted. For example, a sensor may detect the positional shift of the optical unit **20**A with respect to the food F; and, based on the detection result by the sensor, a machine may automatically adjust the position of the optical unit **20**A. The optical unit **20**A images the food F on the conveyed belt **12** to acquire inspection information on the food F. The optical unit **20**A outputs the acquired inspection information on the food F to an information processing apparatus **52** (described later) via a wire **26**.

[0026] As shown in FIGS. **1**, **3** and **4**, the optical unit **20**A is disposed on the stand **30**. The stand **30** supports the optical unit **20**A such that the optical unit **20**A is movable. The stand **30** also determines the height of the imager **22** of the optical unit **20**A from the top surface of the belt **12**. That is, the stand **30** serves as a member that adjusts the focus of the imager **22** of the optical unit **20**A on the food F placed on the top surface of the conveyed belt **12**. The stand **30** includes an adjustment mechanism configured to adjust the height of the stand **30** from the top surface of the belt **12**. Thus, even when the imager **22** on the stand **30** is slightly unfocused, the focus of the imager **22** can be adjusted by adjusting the height of the stand **30** with the adjustment mechanism. Although the stand **30** is attached to the conveyance mechanism **10** in FIG. **1** as an example, the stand **30** may be attached to the optical unit **20**A.

[0027] As shown in FIGS. **1**, **3**, and **4**, the cooling mechanism **40** cools the food F, the stand **30**, and the components of the optical unit **20**A in the surrounding area by blowing air to the conveyed food F on the top surface of the belt **12** and the stand **30**. The cooling mechanism **40** includes a blowing section **41** and an air supply section **42**. The blowing section **41** is disposed on one end of the belt **12** in the width direction and in a space between the belt **12** and the stand **30**. Specifically, the blowing section **41** is an air nozzle. The blowing section **41** is disposed such that its blowing port faces the food F on the top surface of the belt **12** or the stand **30**. The blowing section **41** blows air in the direction of the arrow D**2**. The air supply section **42** is, for example, an air compressor. The air supply section **42** is connected to the blowing section **40** via an air tube **43**. By driving the air supply section **42**, air is supplied to the blowing section **41** via the air tube **43**.

[0028] Although the blowing section **41** is an air nozzle in FIG. **1** as an example, the present invention is not limited thereto. For example, the blowing section **41** may be a fan. Although only one blowing section **41** is provided on one end of the belt **12** in the width direction, the blowing section **41** may be provided on the other end of the belt **12** in the width direction or on both ends of the belt **12** in the width direction. In such a case, multiple blowing sections **41** may be provided on one end and/or the other end of the belt **12** in the width direction. Further, multiple air outlets or multiple blowing sections **41** may be provided to blow air to the food F, the window member **33** of the stand **30**, and the optical unit **20**A, respectively. Further, the air blowing directions may be toward the window member **33** of the stand **30** and the edge of the housing **21** of the optical unit **20**A (see FIG. **5**) to prevent condensation on the window member **33** and the housing **21**, for example.

[0029] The processing apparatus main body **50** is disposed on the floor around the conveyance mechanism **10**. The processing apparatus main body **50** houses the information processing apparatus **52**, which is heavy. The processing apparatus main body **50** includes, for example, a housing **51**

constituted pf two sections: a lower section **51***a* and an upper section **51***b*. The lower section **51***a* of the housing **51** is, for example, a drawer, and a handle is attached to the front of the housing **51**. The lower section **51***a* of the housing **51** houses the information processing apparatus **52**, a power tap **55**, and so forth. On the four positions of the bottom surface of the housing **51**, casters **56** are attached as an example of a transportation mechanism. Thus, the processing apparatus main body **50** can be moved freely, and the position of the processing apparatus main body **50** in the manufacturing line can be changed easily. The information processing apparatus **52** may be mounted on the optical unit **20**A, depending on the weight of the information processing apparatus **52**.

[0030] The information processing apparatus **52** is, for example, a computer. The information processing apparatus **52** includes a processor that performs control and calculations, such as a CPU, and a memory, such as a RAM. CPU is an abbreviation for Central Processing Unit. RAM is an abbreviation for Random Access Memory. The information processing apparatus **52** is connected to the conveyance mechanism **10** and the optical unit **20**A via the wires **26** and controls the conveyance mechanism **10** and the optical unit **20**A. For example, when a multispectral camera is used as the imager **22**, the processing apparatus **52** acquires spectral data of multiple wavelengths (inspection information) on the moisture absorption of the food F from a multispectral image of the food F obtained by the imager **22**. The processing apparatus **52** analyzes the obtained spectral data of the multispectral image of the food F to calculate information indicating a two-dimensional distribution of the moisture content (amount of water) of the food F. As the information indicating the two-dimensional distribution of the moisture content of the food F, the processing apparatus **52** creates a two-dimensional distribution image. The two-dimensional distribution image is a heat map separately colored with multiple tone values or multiple colors.

[0031] The display part **35** is, for example, a liquid crystal display or an organic EL display. The EL is an abbreviation for Electro Luminescence. The display part **35** is attached to the side surface of the housing **51** via an arm, for example. The display part **35** is arranged near the conveyance mechanism **10**. Thus, the operator can quickly check the moisture content of the conveyed food F on the top surface of the belt **12**. For example, the display part **35** displays the two-dimensional distribution image and the statistical values of the moisture content in a predetermined region of the two-dimensional distribution image on the screen, based on the display data output by the processing apparatus **52**. Although the display part **35** is attached to the processing apparatus main body **50** in the present embodiment, the display part **35** may be provided on a stand or may be installed in a room different from the room of the manufacturing line.

[0032] A calibration member **53** is disposed on the bottom surface of the upper section **51***b* of the housing **51**. Specifically, the calibration member **53** is disposed at a position where the distance between the imager **22** of the optical unit **20**A and the top surface of the belt **12** of the moving mechanism **10** can be recreated. The calibration member **53** is used to adjust and calibrate the light reflectivity and the like of the image information obtained by the imager **22** of the optical unit **20**A. As the calibration member **53**, a standard diffusion plate is used, for example. In the top surface of the upper section **51***b* of the housing **51**, an opening **54** is formed so that the imager **22** can image the calibration member **53**. The size of the opening **54** is determined to prevent fall of the optical unit **20**A. The opening **54** has an edge to support the optical unit **20**A. The top of the upper section **51***b* may not be the opening **54**, but a window member made of a transparent material may be attached to the top of the upper section **51***b*. The processing apparatus main body **50** may include an adjustment mechanism configured to adjust the height of the bottom surface on which the calibration member **53** is disposed and/or adjust the height of the window member on which the optical unit **20**A is placed.

Internal Configuration Example of Optical Unit **20**A

[0033] FIG. **5** is a diagram illustrating an example of the internal configuration of the optical unit **20**A according to the present embodiment. The optical unit **20**A includes a housing **21**, the imager **22**, light sources **23**A and **23**B, intake slits **24**, and an exhaust port **25**. In FIG. **5**, the optical unit **20**A is set on the conveyance mechanism **10** such that the light sources **23**A and **23**B are aligned in the conveyance direction D**1** of the belt **12** as an example. The orientation of the optical unit **20**A with respect to the conveyance mechanism **10** is not limited to the examples of FIG. **5** and other figures.

[0034] The housing **21** has a box shape and houses the imager **22** and the light sources **23**A and **23**B. The housing **21** is made of a metal, for example. In the bottom surface of the housing **21**, an opening **21***a* that faces the belt **12** is formed. The opening **21***a* allows light to pass through, such as (i) the light including the wavelength components emitted by the light sources **23**A, **23**B and used in the inspection and (ii) the reflection light reflected by the food F placed on the top surface of the belt **12**.

[0035] The imager **22** is, for example, a multispectral camera. The imager **22** images the food F conveyed in the conveyance direction D**1** in the imaging area by the belt **12** and obtains a multispectral image of the food F. The imager **22**, which includes at least a near-infrared region in its imaging wavelength range, disperses light into multiple wavelength bands to perform imaging. The imager **22** generates a data cube constituted of superposed two-dimensional (x and y axes) plane images of the food F (imaging target) for the respective spectral wavelength regions. The multispectral camera as the imager **22** may include a hyperspectral camera. The imager **22** is not limited to the multispectral camera but may be, for example, an infrared camera.

[0036] The light sources **23**A and **23**B include, for example, halogen lamps and LEDs. The light sources **23**A and **23**B are disposed at a predetermined distance from each other in the front-rear direction with respect to the imager **22**, for example. The light sources **23**A and **23**B emit light including wavelengths used in the inspection toward the food F in the imaging area on the top surface of the belt **12**. The light emitted by the light sources **23**A and **23**B is reflected by the food F conveyed by the belt **12**, and the reflected light is imaged by the imager **22**. The food inspection apparatus **1** may include a sensor that detects a decrease in the intensity of light emitted by the light sources **23**A and **23**B.

[0037] The air intake slits **24** are formed, for example, in the front wall **21***b* of the housing **21**. The air intake slits **24** allow outside air to flow into the housing **21**. The air outlet **25** is provided, for example, on the downstream side of the air intake slit **24** and is formed in the side wall **21***c* of the housing **21**. The air outlet **25** discharges the air in the housing **21** to the outside. The inside of the housing **21** can be efficiently ventilated by the air intake slits **24** and the air outlet **25**. The ventilation prevents stagnation of water vapor in the housing **21** and occurrence of dew condensation.

Configuration Example of Stand **30**

[0038] FIG. **6** is a diagram illustrating an example of the configuration of the stand **30** according to the present embodiment. The stand **30** includes a frame **31**, the four legs **32**, the transparent window member **33**, and a pair of guide members **34**. The frame **31** has a rectangular shape in a plan view. The inner edge of the frame **31** forms an opening **31***a* to which the window member **33** is attached. The opening **31***a* has a size that allows the imager **22** to image the conveyed food F. The width of the frame **31** in the short-side direction is at least equal to or longer than the width of the optical unit **20**A in the y-axis direction (see FIG. **1**). The width of the frame **31** in the long-side direction is at least equal to or longer than the width of the belt **12** in the x-axis direction (see FIG. **1**).

[0039] The legs **32** are attached to the respective corners of the frame **31** and extend downward from the corners by a predetermined length. The legs **32** have screw holes (not-illustrated). Fastening members, such as screws, are fitted into the screw holes in the legs **32** and the screw holes of the attaching brackets **14** of the conveyance mechanism **10**, thereby fastening the four legs **32** to the corresponding four attaching brackets **14**. It is preferable that the length of the legs **32** be determined, based on the designed distance between the imager **22** of the optical unit **20**A and the top surface of the belt **12** of the conveyance mechanism **10**. Each of the legs **32** may have multiple screw holes in the height direction so that the height of the stand **30** from the top surface of the belt **12** can be adjusted stepwise. For another example, the screw holes may be elongated holes so that the height of the stand **30** from the top surface of the belt **12** can be adjusted continuously. The adjustment mechanism that adjusts the height of the legs **32** may be a jack, for example. Further, the stand **30** may not be attached to the conveyance mechanism **10** with the fastening members (e,g., screws) but may be attached by any other known method.

[0040] The transparent window member **33** has a predetermined thickness and has a shape substantially equal to or slightly greater than the external shape of the opening **31***a* of the frame **31**. The window member **33** is removably attached to the opening **31***a* of the frame **31**. The window member **33** may be fitted into the opening **31***a* of the frame **31**, may be mounted on the frame **31**, or may be attached to the frame **31** by being inserted to the insertion hole formed in the lateral surface of the frame portion **31**. Being transparent means having a high transmittance at the wavelength of light. Specifically, the window member **33** is made of a material that can transmit the light emitted by the light sources **23**A and **23**B and that can transmit the light reflected by the conveyed food F. The material of the window member **33** is, for example, polycarbonate, and has a glass transition temperature [Tg] of 170° C. or higher. The material of the window member **33** is not limited to polycarbonate as long as the material is transparent and resistant to heat. Attachment and detachment of the window member **33** to and from the frame **31** may be automated by a machine, for example. Further, the food inspection apparatus **1** may include a sensor that detects stains and so forth of the window member **33**. In this case, the information processing apparatus **52** may determine the timing of cleaning the window member **33**, based on the detection result of the sensor, for example. Further, the window member **33** may not be detachable but may be fixed to the frame **31**.

[0041] The guide members **34** are elongated plate members. The guide members **34** stand in the z-axis direction and face the long side members **31***b* that constitute the frame **31**. Thus, the guide members **34**, which serve as walls having a predetermined height, are provided on the frame **31** in the direction perpendicular to the conveyance direction D**1** (the direction intersecting the conveyance direction D**1**). It is preferable that the distance between the guide members **34** in the y-axis direction be slightly greater than the width of the optical unit **20**A in the y-axis direction. Thus, when the optical unit **20**A on the stand **30** is moved in the left-right direction, the movement of the optical unit **20**A in the front-rear direction is limited by the guide members **34**. Therefore, the optical unit **20**A can be moved to a position above the food F without being dropped off the stand **30**.

[0042] The optical unit **20**A may have a not-illustrated stopper that fixes the optical unit **20**A to the stand **30**, for example. For example, the stopper may be constituted of: a slider that holds the guide members **34** and slidably engages with the guide members **34**; and bolts that fix the position of the slider to the guide members **34**. The optical unit **20**A is attached to the inner side of the slider. In such a case, after the optical unit **20**A is moved to the position above the food F, the bolts are tightened from the outside to fasten the guide members **34** to the slider. Thus, the optical unit **20**A attached to the slider can be fixed to a predetermined position of the stand **30**.

Example of how to set Optical Unit **20**A

[0043] Next, setting of the optical unit **20**A to the conveyance mechanism **10** will be described. As illustrated in FIGS. **1** to **4**, the optical unit **20**A is inserted between the guide members **34** of the stand **30** from one end in the x-axis direction of the stand **30** that is permanently attached to the conveyance mechanism **10**, for example. The optical unit **20**A may be brought close to the stand **30** and inserted between the guide members **34** from above the stand **30**. The optical unit **20**A is then slid on the window member **33** of the stand **30** toward the other end of the stand **30** and is stopped above a position where the food F on the belt **12** is expected to pass through. In an actual inspection, when the position of the optical unit **20**A does not match the position of the food F on the top surface of the belt **12**, the position of the optical unit **20**A can be adjusted by moving the optical unit **20**A along the guide members **34**.

Example of Calibrating Optical Unit **20**A

[0044] FIG. **7** is a diagram for explaining how reference information is obtained in the present embodiment. The reference information is used in calibrating spectral data obtained by the imager **22**. The height H**1** from the bottom surface to the top surface of the upper section **51***b* of the

housing **51** is equal to the height H**3** from the top surface of the belt **12** to the top surface of the window member **33** of the stand **30** in FIG. **4**.

[0045] First, the optical unit **20**A is placed on the top surface of the upper section **51***b* of the housing **51**. The height H**2** of the imager **22** of the optical unit **20**A from the calibration member **53** in the upper section **51***b* of the housing **51** is substantially equal to the height H**4** (see FIG. **4**) of the imager **22** of the optical unit **20**A from the top surface of the belt **12** when the optical unit **20**A is placed on the stand **30** in an actual inspection. When the height H**2** at the housing **51** is not equal to the height H**4** at the conveyance mechanism **10**, the height H**2** at the housing **51** may be adjusted by adjusting the height of the calibration member **53** with an adjustment mechanism, for example. The adjustment mechanism for adjusting the height of the imager **22** may be provided to the optical unit **20**A.

[0046] The light sources **23**A and **23**B of the optical unit **20**A emit light that includes wavelength components used for the inspection to the calibration member **53** in the upper section **51***b* of the housing **51**. The imager **22** acquires light reflected by the calibration member **53**. The information processing apparatus **52** generates reference information on the reflection performance of the reflected light acquired by the imager **22**. In an actual inspection of the moisture content of the food F, the imager **22** of the optical unit **20**A acquires spectroscopic data of the food F conveyed by the belt **12**. The information processing apparatus **52** calibrates the acquired spectral data, based on the reference information acquired by the processing device main body **50** in advance.

[0047] According to the present embodiment, the window member **33** is attached to the stand **30** provided between the conveyance mechanism **10** and the optical unit **20**A. Therefore, steam, oil, and so forth generated by the food F conveyed by the belt **12** adhere to the window member **33** disposed below the optical unit **20**A. The window member **33** thus prevents steam, oil, and so forth of the conveyed food F from directly adhering to the imager **22** of the optical unit **20**A. Furthermore, in the present embodiment, the window member **33** of the stand **30** is removably attached to the frame **31**. Therefore, when the window member **33** is stained with oil or the like, the window member **33** can be removed from the frame **31** and easily cleaned.

[0048] When the reflectivity of the food F (measurement target) is low in the inspection of the amount of moisture in the food F, the light sources **23**A and **23**B need to output high outputs. In such a case, the increase of the temperature around the light sources **23**A and **23**B may cause deformation and breakage of components of the stand **30**, the conveyance mechanism **10**, and the optical unit **20**A. Since the cooling mechanism **40** including the blowing section **41** is provided in the present embodiment, the stand **30**, the conveyance mechanism **10**, and the optical unit **20**A can be efficiently cooled. Such a configuration can prevent deformation and breakage of the components of the stand **30**, the conveyance mechanism **10**, and the optical unit **20**A.

[0049] According to the present embodiment, the optical unit **20**A is movably and detachably placed on the stand **30** that is attached to the conveyance mechanism **10**. Thus, for example, in cleaning the belt **12** of the conveyance mechanism **10**, the optical unit **20**A can be easily removed from the conveyance mechanism **10**. Further, when the heavy information processing apparatus **52** is disposed in the processing apparatus main body **50**, the optical unit **20**A can be made light and transported further easily. Accordingly, the conveyance mechanism **10** can be cleaned efficiently. Further, the movable optical unit **20**A can be placed easily on various apparatuses.

Modification Example

[0050] Next, a modification example of the above-described food inspection apparatus **1** will be described. In the modification example, the window member **33**, which is disposed between the imager **22** of the optical unit **20**B and the belt **12** of the conveyance mechanism **10**, is attached to the optical unit **20**B instead of the stand **30**. In the following, differences between the modification example and the above embodiment are mainly described, and the components common to the above embodiment are described with the same reference numerals.

[0051] FIG. **8** is a diagram illustrating an example of the internal configuration of the optical unit **20**B of the food inspection apparatus **1** according to the modification example. The optical unit **20**B includes the housing **21**, the imager **22**, the light sources **23**A and **23**B, the intake slits **24**, and the exhaust port **25**.

[0052] The housing **21** has a box shape and houses the imager **22** and the light sources **23**A, **23**B. In the bottom surface of the housing **21**, an opening **21***a* that faces the belt **12** is formed. A window member **33** is removably attached to the opening **21***a* of the housing **21**. The window member **33** may be fitted into the **21***a* of the opening of the housing **21** or may be attached to the opening **21***a* by being inserted from the side of the housing **21**. The window member **33** is made of a material that can transmit light emitted by the light sources **23**A and **23**B and that can transmit light reflected by the conveyed food F. The material of the window member **33** is, for example, polycarbonate, and has a glass transition temperature [Tg] of 170° C. or higher.

[0053] Since the window member **33** is attached to the optical unit **20**B in the modification example, the window member **33** is not attached to the opening **31***a* the frame **31** of the stand **30**. To secure a placement section on which the optical unit **20**B is placed, it is preferable that the frame **31** be wider than the frame **31** illustrated in the figures.

[0054] According to the modification example, the window member **33** is attached to the opening **21***a* of the optical unit **20**B. The window member **33** prevents steam, oil, and so forth of the conveyed food F from directly adhering to the imager **22** of the optical unit **20**B. Furthermore, in the modification example, the window member **33** is removably attached to the frame **31** of the stand **30**. Therefore, when the window member **33** is stained with oil or the like, the window member **33** can be removed from the frame **31** and easily cleaned.

[0055] Although the preferred embodiments of the present disclosure have been described in detail with reference to the accompanying drawings, the technical scope of the present disclosure is not limited to such examples. Furthermore, those to which various modification examples and improvements have been applied naturally belong to the technical scope of the present disclosure within the category of the technical idea described in the scope of the claims of those skilled in the art.

[0056] Although embodiments of the present invention have been described and shown in detail, the disclosed embodiments are made for purposes of illustration and

example only and not limitation. The scope of the present invention should be interpreted by terms of the appended claims.

What is claimed is:

1. A food inspection apparatus configured to inspect food being conveyed by a conveyance mechanism, the food inspection apparatus comprising:

an optical unit that is disposed above the conveyance mechanism and that includes an imager, the imager being configured to image the conveyed food to acquire inspection information on the food; and

a transparent window member disposed between the conveyance mechanism and the optical unit.

2. The food inspection apparatus according to claim **1**, further comprising a cooling mechanism configured to cool at least one of the food being conveyed and the window member.

3. The food inspection apparatus according to claim **1**, wherein the window member is made of polycarbonate and has a glass transition temperature [Tg] of 170° C. or higher.

4. The food inspection apparatus according to claim **1**, further comprising a stand on which the optical unit is placed, wherein the stand determines a height of the optical unit from the conveyance mechanism and supports the optical unit such that the optical unit is movable.

5. The food inspection apparatus according to claim **4**, wherein the stand includes an adjustment mechanism that adjusts the height of the optical unit from the conveyance mechanism.

6. The food inspection apparatus according to claim **4**, wherein:

the stand includes a frame having an opening, the opening allowing the imager to image the food being conveyed, and

the window member is detachably attached to the frame of the stand.

7. The food inspection apparatus according to claim **4**, wherein:

the conveyance mechanism includes a support member that supports a belt on which the food is placed, and

the stand is attached to the support member of the conveyance mechanism by an attachment member.

8. The food inspection apparatus according to claim **7**, wherein:

the optical unit includes a housing that houses the imager,

the housing has an opening in a surface facing the conveyance mechanism, the opening allowing the imager to image the food being conveyed, and

the window member is detachably attached to the opening.

9. The food inspection apparatus according to claim **6**, wherein the stand includes a guide member that stands on the frame so as to intersect a conveyance direction of the conveyance mechanism and that guides the optical unit to a position above the food.

10. The food inspection apparatus according to claim **1**, further comprising a processing apparatus main body that houses an information processing apparatus, the information processing apparatus being connected to the optical unit and configured to analyze the inspection information obtained by the imager of the optical unit.

11. The food inspection apparatus according to claim **10**, wherein at least one of the processing apparatus main body and the conveyance mechanism is portable.

12. The food inspection apparatus according to claim **10**, wherein:

the processing apparatus main body includes a housing, and

a calibration member is positioned in the housing such that a distance between the imager of the optical unit and a top surface of a belt of the conveyance mechanism is recreated when the optical unit is placed on the housing.

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