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(54) **PRINT HEAD CONTROL CIRCUIT**

DRUCKKOPFSTEUERUNGSSCHALTUNG

CIRCUIT DE COMMANDE DE TÊTE D'IMPRESSION

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(56) References cited:
WO-A1-2017/111065
US-A1- 2014 247 299
US-A1- 2017 173 950

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Description

BACKGROUND

1. Technical Field

[0001] The present disclosure relates to a print head control circuit.

2. Related Art

[0002] A liquid discharge apparatus such as an ink jet printer forms characters or an image on a recording medium in a manner that the liquid discharge apparatus drives a piezoelectric element provided in a print head by a driving signal and thus discharges a liquid such as an ink with which a cavity is filled, from a nozzle. In such a liquid discharge apparatus, when a problem occurs in the print head, discharge abnormality in which it is not possible to normally discharge the liquid from the nozzle may occur. When such discharge abnormality occurs, discharge accuracy of the ink discharged from the nozzle may be decreased, and quality of an image formed on the recording medium may be decreased. An example of printing apparatuses and associated components are described in US 2014/0247299; US 2017/0173950; and WO 2017/111065.

[0003] JP-A-2017-114020 discloses a print head having a self-diagnosis function of the print head itself determining whether or not a dot satisfying normal print quality can be formed, in accordance with a plurality of signals input to the print head.

[0004] However, in the technology disclosed in JP-A-2017-114020, a plurality of signal lines used for self-diagnosis of the print head is distributed in a cable and a connector. Therefore, a plurality of driving signals propagated in a form of a high voltage signal and the plurality of signals used for self-diagnosis of the print head may interfere with each other, and thus the self-diagnosis function of the print head may not normally operate.

SUMMARY

[0005] Aspects of the invention are set out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

FIG. 1 is a diagram illustrating an overall configuration of a liquid discharge apparatus.
FIG. 2 is a block diagram illustrating an electrical configuration of the liquid discharge apparatus.
FIG. 3 is a diagram illustrating an example of a waveform of a driving signal COM.
FIG. 4 is a diagram illustrating an example of a waveform of a driving signal VOUT.
FIG. 5 is a diagram illustrating a configuration of a driving signal selection circuit.
FIG. 6 is a diagram illustrating decoding contents in a decoder.
FIG. 7 is a diagram illustrating a configuration of a selection circuit corresponding to one discharge section.
FIG. 8 is a diagram illustrating an operation of the driving signal selection circuit.
FIG. 9 is a diagram illustrating a configuration of a temperature abnormality detection circuit.
FIG. 10 is a schematic diagram illustrating an internal configuration of the liquid discharge apparatus when viewed from a Y-direction.
FIG. 11 is a diagram illustrating a configuration of a cable.
FIG. 12 is a perspective view illustrating a configuration of a print head.
FIG. 13 is a plan view illustrating a configuration of an ink discharge surface.
FIG. 14 is a diagram illustrating an overall configuration of one of a plurality of discharge sections in the head.
FIG. 15 is a plan view when a substrate is viewed from a surface 322.
FIG. 16 is a plan view when the substrate is viewed from a surface 321.
FIG. 17 is a diagram illustrating a configuration of a connector.
FIG. 18 is a diagram illustrating another configuration of the connector.
FIG. 19 is a diagram illustrating a specific example when the cable is attached to the connector.
FIG. 20 is a diagram illustrating details of a signal propagated in a cable 19a.
FIG. 21 is a diagram illustrating details of a signal propagated in a cable 19b.
FIG. 22 is a diagram illustrating an example of a wiring pattern formed on the surface 321 of the substrate.
FIG. 23 is a block diagram illustrating an electrical configuration of a liquid discharge apparatus according to a second embodiment.
FIG. 24 is a schematic diagram illustrating an internal configuration of the liquid discharge apparatus in the second embodiment when viewed from the Y-direction.
FIG. 25 is a perspective view illustrating a configuration of a print head in the second embodiment.
FIG. 26 is a plan view illustrating an ink discharge surface of a head in the second embodiment.
FIG. 27 is a plan view illustrating the substrate in the second embodiment when viewed from a surface 322.
FIG. 28 is a plan view illustrating the substrate in the second embodiment when viewed from a surface 321.
FIG. 29 is a diagram illustrating a configuration of a

connector.

FIG. 30 is a diagram illustrating details of a signal propagated in a cable 19a in the second embodiment.

FIG. 31 is a diagram illustrating details of a signal propagated in a cable 19b in the second embodiment.

FIG. 32 is a diagram illustrating details of a signal propagated in a cable 19c in the second embodiment.

FIG. 33 is a diagram illustrating details of a signal propagated in a cable 19d in the second embodiment.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0007] Hereinafter, preferred embodiments of the present disclosure will be described with reference to the drawings. The drawings are used for easy descriptions. The embodiments described below do not limit the scope of the present disclosure described in the claims. All components described later are not necessarily essential constituent elements of the present disclosure.

1. First Embodiment

1.1. Outline of Liquid Discharge Apparatus

[0008] FIG. 1 is a diagram illustrating an overall configuration of a liquid discharge apparatus 1. The liquid discharge apparatus 1 is a serial printing type ink jet printer that forms an image on a medium P in a manner that a carriage 20 discharges an ink to the transported medium P with reciprocating. In the carriage 20, a print head 21 that discharges the ink as an example of a liquid is mounted. In the following descriptions, descriptions will be made on the assumption that a direction in which the carriage 20 moves is an X-direction, a direction in which the medium P is transported is a Y-direction, and a direction in which the ink is discharged is a Z-direction. Descriptions will be made on the assumption that the X-direction, the Y-direction, and the Z-direction are perpendicular to each other. As the medium P, any printing target such as print paper, a resin film, and a cloth can be used.

[0009] The liquid discharge apparatus 1 includes a liquid container 2, a control mechanism 10, the carriage 20, a movement mechanism 30, and a transport mechanism 40.

[0010] Plural kinds of inks to be discharged onto a medium P are stored in the liquid container 2. As the color of the ink stored in the liquid container 2, black, cyan, magenta, yellow, red, and gray are exemplified. As the liquid container 2 in which such an ink is stored, an ink cartridge, a bag-like ink pack formed of a flexible film, an ink tank capable of replenishing ink, or the like is used.

[0011] The control mechanism 10 includes, for example, a processing circuit such as a central processing unit (CPU) or a field programmable gate array (FPGA) and a storage circuit such as a semiconductor memory. The control mechanism 10 controls elements of the liquid discharge apparatus 1.

[0012] The print head 21 is mounted in the carriage 20. The carriage 20 is fixed to an endless belt 32 of the movement mechanism 30. The liquid container 2 may also be mounted in the carriage 20.

[0013] A control signal Ctrl-H for controlling the print head 21 and one ore a plurality of driving signals COM for driving the print head 21 are output by the control mechanism 10 and are input to the print head 21. The print head 21 discharges an ink supplied from the liquid container 2 based on the control signal Ctrl-H and the driving signal COM.

[0014] The movement mechanism 30 includes a carriage motor 31 and the endless belt 32. The carriage motor 31 operates based on a control signal Ctrl-C input from the control mechanism 10. The endless belt 32 rotates by the operation of the carriage motor 31. Thus, the carriage 20 fixed to the endless belt 32 reciprocates in the X-direction.

[0015] The transport mechanism 40 includes a transport motor 41 and a transport roller 42. The transport motor 41 operates based on a control signal Ctrl-T input from the control mechanism 10. The transport roller 42 rotates by the operation of the transport motor 41. A medium P is transported in the Y-direction with the rotation of the transport roller 42.

[0016] As described above, the liquid discharge apparatus 1 forms a desired image on a medium P by landing an ink at any position on the surface of the medium P in a manner that the liquid discharge apparatus discharges the ink from the print head 21 mounted in the carriage 20 with transport of the medium P by the transport mechanism 40 and reciprocation of the carriage 20 by the movement mechanism 30.

1.2. Electrical Configuration of Liquid Discharge Apparatus

[0017] FIG. 2 is a block diagram illustrating an electrical configuration of the liquid discharge apparatus 1. The liquid discharge apparatus 1 includes the control mechanism 10, the print head 21, the carriage motor 31, the transport motor 41, and a linear encoder 90.

[0018] The control mechanism 10 includes a driving signal output circuit 50, a control circuit 100, and a power circuit 110. The control circuit 100 includes a processor such as a microcontroller, for example. The control circuit 100 generates and outputs data or various signals for controlling the liquid discharge apparatus 1, based on various signals such as image data, which are input from a host computer.

[0019] Specifically, the control circuit 100 recognizes a scanning position of the print head 21 based on a detection signal input from the linear encoder 90. The control circuit 100 generates and outputs various signals corresponding to the scanning position of the print head 21.

Specifically, the control circuit 100 generates the control signal Ctrl-C for controlling reciprocation of the print head 21 and outputs the control signal Ctrl-C to the carriage motor 31. The control circuit 100 generates the control signal Ctrl-T for controlling transport of the medium P and outputs the control signal Ctrl-T to the transport motor 41. The control signal Ctrl-C may be signal-converted via a carriage motor driver (not illustrated) and then be input to the carriage motor 31. Similarly, the control signal Ctrl-T may be signal-converted via a transport motor driver (not illustrated) and then be input to the transport motor 41.

[0020] The control circuit 100 generates print data signals SI1 to SIn, a change signal CH, a latch signal LAT, and a clock signal SCK as the control signal Ctrl-H for controlling the print head 21, based on the various signals such as image data, which are input from the host computer and the scanning position of the print head 21. Then, the control circuit 100 outputs the generated signals to the print head 21.

[0021] The control circuit 100 generates diagnosis signals DIG-A to DIG-D used when the print head 21 diagnoses whether or not normal discharge of a liquid is possible. Then, the control circuit 100 outputs the generated signals to the print head 21. Here, although details will be described later, in the liquid discharge apparatus 1 in the first embodiment, each of the diagnosis signals DIG-A to DIG-D and each of the latch signal LAT, the clock signal SCK, the change signal CH, and the print data signal SI1 are propagated to the print head 21 by common wirings. Specifically, the diagnosis signal DIG-A and the latch signal LAT are propagated in a common wiring. The diagnosis signal DIG-B and the clock signal SCK are propagated in a common wiring. The diagnosis signal DIG-C and the change signal CH are propagated in a common wiring. The diagnosis signal DIG-D and the print data signal SI1 are propagated in a common wiring. Here, the control circuit 100 that generates and outputs the diagnosis signals DIG-A to DIG-D is an example of a diagnosis signal output circuit.

[0022] The control circuit 100 outputs a driving control signal dA as a digital signal to the driving signal output circuit 50.

[0023] The driving signal output circuit 50 includes a driving circuit 50a. The driving control signal dA is input to the driving circuit 50a. The driving circuit 50a generates the driving signal COM by performing D-class amplification on an analog signal obtained by performing digital-to-analog signal conversion on the driving control signal dA. That is, the driving control signal dA is a digital signal for defining a waveform of the driving signal COM. The driving circuit 50a generates the driving signal COM by performing D-class amplification on a waveform defined by the driving control signal dA. The driving signal output circuit 50 outputs the driving signal COM generated by the driving circuit 50a. Thus, the driving control signal dA may be a signal capable of defining the waveform of the driving signal COM. For example, the driving control signal dA may be an analog signal. The driving circuit 50a may be capable of amplifying the waveform defined by the driving control signal dA. For example, the driving circuit 50a may be configured by an A-class amplifier circuit, a B-class amplifier circuit, or an AB-class amplifier circuit.

[0024] The driving signal output circuit 50 generates and outputs a reference voltage signal CGND indicating a reference potential of the driving signal COM. The reference voltage signal CGND may be, for example, a signal which has a voltage value of 0 V and has a ground potential. The reference voltage signal CGND may be a signal having a DC voltage having a voltage value of 6 V, for example.

[0025] The driving signal COM and the reference voltage signal CGND are divided in the control mechanism 10 and then are output to the print head 21. Specifically, the driving signal COM is divided into n pieces of driving signals COM1 to COMn respectively corresponding to n pieces of driving signal selection circuits 200 described later in the control mechanism 10. Then, the driving signals COM1 to COMn are output to the print head 21. Similarly, the reference voltage signal CGND is divided into n pieces of reference voltage signals CGND1 to CGNDn in the control mechanism 10, and then is output to the print head 21. The driving signal COM including the driving signals COM1 to COMn is an example of the driving signal.

[0026] The power circuit 110 generates and outputs voltages VHV, VDD1, and VDD2 and a ground signal GND. The voltage VHV is a signal having a DC voltage having a voltage value of 42 V, for example. The voltages VDD1 and VDD2 are signals having a DC voltage having a voltage value of 3.3 V, for example. The ground signal GND is a signal indicating the reference potential of the voltages VHV, VDD1, and VDD2. For example, the ground signal GND is a signal having a voltage value of 0 V and having a ground potential. The voltage VHV is used, for example, as a voltage for amplification in the driving signal output circuit 50. Each of the voltages VDD1 and VDD2 is used, for example, as a power source voltage or a control voltage of various components in the control mechanism 10. The voltages VHV, VDD1, and VDD2 and the ground signal GND are also output to the print head 21. The voltage values of the voltages VHV, VDD1, and VDD2 and the ground signal GND are not limited to 42 V, 3.3 V, and 0 V as described above. The power circuit 110 may generate signals having a plurality of voltage values in addition to the voltages VHV, VDD1, and VDD2 and the ground signal GND.

[0027] The print head 21 includes driving signal selection circuits 200-1 to 200-n, a temperature detection circuit 210, a diagnosis circuit 240, temperature abnormality detection circuits 250-1 to 250-n, and a plurality of discharge sections 600.

[0028] The diagnosis signal DIG-A and the latch signal LAT propagated in the common wiring, the diagnosis signal DIG-B and the clock signal SCK propagated in the

common wiring, the diagnosis signal DIG-C and the change signal CH propagated in the common wiring, and the diagnosis signal DIG-D and the print data signal SI1 propagated in the common wiring are input to the diagnosis circuit 240. The diagnosis circuit 240 diagnoses whether or not normal discharge of the ink is possible, based on the diagnosis signals DIG-A to DIG-D.

[0029] For example, the diagnosis circuit 240 may detect whether or not the voltage value of the any or all of the input diagnosis signals DIG-A to DIG-D is normal. The diagnosis circuit 240 may diagnose whether or not the print head 21 and the control mechanism 10 are normally coupled to each other, based on the detection result. The diagnosis circuit 240 may operate any component, for example, the driving signal selection circuits 200-1 to 200-n and the piezoelectric element 60 in the print head 21, in accordance with a logical level of any signal or a combination of the logical levels of all the signals of the input diagnosis signals DIG-A to DIG-D. The diagnosis circuit 240 may detect whether or not the voltage value obtained by the operation is normal. Then, the diagnosis circuit 240 may diagnose whether or not a normal operation of the print head 21 is possible, based on the detection result. That is, the print head 21 performs self-diagnosis of diagnosing whether or not normal discharge of the ink is possible, based on the diagnosis result of the diagnosis circuit 240.

[0030] When the diagnosis circuit 240 diagnoses that normal discharge of the ink is possible in the print head 21, the diagnosis circuit 240 outputs the latch signal LAT, the clock signal SCK, and the change signal CH as a latch signal cLAT, a clock signal cSCK, and a change signal cCH. Here, the diagnosis signal DIG-D and the print data signal SI1 are branched in the print head 21. One branched signal is input to the diagnosis circuit 240, and the other is input to the driving signal selection circuit 200-1. The print data signal SI1 is a signal having a high transfer rate. When the waveform of the print data signal SI1 is distorted, the print head 21 may erroneously operate. If the print data signal SI1 is branched in the print head 21, and then only one branched signal is input to the diagnosis circuit 240, it is possible to reduce a possibility of distorting the waveform of the print data signal SI1 input to the driving signal selection circuit 200-1.

[0031] The change signal cCH, the latch signal cLAT, and the clock signal cSCK output by the diagnosis circuit 240 may be signals having the same waveforms as the change signal CH, the latch signal LAT, and the clock signal SCK input to the diagnosis circuit 240. The change signal cCH, the latch signal cLAT, and the clock signal cSCK may be signals having waveforms obtained by correcting the change signal CH, the latch signal LAT, and the clock signal SCK. In the embodiment, descriptions will be made on the assumption that the change signal cCH, the latch signal cLAT, and the clock signal cSCK have the same waveforms as the change signal CH, the latch signal LAT, and the clock signal SCK.

[0032] The diagnosis circuit 240 generates a diagnosis signal DIG-E indicating a diagnosis result in the diagnosis circuit 240 and outputs the diagnosis signal DIG-E to the control circuit 100. Here, in the first embodiment, the diagnosis circuit 240 is configured, for example, by one or a plurality of integrated circuit (IC) apparatuses.

[0033] The voltages VHV and VDD1, the clock signal cSCK, the latch signal cLAT, and the change signal cCH are input to each of the driving signal selection circuits 200-1 to 200-n. The driving signals COM1 to COMn and the print data signals SI1 to SIn are input to the driving signal selection circuits 200-1 to 200-n, respectively. The voltages VHV and VDD1 are used as a power source voltage or a control voltage of each of the driving signal selection circuits 200-1 to 200-n. The driving signal selection circuits 200-1 to 200-n select or do not select the driving signals COM1 to COMn based on the print data signals SI1 to SIn, the clock signal cSCK, the latch signal cLAT, and the change signal cCH so as to generate driving signals VOUT1 to VOUTn, respectively.

[0034] Each of the driving signals VOUT1 to VOUTn respectively generated by the driving signal selection circuits 200-1 to 200-n is supplied to the piezoelectric element 60 which is provided in the corresponding discharge section 600 and is an example of a driving element. If each of the driving signals VOUT1 to VOUTn is supplied, the piezoelectric element 60 performs displacement. The ink of an amount depending on the displacement is discharged from the discharge section 600.

[0035] Specifically, the driving signal COM1, the print data signal SI1, the latch signal cLAT, the change signal cCH, and the clock signal cSCK are input to the driving signal selection circuit 200-1. The driving signal selection circuit 200-1 selects or does not select the waveform of the driving signal COM1 based on the print data signal SI1, the latch signal cLAT, the change signal cCH, and the clock signal cSCK, so as to generate the driving signal VOUT1. The driving signal VOUT1 is supplied to one end of the piezoelectric element 60 in the discharge section 600 provided to correspond to the driving signal VOUT1. The reference voltage signal CGND1 is supplied to the other end of the piezoelectric element 60. The piezoelectric element 60 performs displacement by a potential difference between the driving signal VOUT1 and the reference voltage signal CGND1.

[0036] Similarly, the driving signal COMi, the print data signal SIi (i is any of 1 to n), the latch signal cLAT, the change signal cCH, and the clock signal cSCK are input to the driving signal selection circuit 200-i. The driving signal selection circuit 200-i selects or does not select the waveform of the driving signal COMi based on the print data signal SIi, the latch signal cLAT, the change signal cCH, and the clock signal cSCK, so as to generate the driving signal VOUTi. The driving signal VOUTi is supplied to one end of the piezoelectric element 60 in the discharge section 600 provided to correspond to the driving signal VOUTi. The reference voltage signal CGNDi is supplied to the other end of the piezoelectric element 60. The piezoelectric element 60 performs displacement

by a potential difference between the driving signal VOUTi and the reference voltage signal CGNDi.

[0037] Here, the driving signal selection circuits 200-1 to 200-n have the similar circuit configuration. Therefore, when it is not necessary to distinguish the driving signal selection circuits 200-1 to 200-n from each other in the following descriptions, the driving signal selection circuits 200-1 to 200-n are referred to as a driving signal selection circuit 200. In this case, the driving signals COM1 to COMn input to the driving signal selection circuit 200 are referred to as a driving signal COM. The print data signals SI1 to SIn are referred to as a print data signal SI, and the driving signals VOUT1 to VOUTn output from the driving signal selection circuit 200 are referred to as a driving signal VOUT. Details of the operation of the driving signal selection circuit 200 will be described later. Here, each of the driving signal selection circuits 200-1 to 200-i is configured by an integrated circuit apparatus, for example.

[0038] The temperature abnormality detection circuits 250-1 to 250-n are provided to correspond to the driving signal selection circuits 200-1 to 200-n, respectively. Each of the temperature abnormality detection circuits 250-1 to 250-n diagnoses whether or not temperature abnormality occurs in the corresponding circuit of the driving signal selection circuits 200-1 to 200-n. Specifically, the temperature abnormality detection circuits 250-1 to 250-n operate using the voltage VDD2 as the power source voltage. Each of the temperature abnormality detection circuits 250-1 to 250-n detects the temperature of the corresponding circuit of the driving signal selection circuits 200-1 to 200-n. When the temperature abnormality detection circuit diagnoses that the temperature is normal, the temperature abnormality detection circuit generates an abnormality signal XHOT having a high level (H level) and outputs the abnormality signal XHOT to the control circuit 100. When the temperature abnormality detection circuit diagnoses that the temperature of the corresponding circuit of the driving signal selection circuits 200-1 to 200-n is abnormal, each of the temperature abnormality detection circuits 250-1 to 250-n generates the abnormality signal XHOT having a low level (L level) and outputs the abnormality signal XHOT to the control circuit 100.

[0039] Here, the temperature abnormality detection circuits 250-1 to 250-n have the similar circuit configuration. Therefore, when it is not necessary to distinguish the temperature abnormality detection circuits 250-1 to 250-n from each other in the following descriptions, the temperature abnormality detection circuits 250-1 to 250-n are referred to as a temperature abnormality detection circuit 250. Here, although details will be described later, the diagnosis signal DIG-E and the abnormality signal XHOT are propagated in a common wiring. Details of the temperature abnormality detection circuit 250 will be described later. Each of the temperature abnormality detection circuits 250-1 to 250-i is configured by an integrated circuit apparatus, for example. The temperature abnormality detection circuit 250-i and the driving signal selection circuit 200-i may be configured by one integrated circuit apparatus.

[0040] The temperature detection circuit 210 includes a temperature detection element such as a thermistor. The temperature detection circuit 210 generates a temperature signal TH which is an analog signal and includes temperature information of the print head 21, based on a detection signal obtained by detection of the temperature detection element. The temperature detection circuit outputs the temperature signal TH to the control circuit 100.

1.3. Example of Waveform of Driving Signal

[0041] Here, an example of the waveform of the driving signal COM generated by the driving signal output circuit 50 and an example of the waveform of the driving signal VOUT supplied to the piezoelectric element 60 will be described with reference to FIGs. 3 and 4.

[0042] FIG. 3 is a diagram illustrating an example of the waveform of the driving signal COM. As illustrated in FIG. 3, the driving signal COM is a waveform in which a trapezoid waveform Adp1, a trapezoid waveform Adp2, and a trapezoid waveform Adp3. The trapezoid waveform Adp1 is disposed in a period T1 from when the latch signal LAT rises until the change signal CH rises. The trapezoid waveform Adp2 is disposed in a period T2 until the change signal CH rises the next time after the period T1. The trapezoid waveform Adp3 is disposed in a period T3 until the latch signal LAT rises the next time after the period T2. When the trapezoid waveform Adp1 is supplied to the one end of the piezoelectric element 60, the medium amount of the ink is discharged from the discharge section 600 corresponding to this piezoelectric element 60. When the trapezoid waveform Adp2 is supplied to the one end of the piezoelectric element 60, the ink having an amount smaller than the medium amount is discharged from the discharge section 600 corresponding to this piezoelectric element 60. When the trapezoid waveform Adp3 is supplied to the one end of the piezoelectric element 60, the ink is not discharged from the discharge section 600 corresponding to this piezoelectric element 60. The trapezoid waveform Adp3 is a waveform for finely vibrating the ink in the vicinity of a nozzle opening portion of the discharge section 600 to prevent an increase of ink viscosity.

[0043] Here, a period Ta (illustrated in FIG. 3) from the latch signal LAT rises until the latch signal LAT rises the next time corresponds to a printing period in which a new dot is formed on the medium P. That is, the latch signal LAT and the latch signal cLAT are signals for defining a discharge timing of the ink from the print head 21. The change signal CH and the change signal cCH are signals for defining a waveform switching timing between the trapezoid waveforms Adp1, Adp2, and Adp3 in the driving signal COM.

[0044] All voltages at a start timing and an end timing

of each of the trapezoid waveforms Adp1, Adp2, and Adp3 are common and a voltage Vc. That is, each of the trapezoid waveforms Adp1, Adp2, and Adp3 is a waveform which starts at the voltage Vc and ends at the voltage Vc. The driving signal COM may be a signal having a waveform in which one or two trapezoid waveforms are continuous in the period Ta, or may be a signal having a waveform in which four trapezoid waveforms or more are continuous in the period Ta.

[0045] FIG. 4 is a diagram illustrating an example of the waveform of the driving signal VOUT corresponding to each of "a large dot", "a medium dot", "a small dot", and "non-recording".

[0046] As illustrated in FIG. 4, the driving signal VOUT corresponding to "the large dot" has a waveform in which the trapezoid waveform Adp1 disposed in the period T1, the trapezoid waveform Adp2 disposed in the period T2, and a waveform which is disposed in the period T3 and is constant at the voltage Vc are continuous in the period Ta. When the driving signal VOUT is supplied to the one end of the piezoelectric element 60, the medium amount of the ink and the small amount of the ink are discharged from the discharge section 600 corresponding to this piezoelectric element 60, in the period Ta. Thus, the inks are landed on the medium P and are coalesced, and thereby a large dot is formed on the medium P.

[0047] The driving signal VOUT corresponding to "the medium dot" has a waveform in which the trapezoid waveform Adp1 disposed in the period T1 and a waveform which is disposed in the periods T2 and T3 and is constant at the voltage Vc are continuous in the period Ta. When the driving signal VOUT is supplied to the one end of the piezoelectric element 60, the medium amount of the ink is discharged from the discharge section 600 corresponding to this piezoelectric element 60, in the period Ta. Thus, the ink is landed on the medium P, and thereby a medium dot is formed on the medium P.

[0048] The driving signal VOUT corresponding to "the small dot" has a waveform in which a waveform which is disposed in the periods T1 and T3 and is constant at the voltage Vc and the trapezoid waveform Adp2 disposed in the period T2 are continuous in the period Ta. When the driving signal VOUT is supplied to the one end of the piezoelectric element 60, the small amount of the ink is discharged from the discharge section 600 corresponding to this piezoelectric element 60, in the period Ta. Thus, the ink is landed on the medium P, and thereby a small dot is formed on the medium P.

[0049] The driving signal VOUT corresponding to "non-recording" has a waveform in which a waveform which is disposed in the periods T1 and T2 and is constant at the voltage Vc and the trapezoid waveform Adp3 disposed in the period T3 are continuous in the period Ta. When the driving signal VOUT is supplied to the one end of the piezoelectric element 60, in the period Ta, only the ink in the vicinity of the nozzle opening portion of the discharge section 600 corresponding to this piezoelectric element 60 finely vibrates, and the ink is not discharged. Thus, the ink is not landed on the medium P and a dot is not formed on the medium P.

[0050] Here, the waveform constant at the voltage Vc means a waveform in which the previous voltage Vc is configured by a voltage held by a capacitive component of the piezoelectric element 60 when any of the trapezoid waveforms Adp1, Adp2, and Adp3 is not selected as the driving signal VOUT. Therefore, when any of the trapezoid waveforms Adp1, Adp2, and Adp3 is not selected as the driving signal VOUT, the voltage Vc is supplied to the piezoelectric element 60 as the driving signal VOUT.

[0051] The driving signal COM and the driving signal VOUT illustrated in FIGs. 3 and 4 are just examples. Signals having various combinations of waveforms may be used in accordance with a moving speed of the carriage 20 in which the print head 21 is mounted, the physical properties of the ink to be supplied to the print head 21, the material of the medium P, and the like.

1.4. Configuration of Driving Signal Selection Circuit

[0052] Next, a configuration and an operation of the driving signal selection circuit 200 will be described with reference to FIGs. 5 to 8. FIG. 5 is a diagram illustrating a configuration of the driving signal selection circuit 200. As illustrated in FIG. 5, the driving signal selection circuit 200 includes a selection control circuit 220 and a plurality of selection circuits 230.

[0053] The print data signal SI, the latch signal cLAT, the change signal cCH, and the clock signal cSCK are input to the selection control circuit 220. A set of a shift register (S/R)222, a latch circuit 224, and a decoder 226 is provided in the selection control circuit 220 to correspond to each of the plurality of discharge sections 600. That is, the driving signal selection circuit 200 includes sets of shift registers 222, latch circuits 224, and decoders 226. The number of sets is equal to the total number m of discharge sections 600. Here, the print data signal SI is a signal for defining selection of a waveform of the driving signal COM. The clock signal SCK and the clock signal cSCK are clock signals for defining a timing at which the print data signal SI is input.

[0054] Specifically, the print data signal SI is a signal synchronized with the clock signal cSCK. The print data signal SI is a signal which has 2m bits in total and includes 2-bit print data [SIH, SIL] for selecting any of "the large dot", "the medium dot", "the small dot", and "non-recording" for each of m pieces of discharge sections 600. Regarding the print data signal SI, each 2-bit print data [SIH, SIL] which corresponds to the discharge section 600 and is included in the print data signal SI is held in the shift register 222. Specifically, the shift registers 222 from the first stage to the m-th stage, which correspond to the discharge sections 600 are cascade-coupled to each other, and the print data signal SI input in a serial manner is sequentially transferred to the subsequent stage in accordance with the clock signal cSCK. In FIG. 5, in order to distinguish the shift registers 222 from each other, the

shift registers 222 are described as being the first stage, the second stage, ..., and the m-th stage in order from the upstream on which the print data signal SI is input.

[0055] Each of the m pieces of latch circuits 224 latch the 2-bit print data [SIH, SIL] held in each of the m pieces of shift registers 222, at a rising edge of the latch signal cLAT.

[0056] Each of the m pieces of decoders 226 decodes the 2-bit print data [SIH, SIL] latched by each of the m pieces of latch circuits 224. The decoder 226 outputs a selection signal S for each of the periods T1, T2, T3 defined by the latch signal cLAT and the change signal cCH.

[0057] FIG. 6 is a diagram illustrating decoding contents in the decoder 226. The decoder 226 outputs the selection signal S in accordance with the latched 2-bit print data [SIH, SIL]. For example, when the 2-bit print data [SIH, SIL] is [1, 1], the decoder 226 outputs the selection signal S having a logical level which is respectively set to an H level, an H level, and an L level in the periods T1, T2, and T3.

[0058] The selection circuits 230 are provided to correspond to the discharge sections 600, respectively. That is, the number of selection circuits 230 of the driving signal selection circuit 200 is equal to the total number m of the discharge sections 600. FIG. 7 is a diagram illustrating a configuration of the selection circuit 230 corresponding to one discharge section 600. As illustrated in FIG. 7, the selection circuit 230 includes an inverter 232 being a NOT circuit, and a transfer gate 234.

[0059] The selection signal S is logically inverted by the inverter 232 and is input to a negative control end of the transfer gate 234, which is marked with a circle, while the selection signal S is input to a positive control end of the transfer gate 234, which is not marked with a circle. The driving signal COM is supplied to an input end of the transfer gate 234. Specifically, the transfer gate 234 electrically connects (turns on between) the input end and an output end when the selection signal S has an H level, and does not electrically connect (turns off between) the input end and the output end when the selection signal S has an L level. In this manner, the driving signal VOUT is output from the output end of the transfer gate 234.

[0060] Here, the operation of the driving signal selection circuit 200 will be described with reference to FIG. 8. FIG. 8 is a diagram illustrating the operation of the driving signal selection circuit 200. The print data signal SI is serially input in synchronization with the clock signal cSCK and is sequentially transferred into the shift registers 222 corresponding to the discharge sections 600. If the input of the clock signal cSCK stops, the 2-bit print data [SIH, SIL] corresponding to each of the discharge sections 600 is held in each of the shift registers 222. The print data signal SI is input in order of the discharge sections 600 corresponding to the m-th stage, ..., the second stage, and the first stage of shift registers 222.

[0061] If the latch signal cLAT rises, the latch circuits 224 simultaneously latch the 2-bit print data [SIH, SIL] held by the shift registers 222. In FIG. 8, LT1, LT2, ..., and LTm indicate the 2-bit print data [SIH, SIL] latched by the latch circuits 224 respectively corresponding to the first stage, the second stage, ..., and the m-th stage of shift registers 222.

[0062] The decoder 226 outputs the logical level of the selection signal S in each of the periods T1, T2, and T3, based on the contents in FIG. 6, in accordance with the size of a dot defined by the latched 2-bit print data [SIH, SIL].

[0063] Specifically, when the print data [SIH, SIL] is [1, 1], the decoder 226 sets the selection signal S to have an H level, an H level, and an L level in the periods T1, T2, and T3. In this case, the selection circuit 230 selects the trapezoid waveform Adp1 in the period T1, selects the trapezoid waveform Adp2 in the period T2, and does not select the trapezoid waveform Adp3 in the period T3. As a result, the driving signal VOUT corresponding to "the large dot" illustrated in FIG. 4 is generated.

[0064] When the print data [SIH, SIL] is [1, 0], the decoder 226 sets the selection signal S to have an H level, an L level, and an L level in the periods T1, T2, and T3. In this case, the selection circuit 230 selects the trapezoid waveform Adp1 in the period T1, does not select the trapezoid waveform Adp2 in the period T2, and does not select the trapezoid waveform Adp3 in the period T3. As a result, the driving signal VOUT corresponding to "the medium dot" illustrated in FIG. 4 is generated.

[0065] When the print data [SIH, SIL] is [0, 1], the decoder 226 sets the selection signal S to have an L level, an H level, and an L level in the periods T1, T2, and T3. In this case, the selection circuit 230 does not select the trapezoid waveform Adp1 in the period T1, selects the trapezoid waveform Adp2 in the period T2, and does not select the trapezoid waveform Adp3 in the period T3. As a result, the driving signal VOUT corresponding to "the small dot" illustrated in FIG. 4 is generated.

[0066] When the print data [SIH, SIL] is [0, 0], the decoder 226 sets the selection signal S to have an L level, an L level, and an H level in the periods T1, T2, and T3. In this case, the selection circuit 230 does not select the trapezoid waveform Adp1 in the period T1, does not select the trapezoid waveform Adp2 in the period T2, and selects the trapezoid waveform Adp3 in the period T3. As a result, the driving signal VOUT corresponding to "non-recording" illustrated in FIG. 4 is generated.

[0067] As described above, the driving signal selection circuit 200 selects the waveform of the driving signal COM based on the print data signal SI, the latch signal cLAT, the change signal cCH, and the clock signal cSCK, and outputs the driving signal VOUT. In other words, the driving signal selection circuit 200 controls a supply of the driving signal COM to the piezoelectric element 60.

1.5. Configuration of Temperature Abnormality Detection Circuit

[0068] Next, the temperature abnormality detection circuit 250 will be described with reference to FIG. 9. FIG.

9 is a diagram illustrating a configuration of the temperature abnormality detection circuit 250. As illustrated in FIG. 9, the temperature abnormality detection circuit 250 includes a comparator 251, a reference voltage generation circuit 252, a transistor 253, a plurality of diodes 254, and resistors 255 and 256. As described above, all the temperature abnormality detection circuits 250-1 to 250-n have the same configuration. Therefore, in FIG. 9, detailed illustrations of the configuration of the temperature abnormality detection circuit 250-2 to 250-n are omitted.

[0069] The voltage VDD2 is input to the reference voltage generation circuit 252. The reference voltage generation circuit 252 generates a voltage Vref by transforming the voltage VDD2 and supplies the voltage Vref to a positive-side input terminal of the comparator 251. The reference voltage generation circuit 252 is configured by a voltage regulator circuit, for example.

[0070] The plurality of diodes 254 is coupled in series. Among the plurality of diodes 254 coupled in series, the voltage VDD2 is supplied to an anode terminal of the diode 254 located on the highest potential side via the resistor 255, and the ground signal GND is supplied to a cathode terminal of the diode 254 located on the lowest potential side. Specifically, the temperature abnormality detection circuit 250 has diodes 254-1, 254-2, 254-3, and 254-4 as the plurality of diodes 254. The voltage VDD2 is supplied to the anode terminal of the diode 254-1 via the resistor 255, and the anode terminal of the diode 254-1 is coupled to a negative-side input terminal of the comparator 251. A cathode terminal of the diode 254-1 is coupled to an anode terminal of the diode 254-2. A cathode terminal of the diode 254-2 is coupled to an anode terminal of the diode 254-3. A cathode terminal of the diode 254-3 is coupled to an anode terminal of the diode 254-4. The ground signal GND is supplied to the cathode terminal of the diode 254-4. With the resistor 255 and the plurality of diodes 254 configured in a manner as described above, a voltage Vdet is supplied to a negative-side input terminal of the comparator 251. The voltage Vdet is the sum of forward voltages of the plurality of diodes 254. The number of the plurality of diodes 254 in the temperature abnormality detection circuit 250 is not limited to four.

[0071] The comparator 251 operates by a potential difference between the voltage VDD2 and the ground signal GND. The comparator 251 compares the voltage Vref supplied to the positive-side input terminal and the voltage Vdet supplied to the negative-side input terminal to each other, and outputs a signal based on the comparison result from an output terminal.

[0072] The voltage VDD2 is supplied to the drain terminal of the transistor 253 via the resistor 256. The gate terminal of the transistor 253 is coupled to the output terminal of the comparator 251. The ground signal GND is supplied to the source terminal of the transistor 253. The voltage supplied to the drain terminal of the transistor 253 coupled in a manner as described above is output from the temperature abnormality detection circuit 250 as the abnormality signal XHOT.

[0073] The voltage value of the voltage Vref generated by the reference voltage generation circuit 252 is less than the voltage Vdet when the temperature of the plurality of diodes 254 is within a predetermined range. In this case, the comparator 251 outputs a signal having an L level. Thus, the transistor 253 is controlled to turn off. As a result, the temperature abnormality detection circuit 250 outputs the abnormality signal XHOT having an H level.

[0074] The forward voltage of the diode 254 has characteristics in which the forward voltage decreases as the temperatures increases. Thus, when temperature abnormality occurs in the print head 21, the temperature of the diode 254 increases, and thereby the voltage Vdet decreases. When the voltage Vdet becomes less than the voltage Vref by the temperature increase, the output signal of the comparator 251 changes from an L level to an H level. Accordingly, the transistor 253 is controlled to turn on. As a result, the temperature abnormality detection circuit 250 outputs the abnormality signal XHOT having an L level. That is, if the transistor 253 is controlled to turn on or off based on the temperature of the driving signal selection circuit 200, the temperature abnormality detection circuit 250 outputs the voltage VDD2 supplied as the pull-up voltage of the transistor 253, as the abnormality signal XHOT having an H level and outputs the ground signal GND as the abnormality signal XHOT having an L level.

[0075] As illustrated in FIG. 9, outputs of the n pieces of temperature abnormality detection circuits 250-1 to 250-n are commonly coupled. Thus, when temperature abnormality occurs in any of the temperature abnormality detection circuits 250-1 to 250-n, the transistor 253 corresponding to the temperature abnormality detection circuit 250 in which the temperature abnormality occurs is controlled to turn on. As a result, the ground signal GND is supplied to a node to which the abnormality signal XHOT is output, via the transistor 253. Thus, the abnormality signals XHOT output by the temperature abnormality detection circuits 250-1 to 250-n are controlled to have an L level. That is, the temperature abnormality detection circuits 250-1 to 250-n are coupled in a wired-OR manner. Thus, even when the plurality of temperature abnormality detection circuits 250 is provided in the print head 21, it is possible to propagate the abnormality signal XHOT indicating whether or not temperature abnormality occurs in the print head 21, without increasing the number of wirings for propagating the abnormality signal XHOT.

1.6. Configurations of Print Head and Print Head Control Circuit

[0076] Next, details of an electrical coupling between the control mechanism 10 and the print head 21 will be described. In the following descriptions, descriptions will be made on the assumption that the print head 21 in the first embodiment includes six driving signal selection cir-

cuits 200-1 to 200-6. That is, six print data signals SI1 to SI6, six driving signals COM1 to COM6, and six reference voltage signals CGND1 to CGND6, which respectively correspond to the six driving signal selection circuits 200-1 to 200-6, are input to the print head 21 in the first embodiment.

[0077] FIG. 10 is a schematic diagram illustrating an internal configuration of the liquid discharge apparatus 1 when viewed from the Y-direction. As illustrated in FIG. 10, the liquid discharge apparatus 1 includes a main substrate 11, cables 19a and 19b, and the print head 21.

[0078] Various circuits including the driving signal output circuit 50, the control circuit 100, and the power circuit 110 provided in the control mechanism 10 illustrated in FIGs. 1 and 2 are mounted on the main substrate 11. A connector 12a to which one end of the cable 19a is attached and a connector 12b to which one end of the cable 19b is attached are mounted on the main substrate 11. FIG. 10 illustrates one circuit substrate as the main substrate 11. However, the main substrate 11 may be configured by two circuit substrates or more.

[0079] The print head 21 includes a head 310, a substrate 320, and connectors 350 and 360. The other end of the cable 19a is attached to the connector 350, and the other end of the cable 19b is attached to the connector 360. Thus, various signals generated by the control mechanism 10 are input to the print head 21 via the cables 19a and 19b. Details of the configuration of the print head 21 and details of signals propagated in the cables 19a and 19b will be described later.

[0080] The liquid discharge apparatus 1 configured in a manner as described above controls the operation of the print head 21 based on various signals including the driving signals COM1 to COM6, the reference voltage signals CGND1 to CGND6, the print data signals SI1 to SI6, the latch signal LAT, the change signal CH, the clock signal SCK, and the diagnosis signals DIG-A to DIG-D, which are output from the control mechanism 10 mounted on the main substrate 11. That is, in the liquid discharge apparatus 1 illustrated in FIG. 10, a configuration including the control mechanism 10 that outputs various signals for controlling the operation of the print head 21 and the cables 19a and 19b for propagating the various signals for controlling the operation of the print head 21 is an example of the print head control circuit 15 that controls the operation of the print head 21 having a function of performing self-diagnosis. In the first embodiment, the cables 19a and 19b have the same configuration. Thus, if it is not necessary to distinguish the cables 19a and 19b from each other, the cables 19a and 19b are referred to as a cable 19.

[0081] FIG. 11 is a diagram illustrating a configuration of the cable 19. The cable 19 has a substantially rectangular shape having short sides 191 and 192 facing each other and long sides 193 and 194 facing each other. For example, the cable 19 is a flexible flat cable (FFC). The cable 19 includes a plurality of terminals 195 aligned in parallel along the short side 191, a plurality of terminals 196 aligned in parallel along the short side 192, and a plurality of wirings 197 that electrically couples the plurality of terminals 195 and the plurality of terminals 196 to each other.

[0082] Specifically, 26 terminals 195 are aligned in parallel from the long side 193 toward the long side 194, on the short side 191 side of the cable 19 in order of the terminals 195-1 to 195-26. 26 terminals 196 are aligned in parallel from the long side 193 toward the long side 194, on the short side 192 side of the cable 19 in order of the terminals 196-1 to 196-26. In the cable 19, 26 wirings 197 that electrically couple the terminals 195 and the terminals 196 to each other are aligned in parallel from the long side 193 toward the long side 194 in order of the wirings 197-1 to 197-26. The wiring 197-1 electrically couples the terminal 195-1 and the terminal 196-1 to each other. Similarly, the wiring 197-k (k is any of 1 to 26) electrically couples the terminal 195-k and the terminal 196-k to each other.

[0083] The wirings 197-1 to 197-26 are insulated between the wirings and between the wiring and the outside of the cable 19, by an insulator 198. The cable 19 causes a signal input from the terminal 195-k to propagate in the wiring 197-k and to be output from the terminal 196-k. The configuration of the cable 19 illustrated in FIG. 11 is an example, and the embodiment is not limited thereto. For example, the plurality of terminals 195 and the plurality of terminals 196 may be provided on the different surfaces of the cable 19. The number of terminals 195, the number of terminals 196, and the number of wirings 197, which are provided in the cable 19, are not limited to 26.

[0084] Here, in the following descriptions, the terminal 195-k, the terminal 196-k, and the wiring 197-k provided in the cable 19a are referred to as a terminal 195a-k, a terminal 196a-k, and a wiring 197a-k, respectively. Thus, descriptions will be made on the assumption that the terminal 195a-k is electrically coupled to the connector 12a, and the terminal 196a-k is electrically coupled to the connector 350. Similarly, the terminal 195-k, the terminal 196-k, and the wiring 197-k provided in the cable 19b are referred to as a terminal 195b-k, a terminal 196b-k, and a wiring 197b-k, respectively. Thus, descriptions will be made on the assumption that the terminal 195b-k is electrically coupled to the connector 12b, and the terminal 196b-k is electrically coupled to the connector 360.

[0085] Next, the configuration of the print head 21 will be described. FIG. 12 is a perspective view illustrating the configuration of the print head 21. As illustrated in FIG. 12, the print head 21 includes the head 310 and the substrate 320. An ink discharge surface 311 on which the plurality of discharge sections 600 are formed is located on a lower surface of the head 310 in the Z-direction.

[0086] FIG. 13 is a plan view illustrating a configuration of the ink discharge surface 311. As illustrated in FIG. 13, six nozzle plates 632 are provided on the ink discharge surface 311 to be aligned in the X-direction. The

nozzle plate 632 has nozzles 651 provided in the plurality of discharge sections 600. In each of the nozzle plates 632, the nozzles 651 are provided to be aligned in the Y-direction. That is, six nozzle columns L1 to L6 are formed in the ink discharge surface 311. In FIG. 13, the nozzles 651 are provided to be aligned in one line in the Y-direction, in each of the nozzle columns L1 to L6 which are respectively formed in the nozzle plates 632. However, the nozzles 651 may be provided to be aligned in two or more lines in the Y-direction.

[0087] The nozzle columns L1 to L6 are provided to correspond to the driving signal selection circuits 200-1 to 200-6, respectively. Specifically, the driving signal VOUT1 output by the driving signal selection circuit 200-1 is supplied to the one end of the piezoelectric element 60 in a plurality of discharge sections 600 provided in the nozzle column L1. The reference voltage signal CGND1 is supplied to the other end of this piezoelectric element 60. Similarly, the driving signals VOUT2 to VOUT6 output by the driving signal selection circuits 200-2 to 200-6 are respectively supplied to one ends of the piezoelectric elements 60 in a plurality of discharge sections 600 provided in the nozzle columns L2 to L6. The reference voltage signals CGND2 to CGND6 are supplied to the other ends of the corresponding piezoelectric elements 60, respectively.

[0088] Next, the configuration of the discharge section 600 in the head 310 will be described with reference to FIG. 14. FIG. 14 is a diagram illustrating an overall configuration of one of the plurality of discharge sections 600 in the head 310. As illustrated in FIG. 14, the head 310 includes the discharge section 600 and a reservoir 641.

[0089] The reservoir 641 is provided to correspond to each of the nozzle columns L1 to L6. The ink is supplied from the ink supply port 661 into the reservoir 641.

[0090] The discharge section 600 includes the piezoelectric element 60, a vibration plate 621, a cavity 631, and the nozzle 651. The vibration plate 621 deforms by displacement of the piezoelectric element 60 provided on an upper surface in FIG. 14. The vibration plate 621 functions as a diaphragm of increasing and reducing the internal volume of the cavity 631. The cavity 631 is filled with the ink. The cavity 631 functions as a pressure chamber having an internal volume which changes by the displacement of the piezoelectric element 60. The nozzle 651 is an opening portion which is formed in the nozzle plate 632 and communicates with the cavity 631. The ink stored in the cavity 631 is discharged from the nozzle 651 by the change of the internal volume of the cavity 631.

[0091] The piezoelectric element 60 has a structure in which a piezoelectric substance 601 is interposed between a pair of electrodes 611 and 612. In the piezoelectric element 60 having such a structure, the central portions of the electrodes 611 and 612 and the vibration plate 621 bend with respect to both end portions thereof in an up-and-down direction in FIG. 14, in accordance with a voltage supplied to the electrodes 611 and 612. Specifically, the driving signal VOUT is supplied to the electrode 611, and the reference voltage signal CGND is supplied to the electrode 612. If the voltage of the driving signal VOUT is high, the central portion of the piezoelectric element 60 bends upward. If the voltage of the driving signal VOUT is low, the central portion of the piezoelectric element 60 bends downward. That is, if the piezoelectric element 60 bends upward, the internal volume of the cavity 631 increases. Thus, the ink is drawn from the reservoir 641. If the piezoelectric element 60 bends downward, the internal volume of the cavity 631 is reduced. Accordingly, the ink of the amount depending on the degree of the internal volume of the cavity 631 being reduced is discharged from the nozzle 651. As described above, the piezoelectric element 60 drives by the driving signal VOUT based on the driving signal COM, and the ink is discharged from the nozzle 651 by the piezoelectric element 60 driving. The piezoelectric element 60 is not limited to the structure illustrated in FIG. 14. Any type may be provided so long as the piezoelectric element is capable of discharging the ink with the displacement of the piezoelectric element 60. The piezoelectric element 60 is not limited to flexural vibration, and may be configured to use longitudinal vibration.

[0092] Returning to FIG. 12, the substrate 320 has a surface 321 and a surface 322 different from the surface 321. Here, the surface 321 and the surface 322 are surfaces located to face each other with a base material of the substrate 320 interposed between the surfaces 321 and 322. In other words, the surface 321 and the surface 322 are the front surface and the back surface of the substrate 320. The substrate 320 has a substantially rectangular shape formed by a side 323, a side 324 (facing the side 323 in the X-direction), a side 325, and a side 326 (facing the side 325 in the Y-direction). In other words, the substrate 320 has the side 323, the side 324 different from the side 323, the side 325 intersecting the sides 323 and 324, and the side 326 different from the side 325 intersecting the sides 323 and 324. Here, the sides 325 and 326 intersecting the sides 323 and 324 mean a case where a virtual extension line of the side 325 intersects a virtual extension line of the side 323 and a virtual extension line of the side 324, and a virtual extension line of the side 326 intersects a virtual extension line of the side 323 and a virtual extension line of the side 324. That is, the shape of the substrate 320 is not limited to a rectangle. For example, the shape of the substrate 320 may be a polygon such as a hexagon or an octagon, or may have a shape in which a notch or an arc is formed at a portion thereof.

[0093] Here, details of the substrate 320 will be described with reference to FIGs. 15 and 16. FIG. 15 is a plan view when the substrate 320 is viewed from the surface 322. FIG. 16 is a plan view when the substrate 320 is viewed from the surface 321. As illustrated in FIG. 15, electrode groups 330a to 330f are provided on the surface 322 of the substrate 320. Specifically, each of the electrode groups 330a to 330f includes a plurality of electrodes aligned in the Y-direction. The electrode groups

330a to 330f are provided to be aligned from the side 323 toward the side 324 in order of the electrode groups 330a, 330b, 330c, 330d, 330e, and 330f. A flexible printed circuit (FPC) (not illustrated) is electrically coupled to each of the electrode groups 330a to 330f provided in a manner as described above.

[0094] As illustrated in FIGs. 15 and 16, FPC insertion holes 332a to 332c and ink supply path insertion holes 331a to 331f being through-holes penetrating the surfaces 321 and 322 are formed in the substrate 320.

[0095] The FPC insertion hole 332a is located between the electrode group 330a and the electrode group 330b in the X-direction. An FPC electrically coupled to the electrode group 330a and an FPC electrically coupled to the electrode group 330b are inserted into the FPC insertion hole 332a. The FPC insertion hole 332b is located between the electrode group 330c and the electrode group 330d in the X-direction. An FPC electrically coupled to the electrode group 330c and an FPC electrically coupled to the electrode group 330d are inserted into the FPC insertion hole 332b. The FPC insertion hole 332c is located between the electrode group 330e and the electrode group 330f in the X-direction. An FPC electrically coupled to the electrode group 330e and an FPC electrically coupled to the electrode group 330f are inserted into the FPC insertion hole 332c.

[0096] The ink supply path insertion hole 331a is located on the side 323 side of the electrode group 330a in the X-direction. The ink supply path insertion holes 331b and 331c are located between the electrode group 330b and the electrode group 330c in the X-direction. The ink supply path insertion holes 331b and 331c are located to be aligned in the Y-direction such that the ink supply path insertion hole 331b is located on the side 325 side, and the ink supply path insertion hole 331c is located on the side 326 side. The ink supply path insertion holes 331d and 331e are located between the electrode group 330d and the electrode group 330e in the X-direction. The ink supply path insertion holes 331d and 331e are located to be aligned in the Y-direction such that the ink supply path insertion hole 331d is located on the side 325 side, and the ink supply path insertion hole 331e is located on the side 326 side. The ink supply path insertion hole 331f is located on the side 324 side of the electrode group 330f in the X-direction. A portion of an ink supply path (not illustrated) is inserted into each of the ink supply path insertion holes 331a to 331f. The ink supply path communicates with an ink supply port 661 for supplying the ink to the discharge section 600 corresponding to each of the nozzle columns L1 to L6.

[0097] As illustrated in FIGs. 15 and 16, the substrate 320 has fixation portions 346 to 349 for fixing the substrate 320 in the print head 21 to the carriage 20 illustrated in FIG. 1. Each of the fixation portions 346 to 349 is a through-hole penetrating the surfaces 321 and 322 of the substrate 320. The substrate 320 is fixed to the carriage 20 in a manner that screws (not illustrated) inserted into the fixation portion 346 to 349 are attached to the carriage 20. The fixation portions 346 to 349 are not limited to through-holes formed in the substrate 320. For example, the substrate 320 may be fixed to the carriage 20 by fitting the fixation portions 346 to 349.

[0098] The fixation portions 346 and 347 are located on the side 323 side of the ink supply path insertion hole 331a in the X-direction and are provided to be aligned such that the fixation portion 346 is located on the side 325 side, and the fixation portion 347 is located on the side 326 side. The fixation portions 348 and 349 are located on the side 324 side of the ink supply path insertion hole 331f in the X-direction and are provided to be aligned such that the fixation portion 348 is located on the side 325 side, and the fixation portion 349 is located on the side 326 side.

[0099] As illustrated in FIG. 16, an integrated circuit 241 constituting the diagnosis circuit 240 illustrated in FIG. 2 is provided on the surface 321 of the substrate 320. Specifically, the integrated circuit 241 is provided between the fixation portion 347 and the fixation portion 349 and is provided on the side 326 side of the electrode groups 330a to 330f, on the surface 321 side of the substrate 320. The integrated circuit 241 constituting the diagnosis circuit 240 diagnoses whether or not normal discharge of the ink from the nozzle 651 is possible, based on the diagnosis signals DIG-A to DIG-D.

[0100] As illustrated in FIGs. 15 and 16, the connectors 350 and 360 are provided on the substrate 320. The connector 350 is provided along the side 323 on the surface 321 side of the substrate 320. The connector 360 is provided along the side 323 on the surface 322 side of the substrate 320. That is, the connector 350 and the integrated circuit 241 are provided on the same surface of the substrate 320. The connector 360 and the integrated circuit 241 are provided on the different surfaces of the substrate 320.

[0101] Here, a configuration of the connector 350 or 360 will be described with reference to FIG. 17. FIG. 17 is a diagram illustrating the configuration of the connector 350 or 360. As illustrated in FIG. 17, the connector 350 includes a housing 351, a cable attachment section 352 formed in the housing 351, and a plurality of terminals 353. The plurality of terminals 353 is aligned in parallel along the side 323. Specifically, 26 terminals 353 are provided along the side 323 to be aligned. Here, the 26 terminals 353 are referred to as terminals 353-1, 353-2, ..., and 353-26 in order from the side 325 toward the side 326 in a direction along the side 323. The cable attachment section 352 is located on the substrate 320 side of the plurality of terminals 353 in the Z-direction. The cable 19a is attached to the cable attachment section 352. When the cable 19a is attached to the cable attachment section 352, terminals 196a-1 to 196a-26 in the cable 19a electrically come into contact with the terminals 353-1 to 353-26 in the connector 350, respectively.

[0102] The connector 360 includes a housing 361, a cable attachment section 362 formed in the housing 361, and a plurality of terminals 363. The plurality of terminals

363 is aligned in parallel along the side 323. Specifically, 26 terminals 363 are provided along the side 323 to be aligned. Here, the 26 terminals 363 are referred to as terminals 363-1, 363-2, ..., and 363-26 in order from the side 325 toward the side 326 in a direction along the side 323. The cable attachment section 362 is located on the substrate 320 side of the plurality of terminals 363 in the Z-direction. The cable 19b is attached to the cable attachment section 362. When the cable 19b is attached to the cable attachment section 352, terminals 196b-1 to 196b-26 in the cable 19b electrically come into contact with the terminals 363-1 to 363-26 in the connector 360, respectively.

[0103] Here, in the connector 350 illustrated in FIG. 17, the cable attachment section 352 is located on the substrate 320 side in the Z-direction, and the plurality of terminals 353 is located on the ink discharge surface 311 side in the Z-direction. However, as in the connector 350 illustrated in FIG. 18, the plurality of terminals 353 is preferably located on the substrate 320 side in the Z-direction, and the cable attachment section 352 is preferably located on the ink discharge surface 311 side in the Z-direction.

[0104] FIG. 18 is a diagram illustrating another configuration of the connector 350 or 360. In the liquid discharge apparatus 1, most of the ink discharged from the nozzle 651 are landed on a medium P and form an image. However, a portion of the ink discharged from the nozzle 651 may be misted before being landed on the medium P, and thus may float in the liquid discharge apparatus 1. Even after the ink discharged from the nozzle 651 is landed on the medium P, the ink landed on the medium P may float again in the liquid discharge apparatus 1 by an air flow generated with moving the carriage 20 in which the print head 21 is mounted or transporting the medium P. Thus, when the ink floating in the liquid discharge apparatus 1 adheres to the plurality of terminals 353 in the connector 350 or to the terminal 196a in the cable 19 for propagating a signal to the print head 21, the terminals may be short-circuited. As a result, the waveforms of the various signals input to the print head 21 may be distorted, and thus discharge accuracy of the ink discharged from the print head 21 may be deteriorated.

[0105] As in the connector 350 illustrated in FIG. 18, when the plurality of terminals 353 is located on the substrate 320 side in the Z-direction, the cable attachment section 352 is located on the ink discharge surface 311 side in the Z-direction, and the cable 19a is attached to the connector 350, a possibility that the terminal 353 and the terminal 196a are exposed to the ink discharge surface 311 side having a high possibility of the floating ink adhering is reduced. Therefore, it is possible to reduce the concern that the plurality of terminals 353 in the connector 350 or the terminals 196a in the cable 19a are short-circuited by the ink floating in the liquid discharge apparatus 1. Accordingly, it is possible to reduce the concern that the signal propagated in the cable 19 is distorted.

[0106] Here, a specific example of electrical coupling between the cables 19a and 19b and the connectors 350 and 360 will be described with reference to FIG. 19. In descriptions with FIG. 19, since the cables 19a and 19b have the similar configuration, the descriptions will be made on the assumption that the cables 19a and 19b are simply set as the cable 19. Since the connectors 350 and 360 have the similar configuration, descriptions will be made using the connector 350, and the descriptions of the connector 360 will not be repeated.

[0107] FIG. 19 is a diagram illustrating a specific example when the cable 19 is attached to the connector 350. As illustrated in FIG. 19, the terminal 353 of the connector 350 has a substrate attachment section 353a, a housing insertion section 353b, and a cable maintaining section 353c. The substrate attachment section 353a is located at a lower portion of the connector 350 and is provided between the housing 351 and the substrate 320. The substrate attachment section 353a is electrically coupled to an electrode (not illustrated) provided on the substrate 320, by a solder, for example. The housing insertion section 353b is inserted into the housing 351. The housing insertion section 353b electrically couples the substrate attachment section 353a and the cable maintaining section 353c to each other. The cable maintaining section 353c has a curved shape that protrudes toward the inside of the cable attachment section 352. When the cable 19 is attached to the cable attachment section 352, the cable maintaining section 353c and the terminal 196 electrically come into contact with each other via a contact section 180. Thus, the cable 19 is electrically coupled to the connector 350 and the substrate 320. In this case, since the cable 19 is attached, stress is applied to the curved shape formed at the cable maintaining section 353c. With the stress, the cable 19 is held in the cable attachment section 352.

[0108] As described above, the cable 19 and the connector 350 are electrically coupled to each other by the terminal 196 and the terminal 353 coming into contact with each other via the contact section 180. FIG. 11 illustrates contact sections 180-1 to 180-26 at which each of the terminals 196-1 to 196-26 is electrically in contact with the terminal 353 of the connector 350. Here, in the following descriptions, the contact section 180-k provided in the cable 19a is referred to as a contact section 180a-k, and the contact section 180-k provided in the cable 19b is referred to as a contact section 180b-k. That is, descriptions for the cable 19a will be made on the assumption that the terminal 195a-k is electrically coupled to the connector 12a, and the terminal 196a-k is electrically coupled to the connector 350 via the contact section 180a-k. Similarly, descriptions for the cable 19b will be made on the assumption that the terminal 195b-k is electrically coupled to the connector 12b, and the terminal 196b-k is electrically coupled to the connector 360 via the contact section 180b-k.

[0109] In the print head 21 configured in a manner as described above, a plurality of signals including the driv-

ing signals COM1 to COM6, the reference voltage signals CGND1 to CGND6, the print data signals SI1 to SI6, the latch signal LAT, the change signal CH, and the clock signal SCK, which are output from the control mechanism 10, is input to the print head 21 via the connectors 350 and 360. The plurality of signals is propagated in a wiring pattern provided on the substrate 320 and then is input to each of the electrode groups 330a to 330f.

[0110] The various signals input to the electrode groups 330a to 330f are input to the driving signal selection circuits 200-1 to 200-6 respectively corresponding to the nozzle columns L1 to L6, via an FPC electrically coupled to each of the electrode groups 330a to 330f. The driving signal selection circuits 200-1 to 200-6 generate the driving signals VOUT1 to VOUT6 based on the input signals and supply the driving signals VOUT1 to VOUT4 to the piezoelectric elements 60 in the nozzle columns L1 to L6, respectively. In this manner, the various signals input to the connectors 350 and 360 are supplied to the piezoelectric elements 60 in the plurality of discharge sections 600. Each of the driving signal selection circuits 200-1 to 200-6 may be provided in the head 310 or may be mounted on an FPC in a manner of chip-on-film (COF).

1.7. Signal Propagated Between Print Head and Print Head Control Circuit

[0111] In the liquid discharge apparatus 1 configured in a manner as described above, details of the signal propagated between the print head control circuit 15 and the print head 21 will be described with reference to FIGs. 20 and 21.

[0112] FIG. 20 is a diagram illustrating details of the signal propagated in the cable 19a. As illustrated in FIG. 20, the cable 19a includes wirings for propagating driving signals COM1 to COM6, wirings for propagating reference voltage signals CGND1 to CGND6, wirings for propagating a temperature signal TH, a latch signal LAT, a clock signal SCK, a change signal CH, a print data signal SI1, an abnormality signal XHOT, wirings for propagating diagnosis signals DIG-A to DIG-E, a wiring for propagating a voltage VHV, and a plurality of wirings for propagating a plurality of ground signals GND. Various signals propagated in the cable 19a are input to the terminals 353-1 to 353-26 of the connector 350 via the contact sections 180a-1 to 180a-26, respectively.

[0113] Specifically, the driving signals COM1 to COM6 and the reference voltage signals CGND1 to CGND6 are input to the cable 19a from the terminals 195a-11, 195a-9, 195a-7, 195a-5, 195a-3, and 195a-1, respectively. The driving signals COM1 to COM6 are propagated in the wirings 197a-11, 197a-9, 197a-7, 197a-5, 197a-3, and 197a-1 and then are input to the terminals 353-11, 353-9, 353-7, 353-5, 353-3, and 353-1 of the connector 350 via the terminals 196a-11, 196a-9, 196a-7, 196a-5, 196a-3, and 196a-1 and the contact sections 180a-11, 180a-9, 180a-7, 180a-5, 180a-3, and 180a-1, respectively.

[0114] Here, the terminal 353-11 to which the driving signal COM1 is input is an example of a fifth terminal in the first embodiment. The wiring 197a-11 for propagating the driving signal COM1 is an example of a first driving signal propagation wiring in the first embodiment. The contact section 180a-11 at which the terminal 196a-11 and the terminal 353-11 are electrically in contact with each other is an example of a fifth contact section. Any of the terminals 353-9, 353-7, 353-5, 353-3, and 353-1 to which the driving signals COM2 to COM6 are respectively input is another example of the fifth terminal in the first embodiment. Any of the wirings 197a-9, 197a-7, 197a-5, 197a-3, and 197a-1 for respectively propagating the driving signals COM2 to COM6 is another example of the first driving signal propagation wiring in the first embodiment. Any of the contact sections 180a-9, 180a-7, 180a-5, 180a-3, and 180a-1 is another example of the fifth contact section.

[0115] The reference voltage signals CGND1 to CGND6 are input to the cable 19a from the terminals 195a-12, 195a-10, 195a-8, 195a-6, 195a-4, and 195a-2 and are propagated in the wirings 197a-12, 197a-10, 197a-8, 197a-6, 197a-4, and 197a-2, respectively. Then, the reference voltage signals CGND1 to CGND6 are input to the terminals 353-12, 353-10, 353-8, 353-6, 353-4, and 353-2 of the connector 350 via the terminals 196a-12, 196a-10, 196a-8, 196a-6, 196a-4, and 196a-2 and the contact sections 180a-12, 180a-10, 180a-8, 180a-6, 180a-4, and 180a-2, respectively.

[0116] The diagnosis signal DIG-A is input to the cable 19a from the terminal 195a-23 and is propagated in the wiring 197a-23. Then, the diagnosis signal DIG-A is input to the terminal 353-23 of the connector 350 via the terminal 196a-23 and the contact section 180a-23. Similarly, the latch signal LAT is input to the cable 19a from the terminal 195a-23 and is propagated in the wiring 197a-23. Then, the latch signal LAT is input to the terminal 353-23 of the connector 350 via the terminal 196a-23 and the contact section 180a-23. That is, the wiring 197a-23 functions as the wiring for propagating the diagnosis signal DIG-A and the wiring for propagating the latch signal LAT. The terminal 353-23 functions as the terminal to which the diagnosis signal DIG-A is input and the terminal to which the latch signal LAT is input. The contact section 180a-23 is electrically in contact with the wiring for propagating the diagnosis signal DIG-A and is also electrically in contact with the wiring for propagating the latch signal LAT. The diagnosis signal DIG-A is an example of a first diagnosis signal in the first embodiment. The wiring 197a-23 for propagating the diagnosis signal DIG-A is an example of a first diagnosis signal propagation wiring in the first embodiment. The terminal 353-23 to which the diagnosis signal DIG-A is input is an example of a first terminal in the first embodiment. The contact section 180a-23 at which the wiring 197a-23 and the terminal 353-23 are electrically in contact with each other is an example of a first contact section in the first embodiment.

[0117] The diagnosis signal DIG-B is input to the cable 19a from the terminal 195a-21 and is propagated in the wiring 197a-21. Then, the diagnosis signal DIG-B is input to the terminal 353-21 of the connector 350 via the terminal 196a-21 and the contact section 180a-21. Similarly, the clock signal SCK is input from the terminal 195a-21 to the cable 19a and is propagated in the wiring 197a-21. Then, the clock signal SCK is input to the terminal 353-21 of the connector 350 via the terminal 196a-21 and the contact section 180a-21. That is, the wiring 197a-21 functions as the wiring for propagating the diagnosis signal DIG-B and the wiring for propagating the clock signal SCK. The terminal 353-21 functions as the terminal to which the diagnosis signal DIG-B is input and the terminal to which the clock signal SCK is input. The contact section 180a-21 is electrically in contact with the wiring for propagating the diagnosis signal DIG-B and is also electrically in contact with the wiring for propagating the clock signal SCK. The diagnosis signal DIG-B is an example of a second diagnosis signal in the first embodiment. The wiring 197a-21 for propagating the diagnosis signal DIG-B is an example of a second diagnosis signal propagation wiring in the first embodiment. The terminal 353-21 to which the diagnosis signal DIG-B is input is an example of a second terminal in the first embodiment. The contact section 180a-21 at which the wiring 197a-21 and the terminal 353-21 are electrically in contact with each other is an example of a second contact section in the first embodiment.

[0118] The diagnosis signal DIG-C is input from the terminal 195a-19 to the cable 19a and is propagated in the wiring 197a-19. Then, the diagnosis signal DIG-C is input to the terminal 353-19 of the connector 350 via the terminal 196a-19 and the contact section 180a-19. Similarly, the change signal CH is input from the terminal 195a-19 to the cable 19a and is propagated in the wiring 197a-19. Then, the change signal CH is input to the terminal 353-19 of the connector 350 via the terminal 196a-19 and the contact section 180a-19. That is, the wiring 197a-19 functions as the wiring for propagating the diagnosis signal DIG-C and the wiring for propagating the change signal CH. The terminal 353-19 functions as the terminal to which the diagnosis signal DIG-C is input and the terminal to which the change signal CH is input. The contact section 180a-19 is electrically in contact with the wiring for propagating the diagnosis signal DIG-C and is also electrically in contact with the wiring for propagating the change signal CH. The diagnosis signal DIG-C is an example of a third diagnosis signal in the first embodiment. The wiring 197a-19 for propagating the diagnosis signal DIG-C is an example of a third diagnosis signal propagation wiring in the first embodiment. The terminal 353-19 to which the diagnosis signal DIG-C is input is an example of a third terminal in the first embodiment. The contact section 180a-19 at which the wiring 197a-19 and the terminal 353-19 are electrically in contact with each other is an example of a third contact section in the first embodiment.

[0119] The diagnosis signal DIG-D is input from the terminal 195a-17 to the cable 19a and is propagated in the wiring 197a-17. Then, the diagnosis signal DIG-D is input to the terminal 353-17 of the connector 350 via the terminal 196a-17 and the contact section 180a-17. Similarly, the print data signal SI1 is input from the terminal 195a-17 to the cable 19a and is propagated in the wiring 197a-17. Then, the print data signal SI1 is input to the terminal 353-17 of the connector 350 via the terminal 196a-17 and the contact section 180a-17. That is, the wiring 197a-17 functions as the wiring for propagating the diagnosis signal DIG-D and the wiring for propagating the print data signal SI1. The terminal 353-17 functions as the terminal to which the diagnosis signal DIG-D is input and the terminal to which the print data signal SI1 is input. The contact section 180a-17 is electrically in contact with the wiring for propagating the diagnosis signal DIG-D and is also electrically in contact with the wiring for propagating the print data signal SI1. The diagnosis signal DIG-D is an example of a fourth diagnosis signal in the first embodiment. The wiring 197a-17 for propagating the diagnosis signal DIG-D is an example of a fourth diagnosis signal propagation wiring in the first embodiment. The terminal 353-17 to which the diagnosis signal DIG-D is input is an example of a fourth terminal in the first embodiment. The contact section 180a-17 at which the wiring 197a-17 and the terminal 353-17 are electrically in contact with each other is an example of a fourth contact section in the first embodiment.

[0120] The diagnosis signal DIG-E is input to the terminal 353-15 and then is input to the cable 19a via the contact section 180a-15 and the terminal 196a-15. The diagnosis signal DIG-E is propagated in the wiring 197a-15 and then is input from the terminal 195a-15 to the main substrate 11. Similarly, the abnormality signal XHOT is input to the terminal 353-15, is input to the cable 19a via the contact section 180a-15 and the terminal 196a-15, and is propagated in the wiring 197a-15. Then, the abnormality signal XHOT is input from the terminal 195a-15 to the main substrate 11. That is, the wiring 197a-15 functions as the wiring for propagating the diagnosis signal DIG-E and the wiring for propagating the abnormality signal XHOT. The terminal 353-15 functions as the terminal to which the diagnosis signal DIG-E is input and the terminal to which the abnormality signal XHOT is input. The contact section 180a-15 is electrically in contact with the wiring for propagating the diagnosis signal DIG-E and is also electrically in contact with the wiring for propagating the abnormality signal XHOT. The diagnosis signal DIG-E is an example of a fifth diagnosis signal in the first embodiment. The wiring 197a-15 for propagating the diagnosis signal DIG-E is an example of a fifth diagnosis signal propagation wiring in the first embodiment. The terminal 353-15 to which the diagnosis signal DIG-E is input is an example of a sixth terminal in the first embodiment. The contact section 180a-17 at which the wiring 197a-17 and the terminal 353-17 are electrically in contact with each other is an example of a

sixth contact section in the first embodiment.

[0121] As described above, in the first embodiment, each of the diagnosis signals DIG-A to DIG-E and each of the latch signal LAT, the clock signal SCK, the change signal CH, the print data signal SI1, and the abnormality signal XHOT are propagated in the common wiring and are electrically coupled to the common terminal via the common contact section. Here, an example of a method of propagating each of the diagnosis signals DIG-A to DIG-E and each of the latch signal LAT, the clock signal SCK, the change signal CH, the print data signal SI1, and the abnormality signal XHOT in the common wiring and of inputting the signals to the common terminal via the common contact section will be described.

[0122] For example, the control circuit 100 generates the diagnosis signal DIG-A, the latch signal LAT, the diagnosis signal DIG-B, the clock signal SCK, the diagnosis signal DIG-C, the change signal CH, the diagnosis signal DIG-D, and the print data signal SI1 in time division, in accordance with operation states of the liquid discharge apparatus 1 and the print head 21. Specifically, when the liquid discharge apparatus 1 is in a print state of discharging the ink, the control circuit 100 generates the latch signal LAT, the clock signal SCK, the change signal CH, and the print data signal SI1 and outputs the generated signals to the print head 21. When the liquid discharge apparatus 1 is not in the print state of discharging the ink, and the print head 21 performs self-diagnosis, the control circuit 100 generates the diagnosis signals DIG-A to DIG-D and outputs the generated signals to the print head 21. Thus, each of the latch signal LAT, the clock signal SCK, the change signal CH, and the print data signal SI1 and each of the diagnosis signals DIG-A to DIG-D can be propagated in the common wiring, and can be input to the common terminal via the common contact section.

[0123] As a method of propagating the diagnosis signal DIG-E and the abnormality signal XHOT in the common wiring and inputting the diagnosis signal DIG-E and the abnormality signal XHOT to the common terminal via the common contact section, for example, a wiring from which the diagnosis signal DIG-E indicating the diagnosis result in the diagnosis circuit 240 and a wiring from which the abnormality signal XHOT is output are coupled in a wired-OR manner in the print head 21. Then, the signals obtained by the coupling in the wired-OR manner are input to the common terminal, and then are propagated in the common wiring. Thus, when abnormality occurs in at least any of a diagnosis result of diagnosing whether or not the temperature of the temperature abnormality detection circuit 250 is abnormal and a diagnosis result in the diagnosis circuit 240, a signal which has an L level and indicates that normal discharge of the ink in the print head 21 is not possible is propagated. When both the diagnosis result of diagnosing whether or not the temperature of the temperature abnormality detection circuit 250 is abnormal and the diagnosis result in the diagnosis circuit 240 are normal, a signal which has an H level and indicates that normal discharge of the ink in the print head 21 is possible is propagated.

[0124] As described above, a method of propagating each of the diagnosis signals DIG-A to DIG-E and each of the latch signal LAT, the clock signal SCK, the change signal CH, the print data signal SI1, and the abnormality signal XHOT in the common wiring and inputting the signals to the common terminal is an example. The signal propagated in the wiring and the signal input to the terminal may be switched by a selector, for example.

[0125] The print data signal SI, the change signal CH, the latch signal LAT, the clock signal SCK, and the abnormality signal XHOT are signals important for controlling discharging of the print head 21. When a coupling problem occurs in the wiring in which the signals are propagated, the discharge accuracy of the ink may be deteriorated. The wiring in which such important signals are propagated and the wiring in which the signal when the print head 21 performs self-diagnosis are set to the common wiring, and the terminal to which the important signals are input and the terminal to which the signal when the print head 21 performs self-diagnosis is input are set to the common terminal via the common contact section. Thus, it can be diagnosed whether or not the print data signal SI1, the change signal CH, the latch signal LAT, the clock signal SCK, and the abnormality signal XHOT are normally propagated, based on the result of the self-diagnosis of the print head 21. Further, since the plurality of signals is propagated in one wiring, and the plurality of signals is input to one terminal, it is possible to reduce the number of wirings to be provided in the cable 19 and the number of terminals provided in the connector 350.

[0126] The voltage VHV is input from the terminal 195a-13 to the cable 19a and is propagated in the wiring 197a-13. Then, the voltage VHV is input to the terminal 353-13 of the connector 350 via the terminal 196a-13 and the contact section 180a-13.

[0127] The temperature signal TH is input to the terminal 353-25 of the connector 350 and then is input to the cable 19a via the contact section 180a-25 and the terminal 196a-25. The temperature signal TH is propagated in the wiring 197a-25, and then is input from the terminal 195a-25 to the main substrate 11.

[0128] The ground signal GND is input from each of the terminals 195a-14, 195a-16, 195a-18, 195a-20, 195a-22, 195a-24, and 195a-26 to the cable 19a and is propagated in each of the wirings 197a-14, 197a-16, 197a-18, 197a-20, 197a-22, 197a-24, and 197a-26. Then, the ground signal GND is input to each of the terminals 353-14, 353-16, 353-18, 353-20, 353-22, 353-24, and 353-26 of the connector 350 via each of the contact sections 180a-14, 180a-16, 180a-18, 180a-20, 180a-22, 180a-24, and 180a-26 and each of the terminals 196a-14, 196a-16, 196a-18, 196a-20, 196a-22, 196a-24, and 196a-26.

[0129] Here, as illustrated in FIG. 20, the wiring 197a-23 for propagating the diagnosis signal DIG-A, the wiring 197a-21 for propagating the diagnosis signal DIG-B, the

wiring 197a-19 for propagating the diagnosis signal DIG-C, and the wiring 197a-17 for propagating the diagnosis signal DIG-D are provided in the cable 19a to be aligned in order of the wirings 197a-23, 197a-21, 197a-19, and 197a-17. Thus, the wiring 197a-22 for propagating the ground signal GND is located between the wiring 197a-23 and the wiring 197a-21. The wiring 197a-20 for propagating the ground signal GND is located between the wiring 197a-21 and the wiring 197a-19. The wiring 197a-18 for propagating the ground signal GND is located between the wiring 197a-19 and the wiring 197a-17.

[0130] Similarly, the terminal 353-23 to which the diagnosis signal DIG-A is input, the terminal 353-21 to which the diagnosis signal DIG-B is input, the terminal 353-19 to which the diagnosis signal DIG-C is input, and the terminal 353-17 to which the diagnosis signal DIG-D is input are provided in the connector 350 in order of the terminals 353-23, 353-21, 353-19, and 353-17. Thus, the terminal 353-22 to which the ground signal GND is located between the terminal 353-23 and the terminal 353-21. The terminal 353-20 to which the ground signal GND is input is located between the terminal 353-21 and the terminal 353-19. The terminal 353-18 to which the ground signal GND is input is located between the terminal 353-19 and the terminal 353-17.

[0131] The contact section 180a-23, the contact section 180a-21, the contact section 180a-19, and the contact section 180a-17 are provided in the contact section 180 at which the cable 19a and the connector 350 are electrically in contact with each other, to be aligned in order of the contact sections 180a-23, 180a-21, 180a-19, and 180a-17. Thus, the contact section 180a-22 to which the ground signal GND is input is located between the contact section 180a-23 and the contact section 180a-21. The contact section 180a-20 to which the ground signal GND is input is located between the contact section 180a-21 and the contact section 180a-19. The contact section 180a-18 to which the ground signal GND is input is located between the contact section 180a-19 and the contact section 180a-17.

[0132] Here, the ground signal GND is an example of a constant voltage signal. The wiring 197a-22 is an example of a first constant voltage signal propagation wiring. The wiring 197a-20 is an example of a second constant voltage signal propagation wiring. The wiring 197a-18 is an example of a third constant voltage signal propagation wiring. The terminal 353-22 is an example of a first constant voltage terminal. The terminal 353-20 is an example of a second constant voltage terminal. The terminal 353-18 is an example of a third constant voltage terminal. The contact section 180a-22 at which the wiring 197a-22 and the terminal 353-22 are electrically in contact with each other is an example of a first constant-voltage contact section. The contact section 180a-20 at which the wiring 197a-20 and the terminal 353-20 are electrically in contact with each other is an example of a second constant-voltage contact section. The contact section 180a-18 at which the wiring 197a-18 and the terminal 353-18 are electrically in contact with each other is an example of a third constant-voltage contact section.

[0133] As described above, since the wirings 197a-22, 197a-20, and 197a-18 in which the ground signal is propagated are located between the wirings in which the diagnosis signals DIG-A to DIG-D are respectively propagated, each of the wirings 197a-22, 197a-20, and 197a-18 functions as a shield wiring. As a result, a concern that the diagnosis signals DIG-A to DIG-D propagated in the cable 19a interfere with each other is reduced. Thus, a possibility that the waveforms of the diagnosis signals DIG-A to DIG-D input to the diagnosis circuit 240 are distorted is reduced.

[0134] Similarly, since the terminals 353-22, 353-20, and 353-18 to which the ground signal is input are located between the terminals to which the diagnosis signals DIG-A to DIG-D are respectively input, each of the terminals 353-22, 353-20, and 353-18 functions as a shield terminal. As a result, a concern that the diagnosis signals DIG-A to DIG-D input to the connector 350 interfere with each other is reduced. Thus, a possibility that the waveforms of the diagnosis signals DIG-A to DIG-D input to the diagnosis circuit 240 are distorted is reduced.

[0135] Similarly, since the contact sections 180a-22, 180a-20, and 180a-18 at which the wirings in which the ground signal is propagated and the terminals to which the ground signal is input are in contact with each other are located between the contact sections at which the wirings in which the diagnosis signals DIG-A to DIG-D are respectively propagated and the terminals to which the diagnosis signals DIG-A to DIG-D are respectively input, each of the contact sections 180a-22, 180a-20, and 180a-18 functions as a shield. As a result, a concern that the diagnosis signals DIG-A to DIG-D interfere with each other at the contact section 180 at which the cable 19a and the connector 350 are in contact with each other is reduced. Thus, a possibility that the waveforms of the diagnosis signals DIG-A to DIG-D input to the diagnosis circuit 240 are distorted is reduced.

[0136] In the first embodiment, the descriptions are made on the assumption that the wiring in which the ground signal GND is located between the wiring 197a-23 and the wiring 197a-21, between the wiring 197a-21 and the wiring 197a-19, and between the wiring 197a-19 and the wiring 197a-17. However, any wiring may be located so long as it is possible to reduce mutual interference between the diagnosis signals DIG-A to DIG-D. For example, a wiring in which a constant voltage signal having a stable potential, for example, DC 3.3 V, is propagated may be located.

[0137] Similarly, as the terminal located between the terminal 353-23 and the terminal 353-21, between the terminal 353-21 and the terminal 353-19, and between the terminal 353-19 and the terminal 353-17, a terminal to which a constant voltage signal having a stable potential, for example, DC 3.3 V, is input may be provided. As the contact section located between the contact section 180a-23 and the contact section 180a-21, between the

contact section 180a-21 and the contact section 180a-19, and between the contact section 180a-19 and the contact section 180a-17, the contact section 180a to which a constant voltage signal having a stable potential, for example, DC 3.3 V, is input may be provided.

[0138] Two wirings or more including the wiring for propagating the constant voltage signal may be provided between the wiring 197a-23 and the wiring 197a-21, between the wiring 197a-21 and the wiring 197a-19, and between the wiring 197a-19 and the wiring 197a-17. Two terminals or more including the terminal to which the constant voltage signal is input may be provided between the terminal 353-23 and the terminal 353-21, between the terminal 353-21 and the terminal 353-19, and between the terminal 353-19 and the terminal 353-17. Two contact sections or more including the contact section to which the constant voltage signal is input may be provided between the contact section 180a-23 and the contact section 180a-21, between the contact section 180a-21 and the contact section 180a-19, and between the contact section 180a-19 and the contact section 180a-17.

[0139] As described above, in the cable 19a, respectively, the driving signals COM1 to COM6 and the reference voltage signals CGND1 to CGND6 are propagated in the wirings 197a-1 to 197a-12, and the diagnosis signals DIG-A to DIG-E, the temperature signal TH, the latch signal LAT, the clock signal SCK, the change signal CH, the print data signal SI1, the abnormality signal XHOT, and the plurality of ground signals GND are propagated in the wirings 197a-13 to 197a-26. As described above, in the cable 19a, the terminal 196a-k is attached to the connector 350 to be electrically coupled to the terminal 353-k of the connector 350 via the contact section 180a-k.

[0140] That is, when the cable 19a is electrically coupled to the print head 21, the diagnosis signals DIG-A to DIG-D are respectively propagated in the wirings 197a-23, 197a-21, 197a-19, and 197a-17 located on the side 326 side of the substrate 320, on which the integrated circuit 241 constituting the diagnosis circuit 240 is provided. The diagnosis signals DIG-A to DIG-D are input to the terminals 353-23, 353-21, 353-19, and 353-17 via the contact sections 180a-23, 180a-21, 180a-19, and 180a-17, respectively. When the cable 19a is electrically coupled to the print head 21, the driving signals COM1 to COM6 are propagated in the wirings 197a-11, 197a-9, 197a-7, 197a-5, 197a-3, and 197a-1 located on the side 325 side of the substrate 320, and then are input to the terminals 353-11, 353-9, 353-7, 353-5, 353-3, and 353-1 via the contact sections 180a-11, 180a-9, 180a-7, 180a-5, 180a-3, and 180a-1, respectively.

[0141] In other words, the shortest distance between the wiring 197a-11 and the integrated circuit 241 is longer than the shortest distance between the wiring 197a-23 and the integrated circuit 241, longer than the shortest distance between the wiring 197a-21 and the integrated circuit 241, longer than the shortest distance between the wiring 197a-19 and the integrated circuit 241, and longer than the shortest distance between the wiring 197a-17 and the integrated circuit 241. Similarly, the shortest distance between the terminal 353-11 and the integrated circuit 241 is longer than the shortest distance between the terminal 353-23 and the integrated circuit 241, longer than the shortest distance between the terminal 353-21 and the integrated circuit 241, longer than the shortest distance between the terminal 353-19 and the integrated circuit 241, and longer than the shortest distance between the terminal 353-17 and the integrated circuit 241. Similarly, the shortest distance between the contact section 180a-11 and the integrated circuit 241 is longer than the shortest distance between the contact section 180a-23 and the integrated circuit 241, longer than the shortest distance between the contact section 180a-21 and the integrated circuit 241, longer than the shortest distance between the contact section 180a-19 and the integrated circuit 241, and longer than the shortest distance between the contact section 180a-17 and the integrated circuit 241. Here, the shortest distance means a spatial distance when each wiring and the integrated circuit 241, each terminal and the integrated circuit 241, or each contact section and the integrated circuit 241 are joined to each other by a straight line.

[0142] Here, the cable 19a including the wirings 197a-23, 197a-21, 197a-19, and 197a-17 for respectively propagating the diagnosis signals DIG-A to DIG-D and the wiring 197a-11 for propagating the driving signal COM1 is an example of a first cable in the first embodiment. The connector 350 including the terminals 353-23, 353-21, 353-19, and 353-17 to which the diagnosis signals DIG-A to DIG-D are respectively input and the terminal 353-11 to which the driving signal COM1 is input is an example of a first connector in the first embodiment.

[0143] The print data signal SI1, the change signal CH, the latch signal LAT, and the clock signal SCK are signals important for controlling discharging of the print head 21. When a coupling problem occurs in the wirings in which the signals are propagated, the discharge accuracy of the ink may be deteriorated. As illustrated in FIG. 20, since the print data signal SI1, the change signal CH, the latch signal LAT, and the clock signal SCK are respectively propagated along with the diagnosis signals DIG-A to DIG-D in the common wirings and are input along with the diagnosis signals DIG-A to DIG-D from the common terminals via the common contact sections, it is possible to diagnose a coupling state of the wiring in which each of the print data signal SI1, the change signal CH, the latch signal LAT, and the clock signal SCK is propagated, based on the result of self-diagnosis of the print head 21. Further, since the plurality of signals are propagated in one wiring, it is possible to reduce the number of wirings to be provided in the cable 19a and the number of terminals to be provided in the connector 350.

[0144] Next, details of a signal propagated in the cable 19b will be described with reference to FIG. 21. FIG. 21 is a diagram illustrating details of the signal propagated in the cable 19b. As illustrated in FIG. 21, the cable 19b includes wirings for propagating the driving signals

COM1 to COM6, wirings for propagating the reference voltage signals CGND1 to CGND6, wirings for propagating print data signals SI2 to SI6, wirings for propagating voltages VDD1 and VDD2, and a plurality of wirings for propagating a plurality of ground signals GND.

[0145] Specifically, the driving signals COM1 to COM6 are input to the cable 19b from the terminals 195b-12, 195b-10, 195b-8, 195b-6, 195b-4, and 195b-2, respectively. The driving signals COM1 to COM6 are propagated in the wirings 197b-12, 197b-10, 197b-8, 197b-6, 197b-4, and 197b-2. Then, the driving signals COM1 to COM6 are input to the terminals 363-12, 363-10, 363-8, 363-6, 363-4, and 363-2 of the connector 360 via the terminals 196b-12, 196b-10, 196b-8, 196b-6, 196b-4, and 196b-2 and the contact sections 180b-12, 180b-10, 180b-8, 180b-6, 180b-4, and 180b-2, respectively.

[0146] The reference voltage signals CGND1 to CGND6 are input to the cable 19b from the terminals 195b-11, 195b-9, 195b-7, 195b-5, 195b-3, and 195b-1, respectively. The reference voltage signals CGND1 to CGND6 are propagated in the wirings 197b-11, 197b-9, 197b-7, 197b-5, 197b-3, and 197b-1, and then are input to the terminals 363-11, 363-9, 363-7, 363-5, 363-3, and 363-1 of the connector 360 via the terminals 196b-11, 196b-9, 196b-7, 196b-5, 196b-3, and 196b-1 and the contact sections 180b-11, 180b-9, 180b-7, 180b-5, 180b-3, and 180b-1, respectively.

[0147] The print data signals SI2 to SI6 are input to the cable 19b from the terminals 195b-24, 195b-22, 195b-20, 195b-18, and 195b-16, respectively. The print data signals SI2 to SI6 are propagated in the wirings 197b-24, 197b-22, 197b-20, 197b-18, and 197b-16, and then are input to the terminals 363-24, 363-22, 363-20, 363-18, and 363-16 of the connector 360 via the terminals 196b-24, 196b-22, 196b-20, 196b-18, and 196b-16 and the contact sections 180b-24, 180b-22, 180b-20, 180b-18, and 180b-16, respectively.

[0148] The voltage VDD1 is input from the terminal 195b-26 to the cable 19b. The voltage VDD1 is propagated in the wiring 197b-26, and then is input to the terminal 363-26 of the connector 360 via the terminal 196b-26 and the contact section 180b-26. The voltage VDD2 is input from the terminal 195b-21 to the cable 19b. The voltage VDD2 is propagated in the wiring 197b-21, and then is input to the terminal 363-21 of the connector 360 via the terminal 196b-21 and the contact section 180b-21.

[0149] The ground signal GND is input to the cable 19a from each of the terminals 195b-13, 195b-14, 195b-15, 195b-17, 195b-19, 195b-23, and 195b-25. The ground signal GND is propagated in each of the wirings 197b-13, 197b-14, 197b-15, 197b-17, 197b-19, 197b-23, and 197b-25 and then is input to each of the terminals 363-13, 363-14, 363-15, 363-17, 363-19, 363-23, and 363-25 of the connector 360 via each of the terminals 196b-13, 196b-14, 196b-15, 196b-17, 196b-19, 196b-23, and 196b-25 and each of the contact sections 180b-13, 180b-14, 180b-15, 180b-17, 180b-19, 180b-23, and 180b-25.

[0150] As described above, in the liquid discharge apparatus 1 in this embodiment, the diagnosis signals DIG-A to DIG-D output from the print head control circuit 15 are propagated in the cable 19a. The diagnosis signals DIG-A to DIG-D are supplied to the integrated circuit 241 provided on the surface 321 of the substrate 320 via the connector 350 provided on the surface 321 of the substrate 320 in the print head 21. In other words, the connector 350 and the diagnosis circuit are provided on the same surface of the substrate 320 in the print head 21. The cable 19a is electrically coupled to the connector 350. Thus, the diagnosis signals DIG-A to DIG-D are input to the integrated circuit 241 via the connector 350. In this case, preferably, a via or the like is not provided in the wiring pattern for propagating the diagnosis signals DIG-A to DIG-D from the connector 350 to the integrated circuit 241, and is formed only in the surface 321. Similarly, preferably, a via or the like is not provided in the wiring pattern for propagating the diagnosis signal DIG-E output from the integrated circuit 241 to the connector 350, and is formed only in the surface 321. Thus, it is possible to reduce a concern that noise and the like are superimposed in the wirings in which the diagnosis signals DIG-A to DIG-D are propagated in the substrate 320.

[0151] Here, an example of the wirings in which the diagnosis signals DIG-A to DIG-E input from the connector 350 are propagated on the surface 321 of the substrate 320 will be described with reference to FIG. 22. FIG. 22 is a diagram illustrating an example of the wiring pattern formed on the surface 321 of the substrate 320. In FIG. 22, illustrations of some wirings formed in the substrate 320 are omitted. In FIG. 22, the electrode groups 330a to 330f formed on the surface 322 of the substrate 320 are indicated by broken lines.

[0152] As illustrated in FIG. 22, the substrate 320 includes wirings 354-a to 354-o.

[0153] The terminal 353-23 is electrically coupled to the wiring 354-a. The diagnosis signal DIG-A and the latch signal LAT input from the terminal 353-23 are propagated in the wiring 354-a, and then are input to the integrated circuit 241. That is, the wiring 354-a electrically couples the terminal 353-23 to the integrated circuit 241. Such a wiring 354-a in which the diagnosis signal DIG-A and the latch signal LAT are propagated is an example of a first wiring in the first embodiment.

[0154] The terminal 353-21 is electrically coupled to the wiring 354-b. The diagnosis signal DIG-B and the clock signal SCK input from the terminal 353-21 are propagated in the wiring 354-b, and then are input to the integrated circuit 241. That is, the wiring 354-b electrically couples the terminal 353-21 to the integrated circuit 241. Such a wiring 354-b in which the diagnosis signal DIG-B and the clock signal SCK are propagated is an example of a second wiring in the first embodiment.

[0155] The terminal 353-19 is electrically coupled to the wiring 354-c. The diagnosis signal DIG-C and the change signal CH input from the terminal 353-19 are propagated in the wiring 354-c, and then are input to the integrated circuit 241. That is, the wiring 354-c electrically

couples the terminal 353-19 to the integrated circuit 241. Such a wiring 354-c in which the diagnosis signal DIG-C and the change signal CH are propagated is an example of a third wiring in the first embodiment.

[0156] The terminal 353-17 is electrically coupled to the wiring 354-d. The diagnosis signal DIG-D and the print data signal SI1 input from the terminal 353-17 are propagated in the wiring 354-d, and then are input to the integrated circuit 241. That is, the wiring 354-d electrically couples the terminal 353-17 to the integrated circuit 241. Such a wiring 354-d in which the diagnosis signal DIG-D and the print data signal SI1 are propagated is an example of a fourth wiring in the first embodiment.

[0157] The terminal 353-15 is electrically coupled to the wiring 354-e. The diagnosis signal DIG-E and the abnormality signal XHOT output from the integrated circuit 241 are propagated in the wiring 354-e, and then are input to the terminal 353-15. That is, the wiring 354-e electrically couples the terminal 353-15 to the integrated circuit 241.

[0158] Here, preferably, a via or the like is not formed in each of the wirings 354-a to 354-d for respectively propagating the diagnosis signals DIG-A to DIG-D. For example, as illustrated in FIG. 22, the connector 350 and the integrated circuit 241 constituting the diagnosis circuit 240 are preferably provided on the same surface, that is, the surface 321 of the substrate 320. In other words, the wiring 354-a that couples the terminal 353-23 to the integrated circuit 241 and is used for propagating the diagnosis signal DIG-A, the wiring 354-b that couples the terminal 353-21 to the integrated circuit 241 and is used for propagating the diagnosis signal DIG-B, the wiring 353-c that couples the terminal 353-19 to the integrated circuit 241 and is used for propagating the diagnosis signal DIG-C, and the wiring 353-d that couples the terminal 353-17 to the integrated circuit 241 and is used for propagating the diagnosis signal DIG-D are provided on the surface of the substrate 320, which is the same as the surface 321 on which the integrated circuit 241 is provided. Thus, it is not necessary to provide a via or the like in the wirings 354-a, 354-b, 354-c, and 354-d.

[0159] The diagnosis signals DIG-A to DIG-D are signals used when the integrated circuit 241 diagnoses whether or not normal discharge of the ink is possible. Therefore, in a case where the surrounding noise and the like interfere with the diagnosis signals DIG-A to DIG-D when the diagnosis signals DIG-A to DIG-D are propagated, it is not possible that the integrated circuit 241 normally performs the diagnosis. As a result, discharge accuracy of the print head 21 may be deteriorated. If a via or the like is not provided in the wirings 354-a to 354-d for respectively propagating the diagnosis signals DIG-A to DIG-D, it is possible to reduce a concern that the noise and the like interfere with the diagnosis signals DIG-A to DIG-D.

[0160] As described above, when the integrated circuit 241 diagnoses that the normal discharge of the ink in the print head 21 is possible, based on the input diagnosis signals DIG-A to DIG-D, the integrated circuit 241 outputs the latch signal LAT, the clock signal SCK, and the change signal CH which are input, to the driving signal selection circuit 200 as a latch signal cLAT, a clock signal cSCK, and a change signal cCH. Specifically, the latch signal cLAT, the clock signal cSCK, and the change signal cCH output from a terminal (not illustrated) of the integrated circuit 241 are propagated in the wirings 354-f to 354-h and are input to the driving signal selection circuit 200, respectively. FIG. 22 illustrates only the wirings 354-f to 354-h in which the latch signal cLAT, the clock signal cSCK, and the change signal cCH to be input to the driving signal selection circuit 200-1 are propagated, and does not illustrate wirings in which the latch signal cLAT, the clock signal cSCK, and the change signal cCH to be input to the driving signal selection circuit 200-2 to 200-6 are propagated.

[0161] In detail, the integrated circuit 241 constituting the diagnosis circuit 240 is electrically coupled to the wiring 354-f. When the diagnosis circuit 240 diagnoses that the normal discharge of the ink in the print head 21 is possible, the wiring 354-f is electrically coupled to the wiring 354-c via the integrated circuit 241. Thus, the change signal cCH based on the change signal CH is input to the wiring 354-f. The change signal cCH is input to any of the plurality of electrodes in the electrode group 330a provided on the surface 322 of the substrate 320, via the wiring 354-f, a via (not illustrated), and the like. The change signal cCH is input to the driving signal selection circuit 200-1 via an FPC coupled to the electrode group 330a. That is, the wiring 354-f electrically couples the integrated circuit 241 to the driving signal selection circuit 200-1.

[0162] The integrated circuit 241 is electrically coupled to the wiring 354-g. When the diagnosis circuit 240 diagnoses that the normal discharge of the ink in the print head 21 is possible, the wiring 354-g is electrically coupled to the wiring 354-b via the integrated circuit 241. Thus, the clock signal cSCK based on the clock signal SCK is input to the wiring 354-g. The clock signal cSCK is input to any of the plurality of electrodes in the electrode group 330a provided on the surface 322 of the substrate 320, via the wiring 354-g, a via (not illustrated), and the like. The clock signal cSCK is input to the driving signal selection circuit 200-1 via an FPC coupled to the electrode group 330a. That is, the wiring 354-g electrically couples the integrated circuit 241 to the driving signal selection circuit 200-1.

[0163] The integrated circuit 241 is electrically coupled to the wiring 354-h. When the diagnosis circuit 240 diagnoses that the normal discharge of the ink in the print head 21 is possible, the wiring 354-h is electrically coupled to the wiring 354-a via the integrated circuit 241. Thus, the latch signal cLAT based on the latch signal LAT is input to the wiring 354-h. The latch signal cLAT is input to any of the plurality of electrodes in the electrode group 330a provided on the surface 322 of the substrate 320, via the wiring 354-h, a via (not illustrated), and the

like. The latch signal cLAT is input to the driving signal selection circuit 200-1 via an FPC coupled to the electrode group 330a. That is, the wiring 354-h electrically couples the integrated circuit 241 to the driving signal selection circuit 200-1.

[0164] As illustrated in FIG. 22, the terminal 353-17 is electrically coupled to the wiring 354-i. The print data signal SI1 input from the terminal 353-17 is propagated in the wiring 354-i, and then is input to any of the plurality of electrodes in the electrode group 330a provided on the surface 322 of the substrate 320, via a via (not illustrated) and the like. The print data signal SI1 is input to the driving signal selection circuit 200-1 via an FPC coupled to the electrode group 330a. That is, the wiring 354-i electrically couples the terminal 353-17 to the driving signal selection circuit 200-1.

[0165] The terminal 353-11 to which the driving signal COM1 is input is electrically coupled to the wiring 354-j. The driving signal COM1 is propagated in the wiring 354-j, and then is input to any of the plurality of electrodes in the electrode group 330a provided on the surface 322 of the substrate 320, via a via (not illustrated) and the like. The wiring 354-j in which the driving signal COM1 is propagated is an example of a fifth wiring in the first embodiment. The driving signal COM1 is input to the driving signal selection circuit 200-1 via an FPC coupled to the electrode group 330a. That is, the wiring 354-j electrically couples the terminal 353-11 to the driving signal selection circuit 200-1.

[0166] Similarly, the terminals 353-9, 353-7, 353-5, 353-3, and 353-1 to which the driving signals COM2 to COM6 are input are electrically coupled to the wirings 354-k to 354-o, respectively. The driving signals COM2 to COM5 are respectively propagated in the wirings 354-k to 354-o, and then are input to any of the plurality of electrodes in the electrode group 330a provided on the surface 322 of the substrate 320, via a via (not illustrated) and the like. Any of the wiring 354-k to 354-o in which the driving signals COM2 to COM6 are respectively propagated is another example of the fifth wiring in the first embodiment.

[0167] As described above, signals which have a low voltage and include the diagnosis signals DIG-A to DIG-E are input to the terminal 353 provided on the side 326 side in the connector 350 mounted on the substrate 320.

[0168] The diagnosis signals DIG-A to DIG-E are propagated in the wirings 354-a to 354-d along the side 326 of the substrate 320, on which the integrated circuit 241 is provided. Signals which have a high voltage and include the driving signals COM1 to COM6 are input to the terminal 353 provided on the side 325 side in the connector 350 mounted on the substrate 320. The driving signals COM1 to COM6 are propagated in the wirings 354-j to 354-o along the side 325 on which the integrated circuit 241 is not provided. That is, in the substrate 320, the shortest distance between any of the wirings 354-j to 354-o and the side 326 is longer than the shortest distance between the wirings 354-j to 354-o and the side 325. The shortest distance between the wiring 354-a and the side 326 is shorter than the shortest distance between the wiring 354-a and the side 325. The shortest distance between the integrated circuit 241 and the side 326 is shorter than the shortest distance between the integrated circuit 241 and the side 325.

[0169] As described above, since the wiring pattern in which the diagnosis signals DIG-A to DIG-E are propagated is provided along the side 326 on which the integrated circuit 241 is provided in the substrate 320, and the wiring pattern in which the driving signals COM1 to COM6 are propagated is provided along the side 325 facing the side 326 on which the integrated circuit 241 is provided in the substrate 320, it is possible to reduce a concern that the driving signals COM1 to COM6 interfere with the diagnosis signals DIG-A to DIG-E in the wiring patterns provided in the substrate 320. Here, the side 326 of the substrate 320 is an example of a first side, and the side 325 is an example of a second side.

1.8. Advantageous Effects

[0170] As described above, in the print head control circuit 15 in the first embodiment, in the cable 19a, the wiring 197a-23 for propagating the diagnosis signal DIG-A, the wiring 197a-21 for propagating the diagnosis signal DIG-B, the wiring 197a-19 for propagating the diagnosis signal DIG-C, and the wiring 197a-17 for propagating the diagnosis signal DIG-D are located closer to the integrated circuit 241 side constituting the diagnosis circuit 240 than the wiring 197a-11 for propagating the driving signal COM1 in the substrate 320. In other words, the distance between the wiring 197a-11 for propagating the driving signal COM1 and the integrated circuit 241 constituting the diagnosis circuit 240 is longer than the distance between the wiring 197a-23 for propagating the diagnosis signal DIG-A and the integrated circuit 241, longer than the distance between the wiring 197a-21 for propagating the diagnosis signal DIG-B and the integrated circuit 241, longer than the distance between the wiring 197a-19 for propagating the diagnosis signal DIG-C and the integrated circuit 241, and longer than the distance between the wiring 197a-17 for propagating the diagnosis signal DIG-D and the integrated circuit 241.

[0171] As described above, the wirings 197a-23, 197a-21, 197a-19, and 197a-17 in which the diagnosis signals DIG-A to DIG-D to be input to the integrated circuit 241 are propagated are provided closer to the integrated circuit 241 side than the wiring 197a-11 in which the driving signal COM1 is propagated. Thus, it is possible to reduce the distance between each of the wirings 197a-23, 197a-21, 197a-19, and 197a-17 and the integrated circuit 241. Thus, a concern that the waveforms of the diagnosis signals DIG-A to DIG-D are distorted is reduced. Accordingly, it is possible to improve accuracy of the diagnosis signals DIG-A to DIG-D to be input to the integrated circuit 241.

[0172] In the cable 19a, the wirings 197a-23, 197a-21,

197a-19, and 197a-17 in which the diagnosis signals DIG-A to DIG-D are respectively propagated are collectively located on the integrated circuit 241 side in the cable 19a. Thus, it is possible to reduce a concern that the driving signal COM1 propagated in the wiring 197a-11 interferes with the diagnosis signals DIG-A to DIG-D. Accordingly, it is possible to improve accuracy of the diagnosis signals DIG-A to DIG-D input to the integrated circuit 241.

[0173] As described above, in the print head control circuit 15 and the liquid discharge apparatus 1 in the first embodiment, it is possible to improve the accuracy of the diagnosis signals DIG-A to DIG-D input to the integrated circuit 241, and thus to reduce a concern that the self-diagnosis function of the print head 21 does not normally operate.

[0174] Similarly, in the print head 21 in the first embodiment, in the connector 350, the terminal 353-23 to which the diagnosis signal DIG-A is input, the terminal 353-21 to which the diagnosis signal DIG-B is input, the terminal 353-19 to which the diagnosis signal DIG-C is input, and the terminal 353-17 to which the diagnosis signal DIG-D is input are located closer to the integrated circuit 241 side constituting the diagnosis circuit 240 than the terminal 353-11 to which the driving signal COM1 is input. In other words, the distance between the terminal 353-11 to which the driving signal COM1 and the integrated circuit 241 constituting the diagnosis circuit 240 is longer than the distance between the terminal 353-23 to which the diagnosis signal DIG-A is input and the integrated circuit 241, longer than the distance between the terminal 353-21 to which the diagnosis signal DIG-B is input and the integrated circuit 241, longer than the distance between the terminal 353-19 to which the diagnosis signal DIG-C is input and the integrated circuit 241, and longer than the distance between the terminal 353-17 to which the diagnosis signal DIG-D is input and the integrated circuit 241.

[0175] Thus, similar to the print head control circuit 15, in the print head 21 in the first embodiment, it is possible to improve the accuracy of the diagnosis signals DIG-A to DIG-D input to the integrated circuit 241, and thus to reduce the concern that the self-diagnosis function of the print head 21 does not normally operate.

[0176] Similarly, in the liquid discharge apparatus 1 in the first embodiment, in the contact section 180 at which the cable 19a and the connector 350 are electrically in contact with each other, the contact section 180a-23 to which the diagnosis signal DIG-A is input, the contact section 180a-21 to which the diagnosis signal DIG-B is input, the contact section 180a-19 to which the diagnosis signal DIG-C is input, and the contact section 180a-17 to which the diagnosis signal DIG-D is input are located closer to the integrated circuit 241 side constituting the diagnosis circuit 240 than the contact section 180a-11 to which the driving signal COM1 is input. In other words, the distance between the contact section 180a-11 to which the driving signal COM1 is input and the integrated circuit 241 constituting the diagnosis circuit 240 is longer than the distance between the contact section 180a-23 to which the diagnosis signal DIG-A is input and the integrated circuit 241, longer than the distance between the contact section 180a-21 to which the diagnosis signal DIG-B is input and the integrated circuit 241, longer than the distance between the contact section 180a-19 to which the diagnosis signal DIG-C is input and the integrated circuit 241, and longer than the distance between the contact section 180a-17 to which the diagnosis signal DIG-D is input and the integrated circuit 241.

[0177] Accordingly, similar to the print head control circuit 15 and the print head 21, in the liquid discharge apparatus 1 in the first embodiment, it is possible to improve the accuracy of the diagnosis signals DIG-A to DIG-D input to the integrated circuit 241, and thus to reduce the concern that the self-diagnosis function of the print head 21 does not normally operate.

2. Second Embodiment

[0178] Next, a liquid discharge apparatus 1, a print head control circuit 15, and a print head 21 according to a second embodiment will be described. When the liquid discharge apparatus 1, the print head control circuit 15, and the print head 21 in the second embodiment are described, components similar to those in the first embodiment are denoted by the same reference signs, and descriptions thereof will not be repeated or will be briefly made.

[0179] FIG. 23 is a block diagram illustrating an electrical configuration of the liquid discharge apparatus 1 in the second embodiment. As illustrated in FIG. 23, a control circuit 100 in the second embodiment is different from that in the first embodiment in that the control circuit 100 generates two latch signals LAT1 and LAT2 for defining a discharge timing of the print head 21, two change signals CH1 and CH2 for defining a waveform switching timing of the driving signal COM, and two clock signals SCK1 and SCK2 for defining a timing at which a print data signal SI is input, and outputs the generated signals to the print head 21. The control circuit 100 in the third embodiment is different from that in the first embodiment in that the control circuit 100 generates diagnosis signals DIG-A to DIG-D and DIG-F to DIG-I used when the print head 21 diagnoses whether or not normal discharge of a liquid is possible, and outputs the generated signals to the print head 21.

[0180] Here, in the second embodiment, in the liquid discharge apparatus 1, the diagnosis signal DIG-A and the latch signal LAT1 are output to a diagnosis circuit 240 in the print head 21 via a common wiring. The diagnosis signal DIG-B and the clock signal SCK1 are output to the diagnosis circuit 240 via a common wiring. The diagnosis signal DIG-C and the change signal CH1 are output to the diagnosis circuit 240 via a common wiring. The diagnosis signal DIG-D and the print data signal SI1 are output to the diagnosis circuit 240 via a common wiring. The

diagnosis signal DIG-F and the latch signal LAT2 are output to the diagnosis circuit 240 via a common wiring. The diagnosis signal DIG-G and the clock signal SCK2 are output to the diagnosis circuit 240 via a common wiring. The diagnosis signal DIG-H and the change signal CH2 are output to the diagnosis circuit 240 via a common wiring. The diagnosis signal DIG-I and the print data signal SIn are output to the diagnosis circuit 240 via a common wiring.

[0181] The diagnosis circuit 240 diagnoses whether or not normal discharge of the ink is possible, based on the diagnosis signals DIG-A to DIG-D and the diagnosis signals DIG-F to DIG-I. When the diagnosis circuit 240 diagnoses that the normal discharge of the ink is possible in the print head 21, based on the diagnosis signals DIG-A to DIG-D, the latch signal LAT1, the clock signal SCK1, and the change signal CH1 input along with the diagnosis signals DIG-A to DIG-C via the common wirings are output as a latch signal cLAT1, a clock signal cSCK1, and a change signal cCH1. When the diagnosis circuit 240 diagnoses that the normal discharge of the ink is possible in the print head 21, based on the diagnosis signals DIG-F to DIG-I, the latch signal LAT2, the clock signal SCK2, and the change signal CH2 input along with the diagnosis signals DIG-F to DIG-H via the common wirings are output as a latch signal cLAT2, a clock signal cSCK2, and a change signal cCH2.

[0182] Here, the print data signal SI1 input along with the diagnosis signal DIG-D via the common wiring among the signals input to the diagnosis circuit 240 is branched in the print head 21. One branched signal is input to the diagnosis circuit 240, and the other is input to the driving signal selection circuit 200-1. The print data signal SIn input along with the diagnosis signal DIG-I via the common wiring among the signals input to the diagnosis circuit 240 is branched in the print head 21. One branched signal is input to the diagnosis circuit 240, and the other is input to the driving signal selection circuit 200-n.

[0183] In the following descriptions, descriptions will be made on the assumption that the print head 21 in the second embodiment includes ten driving signal selection circuits 200-1 to 200-10. Thus, 10 print data signals SI1 to SI10 respectively corresponding to the ten driving signal selection circuits 200-1 to 200-10, 10 driving signals COM1 to COM10, and 10 reference voltage signals CGND1 to CGND10 are input to the print head 21 in the second embodiment.

[0184] FIG. 24 is a schematic diagram illustrating an internal configuration of the liquid discharge apparatus 1 in the second embodiment when viewed from the Y-direction. As illustrated in FIG. 24, the liquid discharge apparatus 1 in the second embodiment is different from that in the first embodiment in that the liquid discharge apparatus 1 includes four cables 19a, 19b, 19c, and 19d. A connector 12a to which one end of the cable 19a is attached, a connector 12b to which one end of the cable 19b is attached, a connector 12c to which one end of the cable 19c is attached, and a connector 12d to which one end of the cable 19d is attached are mounted on the main substrate 11.

[0185] The print head 21 includes a head 310, a substrate 320, and connectors 350, 360, 370, and 380. The other end of the cable 19a is attached to the connector 350. The other end of the cable 19b is attached to the connector 360. The other end of the cable 19c is attached to the connector 370. The other end of the cable 19d is attached to the connector 360.

[0186] Here, in the liquid discharge apparatus 1 in the second embodiment, which is configured as described above, a configuration in which a control mechanism 10 that outputs various signals for controlling an operation of the print head 21 and the cables 19a, 19b, 19c, and 19d for propagating the various signals for controlling the operation of the print head 21 are provided is an example of a print head control circuit 15 that controls the operation of the print head 21 having a function to perform self-diagnosis in the second embodiment.

[0187] In the following descriptions, a terminal 195-k provided in the cables 19a, 19b, 19c, and 19d is referred to as terminals 195a-k, 195b-k, 195c-k, and 195d-k. A terminal 196-k is referred to as terminals 196a-k, 196b-k, 196c-k, and 196d-k. A wiring 197-k is referred to as wirings 197a-k, 197b-k, 197c-k, and 197d-k. A contact section 180-k is referred to as contact sections 180a-k, 180b-k, 180c-k, and 180d-k. The terminals 195a-k, 195b-k, 195c-k, and 195b-k are electrically coupled to the connectors 12a, 12b, 12c, and 12d, respectively. The terminals 196a-k, 196b-k, 196c-k, and 196d-k are electrically coupled to the connectors 350, 360, 370, and 380 via the contact sections 180a-k, 180b-k, 180c-k, and 180d-k, respectively.

[0188] FIG. 25 is a perspective view illustrating a configuration of the print head 21 in the second embodiment. As illustrated in FIG. 23, the print head 21 includes the head 310 and the substrate 320. An ink discharge surface 311 on which the plurality of discharge sections 600 are formed is located on a lower surface of the head 310 in the Z-direction.

[0189] FIG. 26 is a plan view illustrating an ink discharge surface 311 of the head 310 in the second embodiment. As illustrated in FIG. 26, 10 nozzle plates 632 in which a plurality of nozzles 651 is formed are provided on the ink discharge surface 311 in the second embodiment to be aligned in the X-direction. In each of the nozzle plates 632, nozzle columns L1 to L10 in which the nozzles 651 are provided to be aligned in the X-direction are formed. The nozzle columns L1 to L10 are provided to correspond to the driving signal selection circuits 200-1 to 200-10, respectively.

[0190] Returning to FIG. 25, the substrate 320 has a surface 321 and a surface 322 facing the surface 321 and has a substantially rectangular shape formed by a side 323, a side 324 (facing the side 323 in the X-direction), a side 325, and a side 326 (facing the side 325 in the Y-direction).

[0191] A configuration of the substrate 320 in the sec-

ond embodiment will be described with reference to FIGs. 27 and 28. FIG. 27 is a plan view illustrating the substrate 320 in the second embodiment when viewed from the surface 322. FIG. 28 is a plan view illustrating the substrate 320 in the second embodiment when viewed from the surface 321.

[0192] As illustrated in FIGs. 27 and 28, electrode groups 430a to 430j including a plurality of electrodes provided to be aligned in the Y-direction are provided on the surface 322 of the substrate 320. The electrode groups 430a to 430j are located from the side 323 toward the side 324 in order of the electrode groups 430a, 430b, 430c, 430d, 430e, 430f, 430g, 430h, 430i, and 430j.

[0193] Ink supply path insertion holes 431a to 431j and FPC insertion holes 432a to 432e being through-holes penetrating the surfaces 321 and 322 of the substrate 320 are formed in the substrate 320.

[0194] The FPC insertion hole 432a is located between the electrode group 430a and the electrode group 430b in the X-direction. An FPC electrically coupled to the electrode group 430a and an FPC electrically coupled to the electrode group 430b are inserted into the FPC insertion hole 432a. The FPC insertion hole 432b is located between the electrode group 430c and the electrode group 430d in the X-direction. An FPC electrically coupled to the electrode group 430c and an FPC electrically coupled to the electrode group 430d are inserted into the FPC insertion hole 432b. The FPC insertion hole 432c is located between the electrode group 430e and the electrode group 430f in the X-direction. An FPC electrically coupled to the electrode group 430e and an FPC electrically coupled to the electrode group 430f are inserted into the FPC insertion hole 432c. The FPC insertion hole 432d is located between the electrode group 430g and the electrode group 430h in the X-direction. An FPC electrically coupled to the electrode group 430g and an FPC electrically coupled to the electrode group 430h are inserted into the FPC insertion hole 432d. The FPC insertion hole 432e is located between the electrode group 430i and the electrode group 430j in the X-direction. An FPC electrically coupled to the electrode group 430i and an FPC electrically coupled to the electrode group 430j are inserted into the FPC insertion hole 432e.

[0195] The ink supply path insertion hole 431a is located on the side 323 side of the electrode group 430a in the X-direction. The ink supply path insertion holes 431b and 431c are located between the electrode group 430b and the electrode group 430c in the X-direction. The ink supply path insertion holes 431b and 431c are located to be aligned such that the ink supply path insertion hole 431b is located on the side 325 side, and the ink supply path insertion hole 431c is located on the side 326 side. The ink supply path insertion holes 431d and 431e are located between the electrode group 430d and the electrode group 430e in the X-direction. The ink supply path insertion holes 431d and 431e are located to be aligned such that the ink supply path insertion hole 431d is located on the side 325 side, and the ink supply path insertion hole 431e is located on the side 326 side. The ink supply path insertion holes 431f and 431g are located between the electrode group 430f and the electrode group 430g in the X-direction. The ink supply path insertion holes 431f and 431g are located to be aligned such that the ink supply path insertion hole 431f is located on the side 325 side, and the ink supply path insertion hole 431g is located on the side 326 side. The ink supply path insertion holes 431h and 431i are located between the electrode group 430h and the electrode group 430i in the X-direction. The ink supply path insertion holes 431h and 431i are located to be aligned such that the ink supply path insertion hole 431h is located on the side 325 side, and the ink supply path insertion hole 431i is located on the side 326 side. The ink supply path insertion hole 431j is located on the side 324 side of the electrode group 430j in the X-direction. A portion of an ink supply path (not illustrated) for supplying the ink to an ink supply port 661 is inserted into each of the ink supply path insertion holes 431a to 431j. The ink supply port 661 is used for injecting the ink to the discharge section 600 corresponding to each of the nozzle columns L1 to L10.

[0196] As illustrated in FIG. 28, an integrated circuit 241 constituting the diagnosis circuit 240 is provided on the surface 321 of the substrate 320. The integrated circuit 241 is provided between a fixation portion 347 and a fixation portion 349 and is provided on the side 326 side of the FPC insertion holes 432a to 432e, on the surface 321 side of the substrate 320. The integrated circuit 241 constituting the diagnosis circuit 240 diagnoses whether or not normal discharge of the ink from the nozzle 651 is possible, based on the diagnosis signals DIG-A to DIG-D and DIG-F to DIG-I. FIG. 28 illustrates one integrated circuit 241 as the diagnosis circuit 240. However, two integrated circuits or more may constitute the diagnosis circuit 240. Specifically, an integrated circuit 241 that diagnoses whether or not normal discharge of the ink from the nozzle 651 is possible, based on the diagnosis signals DIG-A to DIG-D, and an integrated circuit 241 that diagnoses whether or not normal discharge of the ink from the nozzle 651 is possible, based on the diagnosis signals DIG-F to DIG-I may be provided.

[0197] As illustrated in FIGs. 27 and 28, the connectors 350, 360, 370, and 380 are provided on the substrate 320. The connector 350 is provided along the side 323 on the surface 321 side of the substrate 320. The connector 360 is provided along the side 323 on the surface 322 side of the substrate 320. Here, the second embodiment is different from the first embodiment in that the number of a plurality of terminals included in each of the connectors 350 and 360 is 20. Other components of the connectors 350 and 360 are similar to those in FIG. 17. Thus, detailed descriptions of the connectors 350 and 360 in the second embodiment will not be repeated. In the second embodiment, 20 terminals 353 provided to be aligned in the connector 350 are referred to as terminals 353-1, 353-2, ..., and 353-20 in order from the side 325 toward the side 326 in a direction along the side 323.

Similarly, in the second embodiment, 20 terminals 363 provided to be aligned in the connector 360 are referred to as terminals 363-1, 363-2, ..., and 363-20 in order from the side 325 toward the side 326 in the direction along the side 323.

[0198] The connector 370 is provided along the side 324 on the surface 321 side of the substrate 320. The connector 380 is provided along the side 324 on the surface 322 side of the substrate 320. A configuration of the connectors 370 and 380 will be described with reference to FIG. 29. FIG. 29 is a diagram illustrating the configuration of the connector 370 or 380.

[0199] The connector 370 includes a housing 371, a cable attachment section 372 formed in the housing 371, and a plurality of terminals 373. The plurality of terminals 373 is provided to be aligned along the side 324. Specifically, 20 terminals 373 are provided to be aligned along the side 324. Here, the 20 terminals 373 are referred to as terminals 373-1, 373-2, ..., and 373-20 in order from the side 325 toward the side 326 in a direction along the side 324. The cable attachment section 372 is located on the substrate 320 side of the plurality of terminals 373 in the Z-direction. The cable 19c is attached to the cable attachment section 372. When the cable 19c is attached to the cable attachment section 372, the terminals 196c-1 to 196c-20 in the cable 19c are electrically coupled to the terminals 373-1 to 373-20 in the connector 370, respectively. Similar to FIG. 18, in the connector 370, the plurality of terminals 373 may be located on the substrate 320 side of the cable attachment section 372 in the Z-direction.

[0200] The connector 380 includes a housing 381, a cable attachment section 382 formed in the housing 381, and a plurality of terminals 383. The plurality of terminals 383 is provided to be aligned along the side 324. Specifically, 20 terminals 383 are provided to be aligned along the side 324. Here, the 20 terminals 383 provided to be aligned are referred to as terminals 383-1, 383-2, ..., and 383-20 in order from the side 325 toward the side 326 in a direction along the side 324. The cable attachment section 382 is located on the substrate 320 side of the plurality of terminals 383 in the Z-direction. The cable 19d is attached to the cable attachment section 382. When the cable 19d is attached to the cable attachment section 382, the terminals 196d-1 to 196d-20 in the cable 19d are electrically coupled to the terminals 383-1 to 383-20 in the connector 380, respectively.

[0201] Next, details of a signal which are propagated in each of the cables 19a, 19b, 19c, and 19d and is input to the print head 21 will be described with reference to FIGs. 30 to 33.

[0202] FIG. 30 is a diagram illustrating details of a signal propagated in the cable 19a in the second embodiment. As illustrated in FIG. 30, the cable 19a includes wirings for propagating driving signals COM1 to COM5, wirings for propagating reference voltage signals CGND1 to CGND5, wirings for propagating a temperature signal TH, a latch signal LAT1, a clock signal SCK1, a change signal CH1, and a print data signal SI1, wirings for propagating diagnosis signals DIG-A to DIG-D, and a plurality of wirings for propagating a plurality of ground signals GND.

[0203] Specifically, the driving signals COM1 to COM5 are input to the cable 19a from the terminals 195a-9, 195a-7, 195a-5, 195a-3, and 195a-1, respectively. The driving signals COM1 to COM5 are propagated in the wirings 197a-9, 197a-7, 197a-5, 197a-3, and 197a-1 and then are input to the terminals 353-9, 353-7, 353-5, 353-3, and 353-1 of the connector 350 via the terminals 196a-9, 196a-7, 196a-5, 196a-3, and 196a-1 and the contact sections 180a-9, 180a-7, 180a-5, 180a-3, and 180a-1, respectively.

[0204] Here, the terminal 353-9 to which the driving signal COM1 is input is an example of an eleventh terminal in the second embodiment. The wiring 197a-9 in which the driving signal COM1 is propagated is an example of a second driving signal propagation wiring in the second embodiment. The contact section 180a-9 at which the wiring 197a-9 and the terminal 353-9 are electrically in contact with each other is an example of an eleventh contact section in the second embodiment. At least any of the terminals 353-7, 353-5, 353-3, and 353-1 to which the driving signal COM2 to the driving signal COM5 are respectively input is another example of the eleventh terminal in the second embodiment. At least any of the wirings 197a-7, 197a-5, 197a-3, and 197a-1 in which the driving signal COM2 to the driving signal COM5 are respectively propagated is another example of the second driving signal propagation wiring in the second embodiment. Any of the contact sections 180a-7, 180a-5, 180a-3, and 180a-1 at which the wirings 197a-7, 197a-5, 197a-3, and 197a-1 are electrically in contact with the terminals 353-7, 353-5, 353-3, and 353-1, respectively, is another example of the eleventh contact section in the second embodiment.

[0205] The reference voltage signals CGND1 to CGND5 are input to the cable 19a from the terminals 195a-10, 195a-8, 195a-6, 195a-4, and 195a-2, respectively. The reference voltage signals CGND1 to CGND5 are propagated in the wirings 197a-10, 197a-8, 197a-6, 197a-4, and 197a-2 and then are input to the terminals 353-10, 353-8, 353-6, 353-4, and 353-2 of the connector 350 via the terminals 196a-10, 196a-8, 196a-6, 196a-4, and 196a-2 and the contact sections 180a-10, 180a-8, 180a-6, 180a-4, and 180a-2, respectively.

[0206] The diagnosis signal DIG-A and the latch signal LAT1 are input from the terminal 195a-17 to the cable 19a. The diagnosis signal DIG-A and the latch signal LAT1 are propagated in the wiring 197a-17, and then are input to the terminal 353-17 of the connector 350 via the terminal 196a-17 and the contact section 180-17. That is, the wiring 197a-17 functions as a wiring for propagating the diagnosis signal DIG-A and a wiring for propagating the latch signal LAT1. The terminal 353-17 functions as a terminal to which the diagnosis signal DIG-A is input and a terminal to which the latch signal LAT1 is input.

The contact section 180a-17 is electrically in contact with the wiring for propagating the diagnosis signal DIG-A and is also electrically in contact with the wiring for propagating the latch signal LAT1. Here, the diagnosis signal DIG-A is an example of a sixth diagnosis signal in the second embodiment. The wiring 197a-17 for propagating the diagnosis signal DIG-A is an example of a sixth diagnosis signal propagation wiring in the second embodiment. The terminal 353-17 to which the diagnosis signal DIG-A is input is an example of a seventh terminal in the second embodiment. The contact section 180a-17 at which the wiring 197a-17 and the terminal 353-17 are electrically in contact with each other is an example of a seventh contact section in the second embodiment.

[0207] The diagnosis signal DIG-B and the clock signal SCK1 are input from the terminal 195a-15 to the cable 19a. The diagnosis signal DIG-B and the clock signal SCK1 are propagated in the wiring 197a-15, and then are input to the terminal 353-15 of the connector 350 via the terminal 196a-15 and the contact section 180a-15. That is, the wiring 197a-15 functions as a wiring for propagating the diagnosis signal DIG-B and a wiring for propagating the clock signal SCK1. The terminal 353-15 functions as a terminal to which the diagnosis signal DIG-B is input and a terminal to which the clock signal SCK1 is input. The contact section 180a-15 is electrically in contact with the wiring for propagating the diagnosis signal DIG-B and is also electrically in contact with the wiring for propagating the clock signal SCK1. Here, the diagnosis signal DIG-B is an example of a seventh diagnosis signal in the second embodiment. The wiring 197a-15 for propagating the diagnosis signal DIG-B is an example of a seventh diagnosis signal propagation wiring in the second embodiment. The terminal 353-15 to which the diagnosis signal DIG-B is input is an example of an eighth terminal in the second embodiment. The contact section 180a-15 at which the wiring 197a-15 and the terminal 353-15 are electrically in contact with each other is an example of an eighth contact section in the second embodiment.

[0208] The diagnosis signal DIG-C and the change signal CH1 are input from the terminal 195a-13 to the cable 19a. The diagnosis signal DIG-C and the change signal CH1 are propagated in the wiring 197a-13, and then are input to the terminal 353-13 of the connector 350 via the terminal 196a-13 and the contact section 180a-13. That is, the wiring 197a-13 functions as a wiring for propagating the diagnosis signal DIG-C and a wiring for propagating the change signal CH1. The terminal 353-13 functions as a terminal to which the diagnosis signal DIG-C is input and a terminal to which the change signal CH1 is input. The contact section 180a-13 is electrically in contact with the wiring for propagating the diagnosis signal DIG-C and is also electrically in contact with the wiring for propagating the change signal CH1. Here, the diagnosis signal DIG-C is an example of an eighth diagnosis signal in the second embodiment. The wiring 197a-13 for propagating the diagnosis signal DIG-C is an example of an eighth diagnosis signal propagation wiring in the second embodiment. The terminal 353-13 to which the diagnosis signal DIG-C is input is an example of a ninth terminal in the second embodiment. The contact section 180a-13 at which the wiring 197a-13 and the terminal 353-13 are electrically in contact with each other is an example of a ninth contact section in the second embodiment.

[0209] The diagnosis signal DIG-D and the print data signal SI1 are input from the terminal 195a-11 to the cable 19a. The diagnosis signal DIG-D and the print data signal SI1 are propagated in the wiring 197a-11, and then are input to the terminal 353-11 of the connector 350 via the terminal 196a-11 and the contact section 180a-11. That is, the wiring 197a-11 functions as a wiring for propagating the diagnosis signal DIG-D and a wiring for propagating the print data signal SI1. The terminal 353-11 functions as a terminal to which the diagnosis signal DIG-D is input and a terminal to which the print data signal SI1 is input. The contact section 180a-11 is electrically in contact with the wiring for propagating the diagnosis signal DIG-D and is also electrically in contact with the wiring for propagating the print data signal SI1. Here, the diagnosis signal DIG-D is an example of a ninth diagnosis signal in the second embodiment. The wiring 197a-11 for propagating the diagnosis signal DIG-D is an example of a ninth diagnosis signal propagation wiring in the second embodiment. The terminal 353-11 to which the diagnosis signal DIG-D is input is an example of a tenth terminal in the second embodiment. The contact section 180a-11 at which the wiring 197a-11 and the terminal 353-11 are electrically in contact with each other is an example of a tenth contact section in the second embodiment.

[0210] The temperature signal TH is input to the terminal 353-19 of the connector 350 and then is input to the cable 19a via the contact section 180a-19 and the terminal 196a-19. The temperature signal TH is propagated in the wiring 197a-19 and then is input from the terminal 195a-19 to the main substrate 11.

[0211] The ground signal GND is input to the cable 19a from each of the terminals 195a-12, 195a-14, 195a-16, 195a-18, and 195a-20. The ground signal GND is propagated in each of the wirings 197a-12, 197a-14, 197a-16, 197a-18, and 197a-20, and then are input to each of the terminals 353-12, 353-14, 353-16, 353-18, and 353-20 of the connector 350 via each of the terminals 196a-12, 196a-14, 196a-16, 196a-18, and 196a-20 and each of the contact sections 180a-12, 180a-14, 180a-16, 180a-18, and 180a-20.

[0212] As described above, in the cable 19a, the driving signals COM1 to COM5 and the reference voltage signals CGND1 to CGND5 are propagated in the wirings 197a-1 to 197a-10, respectively. The diagnosis signals DIG-A to DIG-D, the temperature signal TH, the latch signal LAT1, the clock signal SCK1, the change signal CH1, the print data signal SI1, and the plurality of ground signals GND are propagated in the wirings 197a-11 to

197a-20, respectively. As described above, in the cable 19a, the terminal 196a-k is attached to the connector 350 to be electrically coupled to the terminal 353-k of the connector 350 via the contact section 180a-k. That is, when the cable 19a is electrically coupled to the print head 21, the diagnosis signals DIG-A to DIG-D are respectively propagated in the wirings 197a-17, 197a-15, 197a-13, and 197a-11 located on the side 326 side of the substrate 320, on which the integrated circuit 241 constituting the diagnosis circuit 240 is provided. The diagnosis signals DIG-A to DIG-D are input to the terminals 353-17, 353-15, 353-13, and 353-11 via the contact sections 180a-17, 180a-15, 180a-13, and 180a-11, respectively. When the cable 19a is electrically coupled to the print head 21, the driving signals COM1 to COM5 are propagated in the wirings 197a-9, 197a-7, 197a-5, 197a-3, and 197a-1 located on the side 325 side of the substrate 320, and then are input to the terminals 353-9, 353-7, 353-5, 353-3, and 353-1 via the contact sections 180a-9, 180a-7, 180a-5, 180a-3, and 180a-1, respectively.

[0213] That is, the shortest distance between the wiring 197a-9 and the integrated circuit 241 is longer than the shortest distance between the wiring 197a-17 and the integrated circuit 241, longer than the shortest distance between the wiring 197a-15 and the integrated circuit 241, longer than the shortest distance between the wiring 197a-13 and the integrated circuit 241, and longer than the shortest distance between the wiring 197a-11 and the integrated circuit 241. Similarly, the shortest distance between the terminal 353-9 and the integrated circuit 241 is longer than the shortest distance between the terminal 353-17 and the integrated circuit 241, longer than the shortest distance between the terminal 353-15 and the integrated circuit 241, longer than the shortest distance between the terminal 353-13 and the integrated circuit 241, and longer than the shortest distance between the terminal 353-11 and the integrated circuit 241. Similarly, the shortest distance between the contact section 180a-9 and the integrated circuit 241 is longer than the shortest distance between the contact section 180a-17 and the integrated circuit 241, longer than the shortest distance between the contact section 180a-15 and the integrated circuit 241, longer than the shortest distance between the contact section 180a-13 and the integrated circuit 241, and longer than the shortest distance between the contact section 180a-11 and the integrated circuit 241.

[0214] Here, the cable 19a including the wirings 197a-17, 197a-15, 197a-13, and 197a-11 for respectively propagating the diagnosis signals DIG-A to DIG-D and the wiring 197a-9 for propagating the driving signal COM1 is an example of a second cable in the second embodiment. The connector 350 including the terminals 353-23, 353-21, 353-19, and 353-17 to which the diagnosis signals DIG-A to DIG-D are respectively input and the terminal 353-11 to which the driving signal COM1 is input is an example of a second connector in the second embodiment.

[0215] FIG. 31 is a diagram illustrating details of the signal propagated in the cable 19b in the second embodiment. As illustrated in FIG. 31, the cable 19b includes wirings for propagating the driving signals COM1 to COM5, wirings for propagating the reference voltage signals CGND1 to CGND5, wirings for propagating print data signals SI2 to SI5, a wiring for propagating a voltage VDD1, and a plurality of wirings for propagating a plurality of ground signals GND.

[0216] Specifically, the driving signals COM1 to COM5 are input to the cable 19b from the terminals 195b-10, 195b-8, 195b-6, 195b-4, and 195b-2, respectively. The driving signals COM1 to COM5 are propagated in the wirings 197b-10, 197b-8, 197b-6, 197b-4, and 197b-2. Then, the driving signals COM1 to COM5 are input to the terminals 363-10, 363-8, 363-6, 363-4, and 363-2 of the connector 360 via the terminals 196b-10, 196b-8, 196b-6, 196b-4, and 196b-2 and the contact sections 180b-10, 180b-8, 180b-6, 180b-4, and 180b-2, respectively.

[0217] The reference voltage signals CGND1 to CGND5 are input to the cable 19b from the terminals 195b-9, 195b-7, 195b-5, 195b-3, and 195b-1, respectively. The reference voltage signals CGND1 to CGND5 are propagated in the wirings 197b-9, 197b-7, 197b-5, 197b-3, and 197b-1, and then are input to the terminals 363-9, 363-7, 363-5, 363-3, and 363-1 of the connector 360 via the terminals 196b-9, 196b-7, 196b-5, 196b-3, and 196b-1 and the contact sections 180b-9, 180b-7, 180b-5, 180b-3, and 180b-1, respectively.

[0218] The print data signals SI2 to SI5 are input to the cable 19b from the terminals 195b-18, 195b-16, 195b-14, and 195b-12, respectively. The print data signals SI2 to SI5 are propagated in the wirings 197b-18, 197b-16, 197b-14, and 197b-12, and then are input to the terminals 363-18, 363-16, 363-14, and 363-12 of the connector 360 via the terminals 196b-18, 196b-16, 196b-14, and 196b-12 and the contact sections 180b-18, 180b-16, 180b-14, and 180b-12, respectively.

[0219] The voltage VDD1 is input from the terminal 195b-20 to the cable 19b. The voltage VDD1 is propagated in the wiring 197b-20, and then is input to the terminal 363-20 of the connector 360 via the terminal 196b-20 and the contact section 180b-20.

[0220] The ground signal GND is input to the cable 19a from each of the terminals 195b-11, 195b-13, 195b-15, 195b-17, and 195b-19. The ground signal GND is propagated in each of the wirings 197b-11, 197b-13, 197b-15, 197b-17, and 197b-19 and then is input to each of the terminals 363-11, 363-13, 363-15, 363-17, and 363-19 of the connector 360 via each of the terminals 196b-11, 196b-13, 196b-15, 196b-17, and 196b-19 and each of the contact sections 180b-11, 180b-13, 180b-15, 180b-17, and 180b-19.

[0221] FIG. 32 is a diagram illustrating details of the signal propagated in the cable 19c in the second embodiment. As illustrated in FIG. 32, the cable 19c includes wirings for propagating driving signals COM6 to COM10, wirings for propagating reference voltage signals CGND6 to CGND10, wirings for propagating an abnor-

mality signal XHOT, a latch signal LAT2, a clock signal SCK2, a change signal CH2, and a print data signal SI10, wirings for propagating diagnosis signals DIG-E to DIG-I, and a plurality of wirings for propagating a plurality of ground signals GND.

[0222] Specifically, the driving signals COM6 to COM10 are input to the cable 19c from the terminals 195c-2, 195c-4, 195c-6, 195c-8, and 195c-10, respectively. The driving signals COM6 to COM10 are propagated in the wirings 197c-2, 197c-4, 197c-6, 197c-8, and 197c-10 and then are input to the terminals 373-2, 373-4, 373-6, 373-8, and 373-10 of the connector 370 via the terminals 196c-2, 196c-4, 196c-6, 196c-8, and 196c-10 and the contact sections 180c-2, 180c-4, 180c-6, 180c-8, and 180c-10, respectively.

[0223] Here, the terminal 373-10 to which the driving signal COM10 is input is an example of a fifth terminal in the second embodiment. The wiring 197c-10 in which the driving signal COM10 is propagated is an example of a first driving signal propagation wiring in the second embodiment. The contact section 180c-10 at which the wiring 197c-10 and the terminal 373-10 are electrically in contact with each other is an example of a fifth contact section in the second embodiment. At least any of the terminals 373-2, 373-4, 373-6, and 373-8 to which the driving signal COM6 to the driving signal COM9 are respectively input is another example of the fifth terminal in the second embodiment. At least any of the wirings 197c-2, 197c-4, 197c-6, and 197c-8 in which the driving signal COM6 to the driving signal COM9 are respectively propagated is another example of the first driving signal propagation wiring in the second embodiment. The contact sections 180c-2, 180c-4, 180c-6, and 180c-8 at which the wirings 197c-2, 197c-4, 197c-6, and 197c-8 are electrically in contact with the terminals 373-2, 373-4, 373-6, and 373-8, respectively, is another example of the fifth contact section in the second embodiment.

[0224] The reference voltage signals CGND6 to CGND10 are input to the cable 19c from the terminals 195c-1, 195c-3, 195c-5, 195c-7, and 195c-9, respectively. The reference voltage signals CGND6 to CGND10 are propagated in the wirings 197c-1, 197c-3, 197c-5, 197c-7, and 197c-9, and then are input to the terminals 373-1, 373-3, 373-5, 373-7, and 373-9 of the connector 370 via the terminals 196c-1, 196c-3, 196c-5, 196c-7, and 196c-9 and the contact sections 180c-1, 180c-3, 180c-5, 180c-7, and 180c-9, respectively.

[0225] The diagnosis signal DIG-E and the abnormality signal XHOT are input to the terminal 373-12 of the connector 370 and then is input to the cable 19c via the contact section 180c-12 and the terminal 196c-12. The diagnosis signal DIG-E is propagated in the wiring 197c-12 and then is input from the terminal 195c-12 to the main substrate 11. That is, the wiring 197c-12 functions as a wiring for propagating the diagnosis signal DIG-E and a wiring for propagating the abnormality signal XHOT. The terminal 373-12 functions as a terminal to which the diagnosis signal DIG-E is input and a terminal to which the abnormality signal XHOT is input. The contact section 180c-12 is electrically in contact with the wiring for propagating the diagnosis signal DIG-E and is also electrically in contact with the wiring for propagating the abnormality signal XHOT. Here, the diagnosis signal DIG-E is an example of a fifth diagnosis signal in the second embodiment. The wiring 197c-12 for propagating the diagnosis signal DIG-E is an example of a fifth diagnosis signal propagation wiring in the second embodiment. The terminal 373-12 to which the diagnosis signal DIG-E is input is an example of a sixth terminal in the second embodiment. The contact section 180c-12 at which the wiring 197c-12 and the terminal 373-12 are electrically in contact with each other is an example of a sixth contact section in the second embodiment.

[0226] The diagnosis signal DIG-F and the latch signal LAT2 are input from the terminal 195c-14 to the cable 19c. The diagnosis signal DIG-F and the latch signal LAT2 are propagated in the wiring 197c-14, and then are input to the terminal 373-14 of the connector 370 via the terminal 196c-14 and the contact section 180c-14. That is, the wiring 197c-14 functions as a wiring for propagating the diagnosis signal DIG-F and a wiring for propagating the latch signal LAT2. The terminal 373-14 functions as a terminal to which the diagnosis signal DIG-F is input and a terminal to which the latch signal LAT2 is input. The contact section 180c-14 is electrically in contact with the wiring for propagating the diagnosis signal DIG-F and is also electrically in contact with the wiring for propagating the latch signal LAT2. Here, the diagnosis signal DIG-F is an example of a first diagnosis signal in the second embodiment. The wiring 197c-14 for propagating the diagnosis signal DIG-F is an example of a first diagnosis signal propagation wiring in the second embodiment. The terminal 373-14 to which the diagnosis signal DIG-F is input is an example of a first terminal in the second embodiment. The contact section 180c-14 at which the wiring 197c-14 and the terminal 373-14 are electrically in contact with each other is an example of a first contact section in the second embodiment.

[0227] The diagnosis signal DIG-G and the clock signal SCK2 are input from the terminal 195c-16 to the cable 19c. The diagnosis signal DIG-G and the clock signal SCK2 are propagated in the wiring 197c-16, and then are input to the terminal 373-16 of the connector 370 via the terminal 196c-16 and the contact section 180c-16. That is, the wiring 197c-16 functions as a wiring for propagating the diagnosis signal DIG-G and a wiring for propagating the clock signal SCK2. The terminal 373-16 functions as a terminal to which the diagnosis signal DIG-G is input and a terminal to which the clock signal SCK2 is input. The contact section 180c-16 is electrically in contact with the wiring for propagating the diagnosis signal DIG-G and is also electrically in contact with the wiring for propagating the clock signal SCK2. Here, the diagnosis signal DIG-G is an example of a second diagnosis signal in the second embodiment. The wiring 197c-16 for propagating the diagnosis signal DIG-G is an example

of a second diagnosis signal propagation wiring in the second embodiment. The terminal 373-16 to which the diagnosis signal DIG-G is input is an example of a second terminal in the second embodiment. The contact section 180c-16 at which the wiring 197c-16 and the terminal 373-16 are electrically in contact with each other is an example of a second contact section in the second embodiment.

[0228] The diagnosis signal DIG-H and the change signal CH2 are input from the terminal 195c-18 to the cable 19c. The diagnosis signal DIG-H and the change signal CH2 are propagated in the wiring 197c-18, and then are input to the terminal 373-18 of the connector 370 via the terminal 196c-18 and the contact section 180c-18. That is, the wiring 197c-18 functions as a wiring for propagating the diagnosis signal DIG-H and a wiring for propagating the change signal CH2. The terminal 373-18 functions as a terminal to which the diagnosis signal DIG-H is input and a terminal to which the change signal CH2 is input. The contact section 180c-18 is electrically in contact with the wiring for propagating the diagnosis signal DIG-H and is also electrically in contact with the wiring for propagating the change signal CH2. Here, the diagnosis signal DIG-H is an example of a third diagnosis signal in the second embodiment. The wiring 197c-18 for propagating the diagnosis signal DIG-H is an example of a third diagnosis signal propagation wiring in the second embodiment. The terminal 373-18 to which the diagnosis signal DIG-H is input is an example of a third terminal in the second embodiment. The contact section 180c-18 at which the wiring 197c-18 and the terminal 373-18 are electrically in contact with each other is an example of a third contact section in the second embodiment.

[0229] The diagnosis signal DIG-I and the print data signal SI10 are input from the terminal 195c-20 to the cable 19c. The diagnosis signal DIG-I and the print data signal SI10 are propagated in the wiring 197c-20, and then are input to the terminal 373-20 of the connector 370 via the terminal 196c-20 and the contact section 180c-20. That is, the wiring 197c-20 functions as a wiring for propagating the diagnosis signal DIG-I and a wiring for propagating the print data signal SI10. The terminal 373-20 functions as a terminal to which the diagnosis signal DIG-I is input and a terminal to which the print data signal SI10 is input. The contact section 180c-20 is electrically in contact with the wiring for propagating the diagnosis signal DIG-I and is also electrically in contact with the wiring for propagating the print data signal SI10. Here, the diagnosis signal DIG-I is an example of a fourth diagnosis signal in the second embodiment. The wiring 197c-20 for propagating the diagnosis signal DIG-I is an example of a fourth diagnosis signal propagation wiring in the second embodiment. The terminal 373-20 to which the diagnosis signal DIG-I is input is an example of a fourth terminal in the second embodiment. The contact section 180c-20 at which the wiring 197c-20 and the terminal 373-20 are electrically in contact with each other is an example of a fourth contact section in the second embodiment.

[0230] The ground signal GND is input to the cable 19c from each of the terminals 195c-11, 195c-13, 195c-15, 195c-17, and 195c-19 and is propagated in each of the wirings 197c-11, 197c-13, 197c-15, 197c-17, and 197c-19. Then, the ground signal GND is input to each of the terminals 373-11, 373-13, 373-15, 373-17, and 373-19 of the connector 370 via each of the terminals 196c-11, 196c-13, 196c-15, 196c-17, and 196c-19 and each of the contact sections 180c-11, 180c-13, 180c-15, 180c-17, and 180c-19.

[0231] As described above, in the cable 19c, the driving signals COM6 to COM10 and the reference voltage signals CGND6 to CGND10 are propagated in the wirings 197c-1 to 197c-10, respectively. The diagnosis signals DIG-E to DIG-I, the temperature signal TH, the latch signal LAT2, the clock signal SCK2, the change signal CH2, the print data signal SI10, and the plurality of ground signals GND are propagated in the wirings 197c-11 to 197c-20, respectively. As described above, in the cable 19c, the terminal 196c-k is attached to the connector 370 to be electrically coupled to the terminal 373-k of the connector 370. That is, when the cable 19c is electrically coupled to the print head 21, the diagnosis signals DIG-F to DIG-I are respectively propagated in the wirings 197c-14, 197c-16, 197c-18, and 197c-20 located on the side 326 side of the substrate 320, on which the integrated circuit 241 constituting the diagnosis circuit 240 is provided. The diagnosis signals DIG-F to DIG-I are input to the terminals 373-14, 373-16, 373-18, and 373-20 via the contact sections 180c-14, 180c-16, 180c-18, and 180c-20, respectively. When the cable 19c is electrically coupled to the print head 21, the driving signals COM6 to COM10 are propagated in the wirings 197c-2, 197c-4, 197c-6, 197c-8, and 197c-10 located on the side 325 side of the substrate 320, and then are input to the terminals 373-2, 373-4, 373-6, 373-8, and 373-10, respectively.

[0232] That is, the shortest distance between the wiring 197c-10 and the integrated circuit 241 is longer than the shortest distance between the wiring 197c-14 and the integrated circuit 241, longer than the shortest distance between the wiring 197c-16 and the integrated circuit 241, longer than the shortest distance between the wiring 197c-18 and the integrated circuit 241, and longer than the shortest distance between the wiring 197c-20 and the integrated circuit 241. Similarly, the shortest distance between the terminal 373-10 and the integrated circuit 241 is longer than the shortest distance between the terminal 373-14 and the integrated circuit 241, longer than the shortest distance between the terminal 373-16 and the integrated circuit 241, longer than the shortest distance between the terminal 373-18 and the integrated circuit 241, and longer than the shortest distance between the terminal 373-20 and the integrated circuit 241. Similarly, the shortest distance between the contact section 180c-10 and the integrated circuit 241 is longer than

the shortest distance between the contact section 180c-14 and the integrated circuit 241, longer than the shortest distance between the contact section 180c-16 and the integrated circuit 241, longer than the shortest distance between the contact section 180c-18 and the integrated circuit 241, and longer than the shortest distance between the contact section 180c-20 and the integrated circuit 241.

[0233] Here, the cable 19c including the wirings 197c-14, 197c-16, 197c-18, and 197c-20 for respectively propagating the diagnosis signals DIG-F to DIG-I and the wiring 197c-10 for propagating the driving signal COM10 is an example of a first cable in the second embodiment. The connector 370 including the terminals 373-14, 373-16, 373-18, and 373-20 to which the diagnosis signals DIG-F to DIG-I are respectively input and the terminal 373-10 to which the driving signal COM10 is input is an example of a first connector in the second embodiment.

[0234] FIG. 33 is a diagram illustrating details of the signal propagated in the cable 19d in the second embodiment. As illustrated in FIG. 33, the cable 19d includes wirings for propagating the driving signals COM6 to COM10, wirings for propagating the reference voltage signals CGND6 to CGND10, wirings for propagating print data signals SI6 to SI9, wirings for propagating voltages VHV and VDD2, and a plurality of wirings for propagating a plurality of ground signals GND.

[0235] Specifically, the driving signals COM6 to COM10 are input to the cable 19d from the terminals 195d-1, 195d-3, 195d-5, 195d-7, and 195d-9, respectively. The driving signals COM6 to COM10 are propagated in the wirings 197d-1, 197d-3, 197d-5, 197d-7, and 197d-9, and then are input to the terminals 383-1, 383-3, 383-5, 383-7, and 383-9 of the connector 380 via the terminals 196d-1, 196d-3, 196d-5, 196d-7, and 196d-9 and the contact sections 180d-1, 180d-3, 180d-5, 180d-7, and 180d-9, respectively.

[0236] The reference voltage signals CGND6 to CGND10 are input to the cable 19d from the terminals 195d-2, 195d-4, 195d-6, 195d-8, and 195d-10, respectively. The reference voltage signals CGND6 to CGND10 are propagated in the wirings 197d-2, 197d-4, 197d-6, 197d-8, and 197d-10, and then are input to the terminals 383-2, 383-4, 383-6, 383-8, and 383-10 of the connector 380 via the terminals 196d-2, 196d-4, 196d-6, 196d-8, and 196d-10 and the contact sections 180d-2, 180d-4, 180d-6, 180d-8, and 180d-10, respectively.

[0237] The print data signals SI6 to SI9 are input to the cable 19d from the terminals 195d-13, 195d-15, 195d-17, and 195d-19, respectively. The print data signals SI6 to SI9 are propagated in the wirings 197d-13, 197d-15, 197d-17, and 197d-19, and then are input to the terminals 383-13, 383-15, 383-17, and 383-19 of the connector 380 via the terminals 196d-13, 196d-15, 196d-17, and 196d-19 and the contact sections 180d-13, 180d-15, 180d-17, and 180d-19.

[0238] The voltage VHV is input from the terminal 195d-11 to the cable 19d. The voltage VHV is propagated in the wiring 197d-11, and then is input to the terminal 383-11 of the connector 380 via the terminal 196d-11 and the contact section 180d-11. The voltage VDD2 is input from the terminal 195d-16 to the cable 19d. The voltage VDD2 is propagated in the wiring 197d-16 and then is input to the terminal 383-16 of the connector 380 via the terminal 196d-16 and the contact section 180d-16.

[0239] The ground signal GND is input from the cable 19d from each of the terminals 195d-12, 195d-14, 195d-18, and 195d-20. The ground signal GND is propagated in each of the wirings 197d-12, 197d-14, 197d-18, and 197d-20, and then is input to each of the terminals 383-12, 383-14, 383-18, and 383-20 of the connector 380 via each of the terminals 196d-12, 196d-14, 196d-18, and 196d-20 and each of the contact sections 180d-12, 180d-14, 180d-18, and 180d-20.

[0240] As described above, in the second embodiment, in the print head control circuit 15, the print head 21, and the liquid discharge apparatus 1, even when the connector 350 to which the diagnosis signals DIG-A to DIG-D are input and the connector 370 to which the diagnosis signals DIG-F to DIG-I are input are provided, similar to the first embodiment, it is possible to improve the accuracy of the diagnosis signals DIG-A to DIG-D and DIG-F to DIG-I input to the integrated circuit 241, and accordingly, to reduce the concern that the self-diagnosis function of the print head 21 does not normally operate.

[0241] The present disclosure includes configurations which are substantially the same as the configurations described in the above embodiments (for example, configurations having the same functions, methods, and results or configurations having the same purposes and effects). The present disclosure includes configurations in which non-essential components of the configurations described in the embodiments are replaced. The present disclosure includes configurations having the same advantageous effects as those of the configurations described in the embodiments or includes configurations capable of achieving the same object. The present disclosure includes configurations in which a known technique is added to the configurations described in the embodiments.

Claims

1. A print head control circuit (15) that is configured to control an operation of a print head (21) including

a driving element (60) that is configured to drive based on a driving signal, so as to cause the discharge of a liquid from a nozzle (651),
a first terminal (353-23) to which a first diagnosis signal (DIG-A) is input,
a second terminal (353-21) to which a second diagnosis signal (DIG-B) is input,

a third terminal (353-19) to which a third diagnosis signal (DIG-C) is input,
a fourth terminal (353-17) to which a fourth diagnosis signal (DIG-D) is input,
a fifth terminal (353-11) to which the driving signal is input, and
a diagnosis circuit (240) that is configured to diagnose whether or not normal discharge of the liquid is possible, based on the first diagnosis signal, the second diagnosis signal, the third diagnosis signal, and the fourth diagnosis signal,
the print head circuit comprising:

a first cable (19a) including

a first diagnosis signal propagation wiring (197a-23) for propagating the first diagnosis signal,
a second diagnosis signal propagation wiring (197a-21) for propagating the second diagnosis signal,
a third diagnosis signal propagation wiring (197a-19) for propagating the third diagnosis signal,
a fourth diagnosis signal propagation wiring (197a-17) for propagating the fourth diagnosis signal, and
a first driving signal propagation wiring (197a-11) for propagating the driving signal;

a diagnosis signal output circuit (100) that is configured to output the first diagnosis signal, the second diagnosis signal, the third diagnosis signal, and the fourth diagnosis signal; and
a driving signal output circuit (50) that is configured to output the driving signal, wherein
when the first cable is electrically coupled to the print head, a shortest distance between the first driving signal propagation wiring and the diagnosis circuit is longer than a shortest distance between the first diagnosis signal propagation wiring and the diagnosis circuit, longer than a shortest distance between the second diagnosis signal propagation wiring and the diagnosis circuit, longer than a shortest distance between the third diagnosis signal propagation wiring and the diagnosis circuit, and longer than a shortest distance between the fourth diagnosis signal propagation wiring and the diagnosis circuit; and wherein
the first cable further includes a first constant voltage signal propagation wiring (197a-22), a second constant voltage signal propagation wiring (197a-20), and a third constant voltage signal propagation wiring (197a-18), for propagating a constant voltage signal (GND),
the first diagnosis signal propagation wiring, the second diagnosis signal propagation wiring, the third diagnosis signal propagation wiring, and the fourth diagnosis signal propagation wiring are provided in the first cable to be aligned in order of the first diagnosis signal propagation wiring, the second diagnosis signal propagation wiring, the third diagnosis signal propagation wiring, and the fourth diagnosis signal propagation wiring,
the first constant voltage signal propagation wiring is located between the first diagnosis signal propagation wiring and the second diagnosis signal propagation wiring,
the second constant voltage signal propagation wiring is located between the second diagnosis signal propagation wiring and the third diagnosis signal propagation wiring, and
the third constant voltage signal propagation wiring is located between the third diagnosis signal propagation wiring and the fourth diagnosis signal propagation wiring.

2. The print head control circuit according to claim 1, wherein

the print head further includes

a first connector (350) including the first terminal, the second terminal, the third terminal, the fourth terminal, and the fifth terminal, and
a substrate (320),

the first connector and the diagnosis circuit are provided on the same surface of the substrate, and
the first cable is electrically coupled to the first connector.

3. The print head control circuit according to claim 1, wherein
the first diagnosis signal propagation wiring is also configured to be used as a wiring for propagating a signal for defining a discharge timing of the liquid.

4. The print head control circuit according to claim 1, wherein
the second diagnosis signal propagation wiring is also configured to be used as a wiring for propagating a clock signal.

5. The print head control circuit according to claim 1, wherein

the third diagnosis signal propagation wiring is also configured to be used as a wiring for propagating a signal for defining a waveform switching timing of the driving signal.

6. The print head control circuit according to claim 1, wherein
the fourth diagnosis signal propagation wiring is also configured to be used as a wiring for propagating a signal for defining selection of a waveform of the driving signal.

7. The print head control circuit according to claim 1, wherein

the print head further includes a sixth terminal, and
the first cable further includes a fifth diagnosis signal propagation wiring for propagating a fifth diagnosis signal which is input to the sixth terminal and configured to indicate a diagnosis result of the diagnosis circuit.

8. The print head control circuit according to claim 7, wherein
the fifth diagnosis signal propagation wiring is also configured to be used as a wiring for propagating a signal indicating whether or not temperature abnormality occurs in the print head.

9. The print head control circuit according to claim 1, wherein

the print head further includes

a seventh terminal to which a sixth diagnosis signal is input,
an eighth terminal to which a seventh diagnosis signal is input,
a ninth terminal to which an eighth diagnosis signal is input,
a tenth terminal to which a ninth diagnosis signal is input, and
an eleventh terminal to which the driving signal is input,

the diagnosis circuit is configured to diagnose whether or not the normal discharge of the liquid is possible, based on the sixth diagnosis signal, the seventh diagnosis signal, the eighth diagnosis signal, and the ninth diagnosis signal,
the print head control circuit further comprises a second cable including

a sixth diagnosis signal propagation wiring for propagating the sixth diagnosis signal,
a seventh diagnosis signal propagation wiring for propagating the seventh diagnosis signal,
an eighth diagnosis signal propagation wiring for propagating the eighth diagnosis signal,
a ninth diagnosis signal propagation wiring for propagating the ninth diagnosis signal, and
a second driving signal propagation wiring for propagating the driving signal, and

when the second cable is electrically coupled to the print head, a shortest distance between the second driving signal propagation wiring and the diagnosis circuit is longer than a shortest distance between the sixth diagnosis signal propagation wiring and the diagnosis circuit, longer than a shortest distance between the seventh diagnosis signal propagation wiring and the diagnosis circuit, longer than a shortest distance between the eighth diagnosis signal propagation wiring and the diagnosis circuit, and longer than a shortest distance between the ninth diagnosis signal propagation wiring and the diagnosis circuit.

Patentansprüche

1. Druckkopfsteuerungsschaltung (15), die konfiguriert ist, einen Betrieb eines Druckkopfs (21) zu steuern, enthaltend

ein Antriebselement (60), das konfiguriert ist, basierend auf einem Antriebssignal anzutreiben, um so Abgabe einer Flüssigkeit aus einer Düse (651) zu veranlassen,
einen ersten Anschluss (353-23), in den ein erstes Diagnosesignal (DIG-A) eingegeben wird,
einen zweiten Anschluss (353-21), in den ein zweites Diagnosesignal (DIG-B) eingegeben wird,
einen dritten Anschluss (353-19), in den ein drittes Diagnosesignal (DIG-C) eingegeben wird,
einen vierten Anschluss (353-17), in den ein viertes Diagnosesignal (DIG-D) eingegeben wird,
einen fünften Anschluss (353-11), in den das Antriebssignal eingegeben wird, und
eine Diagnoseschaltung (240), die konfiguriert ist, basierend auf dem ersten Diagnosesignal, dem zweiten Diagnosesignal, dem dritten Diagnosesignal und dem vierten Diagnosesignal zu diagnostizieren, ob normale Abgabe der Flüssigkeit möglich ist oder nicht,
wobei die Druckkopfschaltung umfasst:

ein erstes Kabel (19a), enthaltend
eine erste Diagnosesignalausbreitungsver-

drahtung (197a-23) zum Ausbreiten des ersten Diagnosesignals, eine zweite Diagnosesignalausbreitungsverdrahtung (197a-21) zum Ausbreiten des zweiten Diagnosesignals,
eine dritte Diagnosesignalausbreitungsverdrahtung (197a-19) zum Ausbreiten des dritten Diagnosesignals,
eine vierte Diagnosesignalausbreitungsverdrahtung (197a-17) zum Ausbreiten des vierten Diagnosesignals und
eine erste Antriebssignalausbreitungsverdrahtung (197a-11) zum Ausbreiten des Antriebssignals;
eine Diagnosesignalausgabeschaltung (100), die konfiguriert ist, das erste Diagnosesignal, das zweite Diagnosesignal, das dritte Diagnosesignal und das vierte Diagnosesignal auszugeben; und
eine Antriebssignalausgabeschaltung (50), die konfiguriert ist, das Antriebssignal auszugeben, wobei,
wenn das erste Kabel elektrisch an den Druckkopf gekoppelt ist, ein kürzester Abstand zwischen der ersten Antriebssignalausbreitungsverdrahtung und der Diagnoseschaltung länger ist als ein kürzester Abstand zwischen der ersten Diagnosesignalausbreitungsverdrahtung und der Diagnoseschaltung, länger als ein kürzester Abstand zwischen der zweiten Diagnosesignalausbreitungsverdrahtung und der Diagnoseschaltung, länger als ein kürzester Abstand zwischen der dritten Diagnosesignalausbreitungsverdrahtung und der Diagnoseschaltung und länger als ein kürzester Abstand zwischen der vierten Diagnosesignalausbreitungsverdrahtung und der Diagnoseschaltung; und wobei
das erste Kabel weiter eine erste Konstantspannungssignal-Ausbreitungsverdrahtung (197a-22), eine zweite Konstantspannungssignal-Ausbreitungsverdrahtung (197a-20) und eine dritte Konstantspannungssignal-Ausbreitungsverdrahtung (197a-18) zum Ausbreiten eines Konstantspannungssignals (GND) enthält,
die erste Diagnosesignalausbreitungsverdrahtung, die zweite Diagnosesignalausbreitungsverdrahtung, die dritte Diagnosesignalausbreitungsverdrahtung und die vierte Diagnosesignalausbreitungsverdrahtung in dem ersten Kabel vorgesehen sind, um in der Reihenfolge der ersten Diagnosesignalausbreitungsverdrahtung, der zweiten Diagnosesignalausbreitungsverdrahtung, der dritten Diagnosesignalausbreitungsverdrahtung und der vierten Diagnosesignalausbreitungsverdrahtung ausgerichtet zu sein,
die erste Konstantspannungssignal-Ausbreitungsverdrahtung sich zwischen der ersten Diagnosesignalausbreitungsverdrahtung und der zweiten Diagnosesignalausbreitungsverdrahtung befindet,
die zweite Konstantspannungssignal-Ausbreitungsverdrahtung sich zwischen der zweiten Diagnosesignalausbreitungsverdrahtung und der dritten Diagnosesignalausbreitungsverdrahtung befindet und
die dritte Konstantspannungssignal-Ausbreitungsverdrahtung sich zwischen der dritten Diagnosesignalausbreitungsverdrahtung und der vierten Diagnosesignalausbreitungsverdrahtung befindet.

2. Druckkopfsteuerschaltung nach Anspruch 1, wobei der Druckkopf weiter enthält

einen ersten Verbinder (350) der den ersten Anschluss, den zweiten Anschluss, den dritten Anschluss, den vierten Anschluss und den fünften Anschluss enthält, und
ein Substrat (320),
wobei der erste Verbinder und die Diagnoseschaltung auf derselben Oberfläche des Substrats vorgesehen sind und
das erste Kabel elektrisch an den ersten Verbinder gekoppelt ist.

3. Druckkopfsteuerschaltung nach Anspruch 1, wobei die erste Diagnosesignalausbreitungsverdrahtung auch konfiguriert ist, als eine Verdrahtung zum Ausbreiten eines Signals zum Definieren eines Abgabezeitpunkts der Flüssigkeit verwendet zu werden.

4. Druckkopfsteuerschaltung nach Anspruch 1, wobei die zweite Diagnosesignalausbreitungsverdrahtung auch konfiguriert ist, als eine Verdrahtung zum Ausbreiten eines Taktsignals verwendet zu werden.

5. Druckkopfsteuerschaltung nach Anspruch 1, wobei die dritte Diagnosesignalausbreitungsverdrahtung auch konfiguriert ist, als eine Verdrahtung zum Ausbreiten eines Signals zum Definieren eines Wellenformumschaltzeitpunkts des Antriebssignals verwendet zu werden.

6. Druckkopfsteuerschaltung nach Anspruch 1, wobei die vierte Diagnosesignalausbreitungsverdrahtung auch konfiguriert ist, als eine Verdrahtung zum Ausbreiten eines Signals zum Definieren einer Auswahl einer Wellenform des Antriebssignals verwendet zu werden.

7. Druckkopfsteuerschaltung nach Anspruch 1, wobei

der Druckkopf einen sechsten Anschluss enthält und
das erste Kabel weiter eine fünfte Diagnosesignalausbreitungsverdrahtung zum Ausbreiten eines fünften Diagnosesignals enthält, das in den sechsten Anschluss eingegeben wird und konfiguriert ist, ein Diagnoseergebnis der Diagnoseschaltung anzuzeigen.

8. Druckkopfsteuerschaltung nach Anspruch 7, wobei die fünfte Diagnosesignalausbreitungsverdrahtung auch konfiguriert ist, als eine Verdrahtung zum Ausbreiten eines Signals verwendet zu werden, das anzeigt, ob eine Temperaturanomalie in dem Druckkopf auftritt oder nicht.

9. Druckkopfsteuerschaltung nach Anspruch 1, wobei

der Druckkopf weiter enthält
einen siebenten Anschluss, in den ein sechstes Diagnosesignal eingegeben wird,
einen achten Anschluss, in den ein siebentes Diagnosesignal eingegeben wird,
einen neunten Anschluss, in den ein achtes Diagnosesignal eingegeben wird,
einen zehnten Anschluss, in den ein neuntes Diagnosesignal eingegeben wird, und
einen elften Anschluss, in den das Antriebssignal eingegeben wird,
wobei die Diagnoseschaltung konfiguriert ist, basierend auf dem sechsten Diagnosesignal, dem siebenten Diagnosesignal, dem achten Diagnosesignal und dem neunten Diagnosesignal zu diagnostizieren, ob die normale Abgabe der Flüssigkeit möglich ist oder nicht,
die Druckkopfsteuerschaltung weiter ein zweites Kabel umfasst, enthaltend
eine sechste Diagnosesignalausbreitungsverdrahtung zum Ausbreiten des sechsten Diagnosesignals,
eine siebente Diagnosesignalausbreitungsverdrahtung zum Ausbreiten des siebenten Diagnosesignals,
eine achte Diagnosesignalausbreitungsverdrahtung zum Ausbreiten des achten Diagnosesignals,
eine neunte Diagnosesignalausbreitungsverdrahtung zum Ausbreiten des neunten Diagnosesignals und
eine zweite Antriebssignalausbreitungsverdrahtung zum Ausbreiten des Antriebssignals und
wenn das zweite Kabel elektrisch an den Druckkopf gekoppelt ist, ein kürzester Abstand zwischen der zweiten Antriebssignalausbreitungsverdrahtung und der Diagnoseschaltung länger ist als ein kürzester Abstand zwischen der sechsten Diagnosesignalausbreitungsverdrahtung und der Diagnoseschaltung, länger als ein kürzester Abstand zwischen der siebenten Diagnosesignalausbreitungsverdrahtung und der Diagnoseschaltung, länger als ein kürzester Abstand zwischen der achten Diagnosesignalausbreitungsverdrahtung und der Diagnoseschaltung und länger als ein kürzester Abstand zwischen der neunten Diagnosesignalausbreitungsverdrahtung und der Diagnoseschaltung.

Revendications

1. Circuit de commande de tête d'impression (15) configuré pour commander un fonctionnement d'une tête d'impression (21) incluant

un élément d'entraînement (60) configuré pour un entraînement sur la base d'un signal d'entraînement, de manière à générer la décharge d'un liquide à partir d'une buse (651),
une première borne (353-23) dans laquelle est entré un premier signal de diagnostic (DIG-A),
une deuxième borne (353-21) dans laquelle est entré un deuxième signal de diagnostic (DIG-B),
une troisième borne (353-19) dans lequel est entré un troisième signal de diagnostic (DIG-C),
une quatrième borne (353-17) dans laquelle est entré un quatrième signal de diagnostic (DIG-D),
une cinquième borne (353-11) dans laquelle est entré le signal d'entraînement, et
un circuit de diagnostic (240) configuré pour diagnostiquer si la décharge normale de liquide est possible ou non, sur la base du premier signal de diagnostic, du deuxième signal de diagnostic, du troisième signal de diagnostic, et du quatrième signal de diagnostic,
le circuit de tête d'impression comprenant :

un premier câble (19a) incluant
un premier câblage de propagation de signal de diagnostic (197a-23) pour la propagation du premier signal de diagnostic,
un deuxième câblage de propagation de signal de diagnostic (197a-21) pour la propagation du deuxième signal de diagnostic,
un troisième câblage de propagation de signal de diagnostic (197a-19) pour la propagation du troisième signal de diagnostic,
un quatrième câblage de propagation de signal de diagnostic (197a-17) pour la propagation du quatrième signal de diagnostic, et
un premier câblage de propagation de signal d'entraînement (197a-11) pour la propagation du signal d'entraînement ;
un circuit d'émission de signal de diagnostic (100) configuré pour émettre le premier si-

gnal de diagnostic, le deuxième signal de diagnostic, le troisième signal de diagnostic, et le quatrième signal de diagnostic ; et un circuit d'émission de signal d'entraînement (50) configuré pour émettre le signal d'entraînement, dans lequel
lorsque le premier câble est couplé électriquement à la tête d'impression, une distance la plus courte entre le premier câblage de propagation de signal d'entraînement et le circuit de diagnostic est plus longue qu'une distance la plus courte entre le premier câblage de propagation de signal de diagnostic et le circuit de diagnostic, plus longue qu'une distance la plus courte entre le deuxième câblage de propagation de signal de diagnostic et le circuit de diagnostic, plus longue qu'une distance la plus courte entre le troisième câblage de propagation de signal de diagnostic et le circuit de diagnostic, et plus longue qu'une distance la plus courte entre le quatrième câblage de propagation de signal de diagnostic et le circuit de diagnostic ; et dans lequel
le premier câble inclut en outre un premier câblage de propagation de signal de tension constante (197a-22), un deuxième câblage de propagation de signal de tension constante (197a-20), et un troisième câblage de propagation de signal de tension constante (197a-18), pour la propagation d'un signal de tension constante (GND),
le premier câblage de propagation de signal de diagnostic, le deuxième câblage de propagation de signal de diagnostic, le troisième câblage de propagation de signal de diagnostic, et le quatrième câblage de propagation de signal de diagnostic sont disposés dans le premier câble pour être alignés dans l'ordre du premier câblage de propagation de signal de diagnostic, du deuxième câblage de propagation de signal de diagnostic, du troisième câblage de propagation de signal de diagnostic, et du quatrième câblage de propagation de signal de diagnostic,
le premier câblage de propagation de signal de tension constante se trouve entre le premier câblage de propagation de signal de diagnostic et le deuxième câblage de propagation de signal de diagnostic,
le deuxième câblage de propagation de signal de tension constante se trouve entre le deuxième câblage de propagation de signal de diagnostic et le troisième câblage de propagation de signal de diagnostic, et
le troisième câblage de propagation de signal de tension constante se trouve entre le troisième câblage de propagation de signal de diagnostic et le quatrième câblage de propagation de signal de diagnostic.

2. Circuit de commande de tête d'impression selon la revendication 1, dans lequel

la tête d'impression inclut en outre
un premier connecteur (350) incluant la première borne, la deuxième borne, la troisième borne, la quatrième borne, et la cinquième borne, et
un substrat (320),
le premier connecteur et le circuit de diagnostic sont disposés sur la même surface du substrat, et
le premier câble est couplé électriquement au premier connecteur.

3. Circuit de commande de tête d'impression selon la revendication 1, dans lequel
le premier câblage de propagation de signal de diagnostic est également configuré pour être utilisé comme câblage pour la propagation d'un signal destiné à définir un temps de décharge du liquide.

4. Circuit de commande de tête d'impression selon la revendication 1, dans lequel
le deuxième câblage de propagation de signal de diagnostic est également utilisé comme câblage pour la propagation d'un signal d'horloge.

5. Circuit de commande de tête d'impression selon la revendication 1, dans lequel
le troisième câblage de propagation de signal de diagnostic est également utilisé comme câblage pour la propagation d'un signal destiné à définir une synchronisation de commutation de forme d'onde du signal d'entraînement.

6. Circuit de commande de tête d'impression selon la revendication 1, dans lequel
le quatrième câblage de propagation de signal de diagnostic est également utilisé comme câblage pour la propagation d'un signal destiné à définir la sélection d'une forme d'onde du signal d'entraînement.

7. Circuit de commande de tête d'impression selon la revendication 1, dans lequel

la tête d'impression inclut en outre une sixième borne, et
le premier câble inclut en outre un cinquième câblage de propagation de signal de diagnostic pour la propagation d'un cinquième signal de diagnostic, lequel est entré dans la sixième borne et configuré pour indiquer un résultat de diagnostic du circuit de diagnostic.

8. Circuit de commande de tête d'impression selon la revendication 7, dans lequel
le cinquième câblage de propagation de signal de diagnostic est également configuré pour être utilisé comme câblage pour la propagation d'un signal indiquant si une anomalie de température apparaît ou non dans la tête d'impression.

9. Circuit de commande de tête d'impression selon la revendication 1, dans lequel

le tête d'impression inclut en outre
une septième borne dans laquelle est entré un sixième signal de diagnostic,
une huitième borne dans laquelle est entré un septième signal de diagnostic,
une neuvième borne dans laquelle est entré un huitième signal de diagnostic,
une dixième borne dans laquelle est entré un neuvième signal de diagnostic, et
une onzième borne dans laquelle est entré le signal d'entraînement,
le circuit de diagnostic est configuré pour diagnostiquer si une décharge normale du liquide est possible ou non, sur la base du sixième signal de diagnostic, du septième signal de diagnostic, du huitième signal de diagnostic, et du neuvième signal de diagnostic,
le circuit de commande de tête d'impression comprend en outre un deuxième câble incluant un sixième câblage de propagation de signal de diagnostic pour la propagation du sixième signal de diagnostic,
un septième câblage de propagation de signal de diagnostic pour la propagation du septième signal de diagnostic,
un huitième câblage de propagation de signal de diagnostic pour la propagation du huitième signal de diagnostic,
un neuvième câblage de propagation de signal de diagnostic pour la propagation du neuvième signal de diagnostic, et
un deuxième câblage de propagation de signal d'entraînement pour la propagation du signal d'entraînement, et
lorsque le deuxième câble est couplé électriquement à la tête d'impression, une distance la plus courte entre le deuxième câblage de propagation de signal d'entraînement et le circuit de diagnostic est plus longue qu'une distance la plus courte entre le sixième câblage de propagation de signal de diagnostic et le circuit de diagnostic, plus longue qu'une distance la plus courte entre le septième câblage de propagation de signal de diagnostic et le circuit de diagnostic, plus longue qu'une distance la plus courte entre le huitième câblage de propagation de signal de diagnostic et le circuit de diagnostic, et plus longue qu'une distance la plus courte entre le neuvième câblage de propagation de signal de diagnostic et le circuit de diagnostic.

FIG. 1

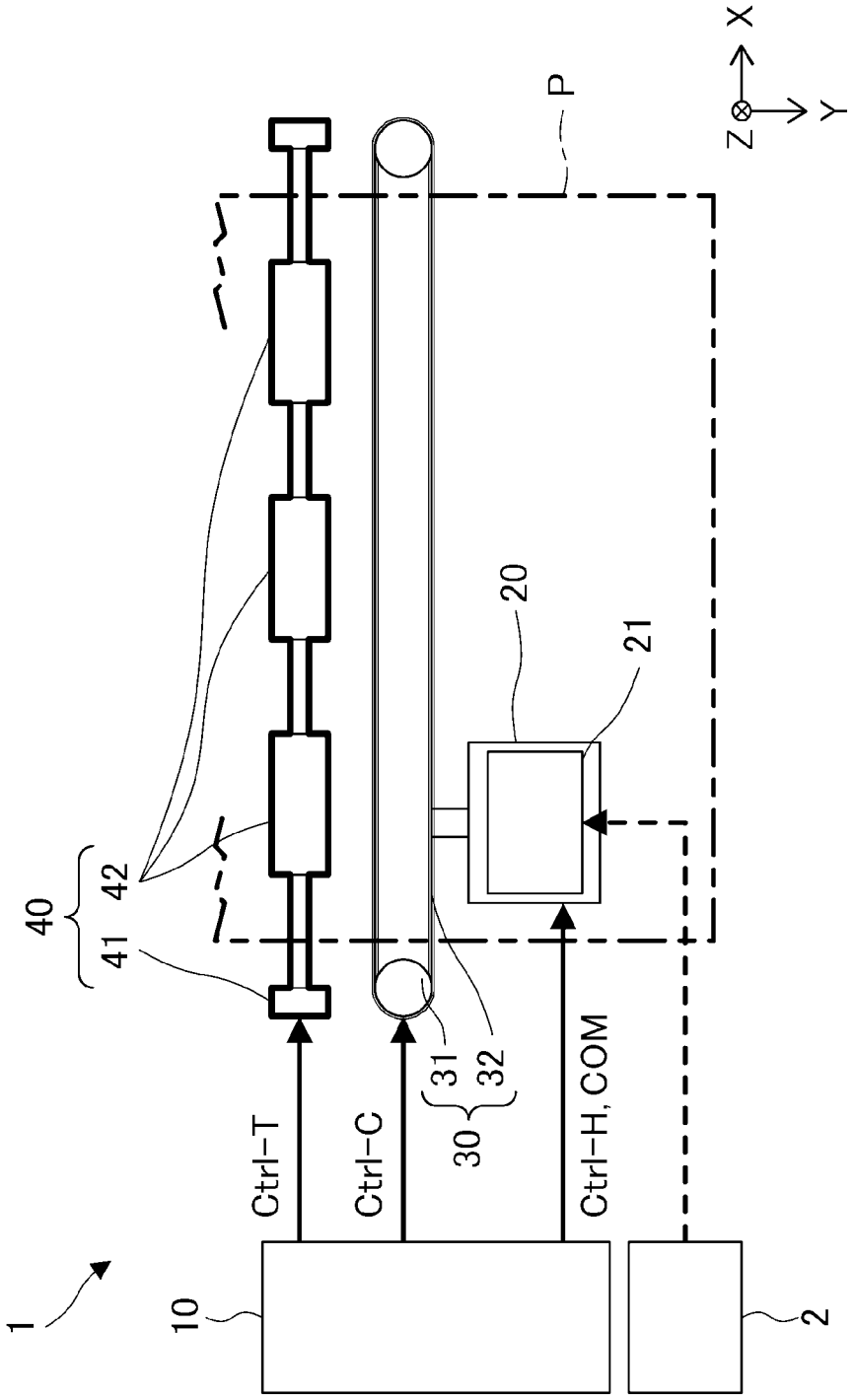


FIG. 2

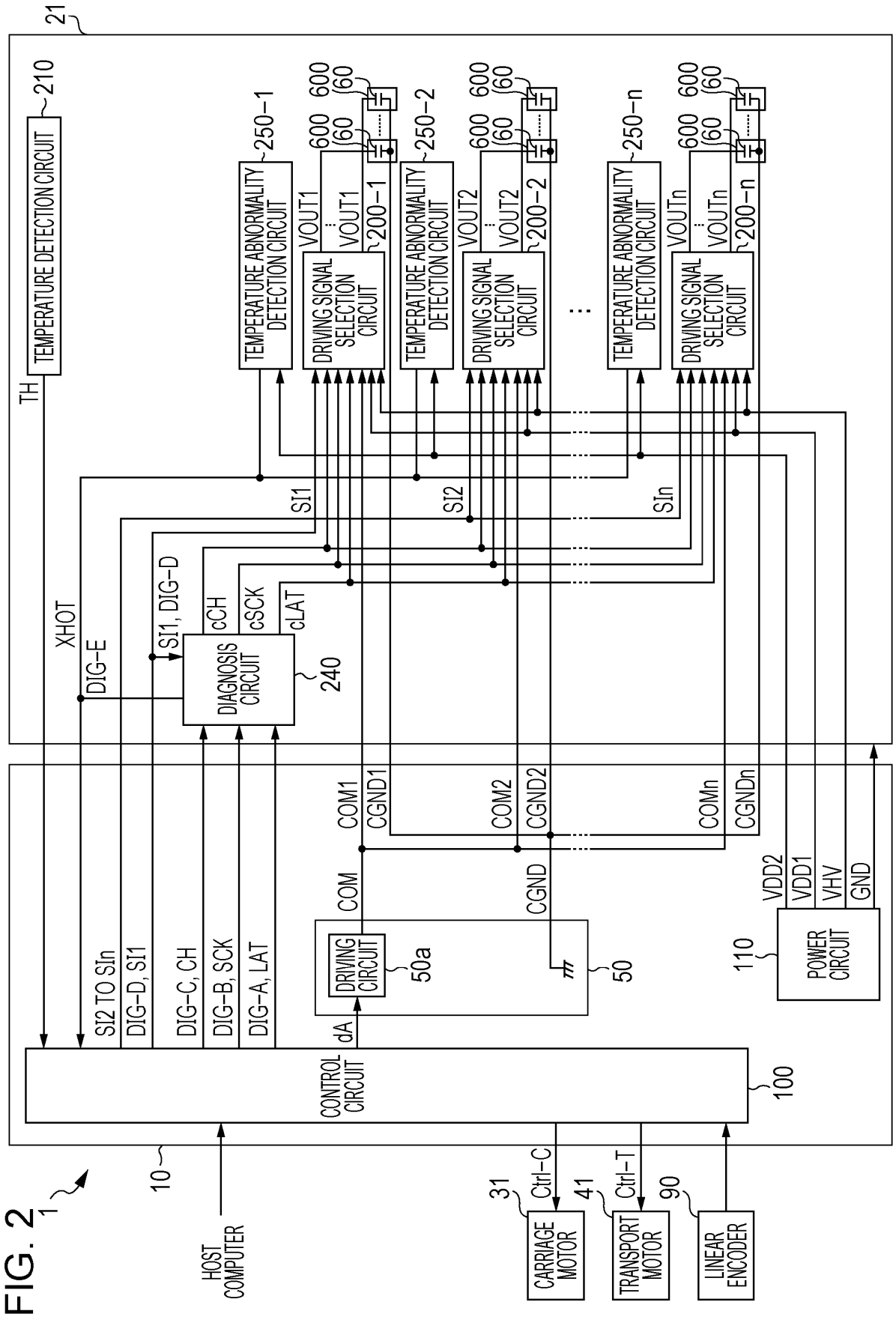

1
10
21
HOST COMPUTER
TEMPERATURE DETECTION CIRCUIT
210
TH
XHOT
DIG-E
SI1, DIG-D
DIAGNOSIS CIRCUIT
240
cCH
cSCK
cLAT
SI1
SI2
SIn
TEMPERATURE ABNORMALITY DETECTION CIRCUIT
250-1
250-2
250-n
DRIVING SIGNAL SELECTION CIRCUIT
VOUT1
VOUT2
VOUTn
200-1
200-2
200-n
600
60
SI2 TO SIn
DIG-D, SI1
DIG-C, CH
DIG-B, SCK
DIG-A, LAT
CONTROL CIRCUIT
100
dA
DRIVING CIRCUIT
50a
50
COM
COM1
COM2
COMn
CGND
CGND1
CGND2
CGNDn
VDD2
VDD1
VHV
GND
POWER CIRCUIT
110
31
Ctrl-C
CARRIAGE MOTOR
41
Ctrl-T
TRANSPORT MOTOR
90
LINEAR ENCODER

FIG. 3

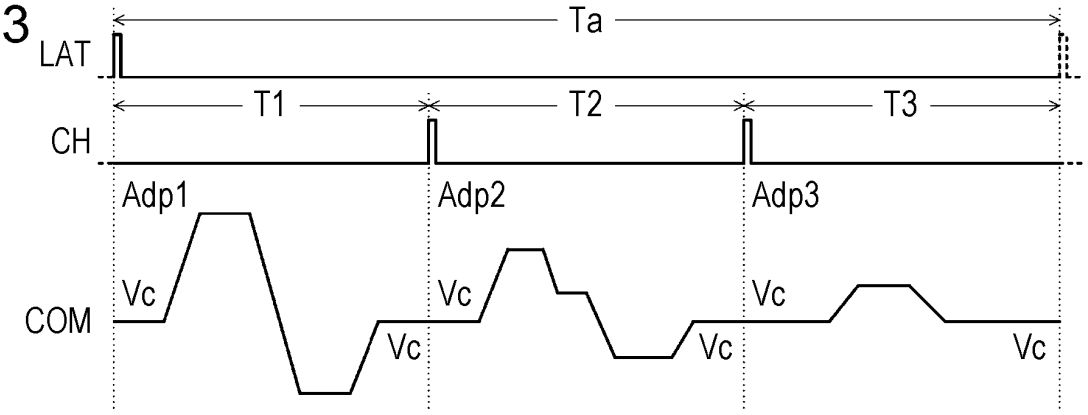

Ta
LAT
T1
T2
T3
CH
Adp1
Adp2
Adp3
COM
Vc

FIG. 4

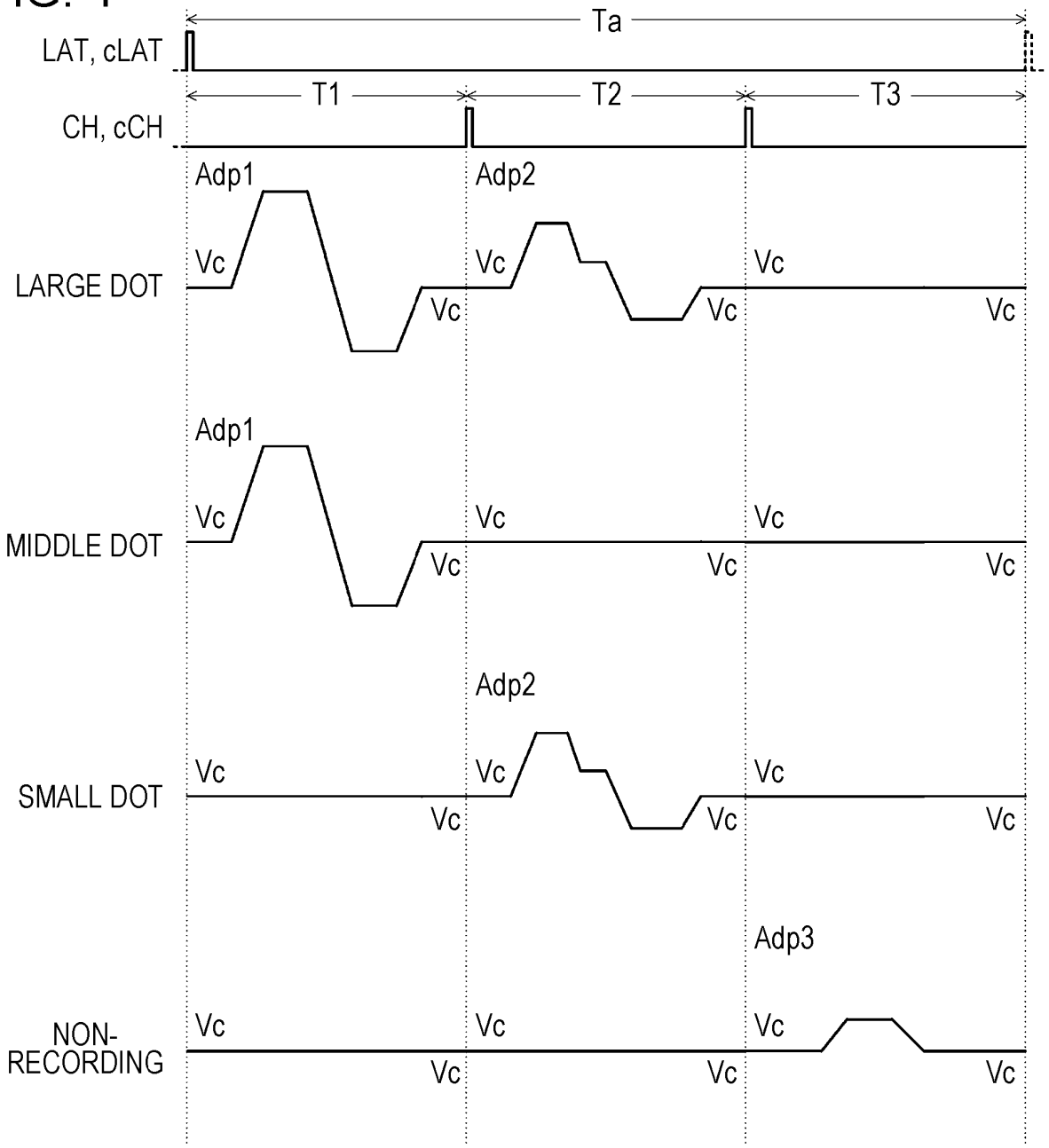

Ta
LAT, cLAT
T1
T2
T3
CH, cCH
Adp1
Adp2
LARGE DOT
MIDDLE DOT
SMALL DOT
Adp3
NON-
RECORDING
Vc

FIG. 5

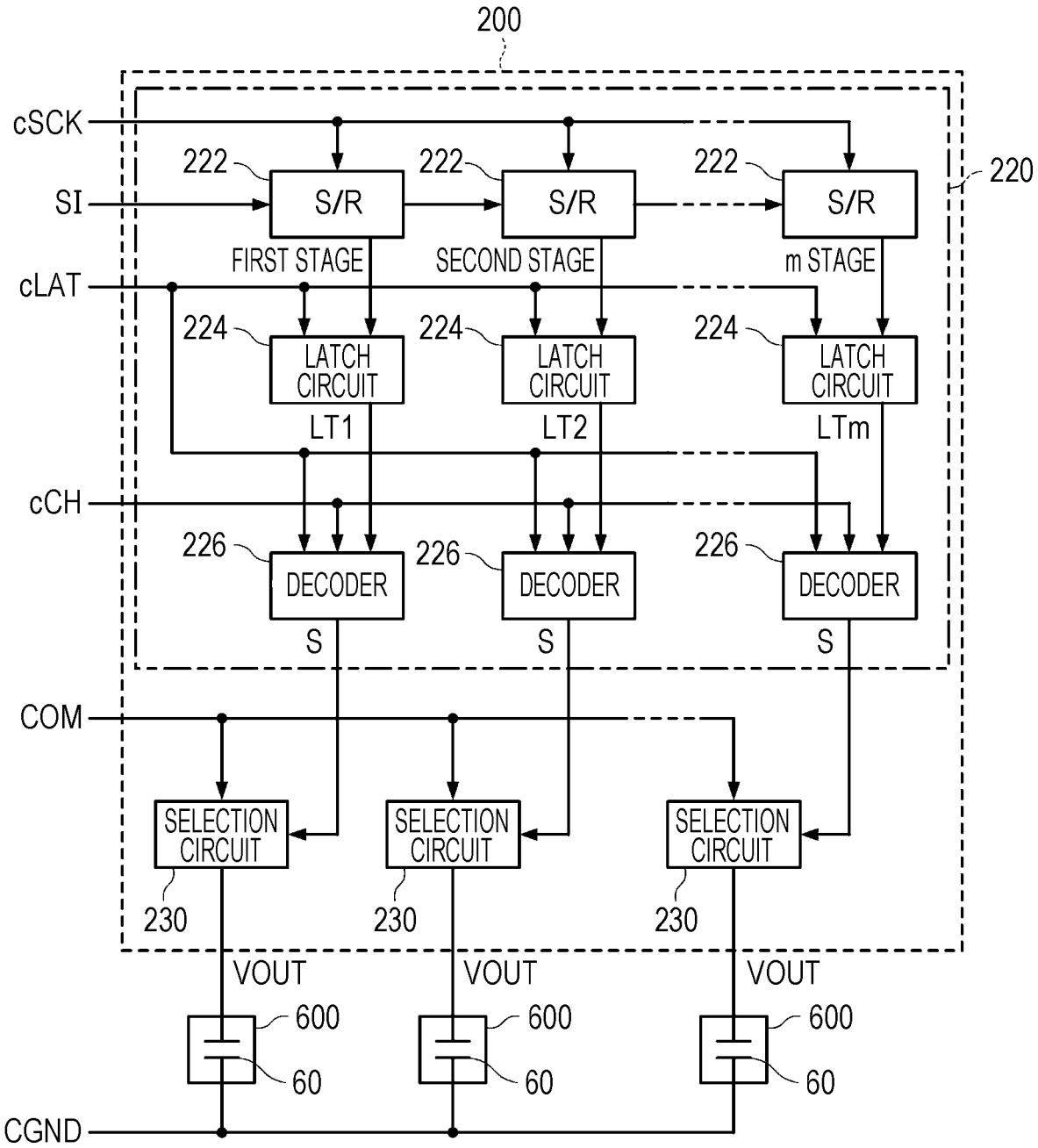

200
220
cSCK
SI
cLAT
cCH
COM
CGND
222
S/R
FIRST STAGE
SECOND STAGE
m STAGE
224
LATCH CIRCUIT
LT1
LT2
LTm
226
DECODER
S
SELECTION CIRCUIT
230
VOUT
600
60

FIG. 6

[SIH, SIL]		[1, 1] LARGE DOT	[1, 0] MEDIUM DOT	[0, 1] SMALL DOT	[0, 0] NON-RECORDING
S	T1	H	H	L	L
	T2	H	L	H	L
	T3	L	L	L	H

FIG. 7

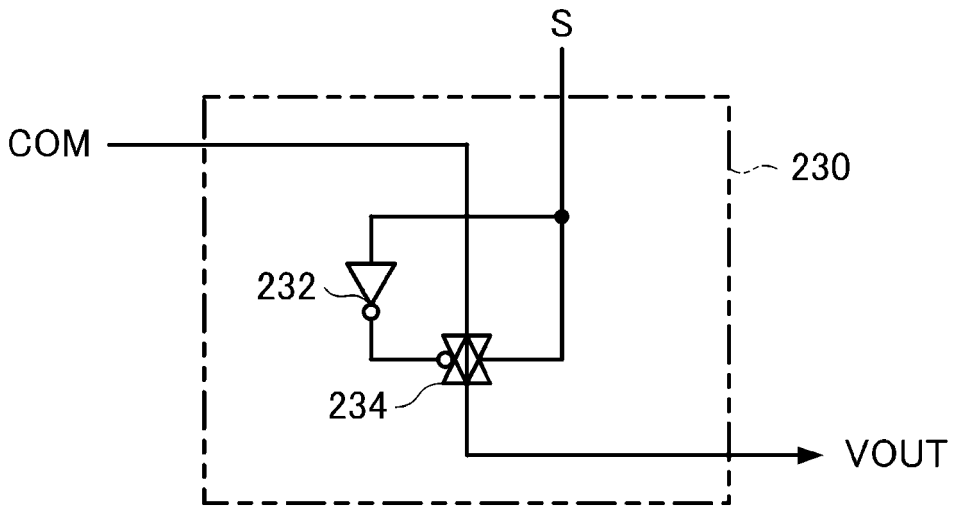


FIG. 8

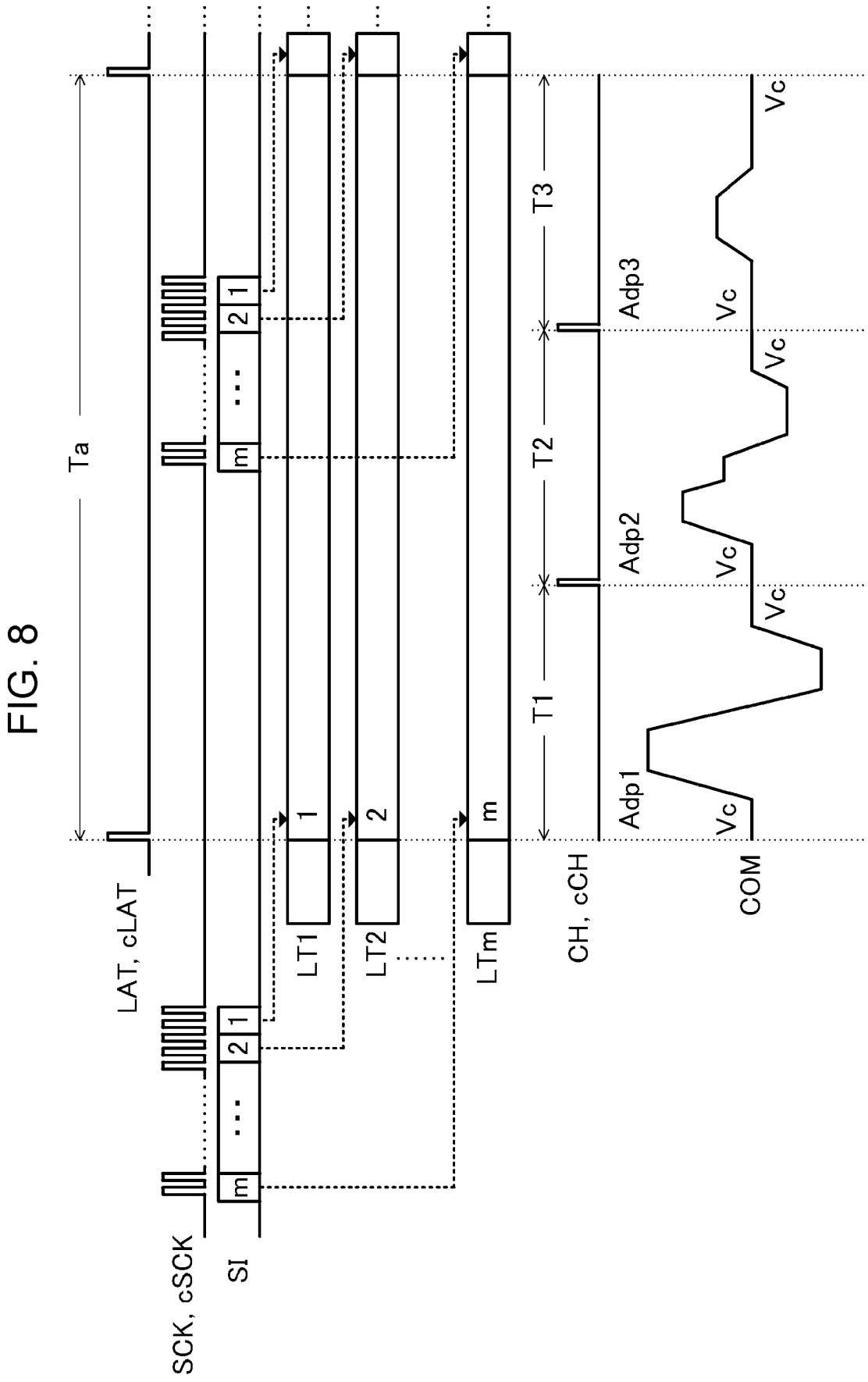

Ta
LAT, cLAT
SCK, cSCK
SI
m
2
1
LT1
LT2
LTm
CH, cCH
T1
T2
T3
Adp1
Adp2
Adp3
Vc
COM

FIG. 9

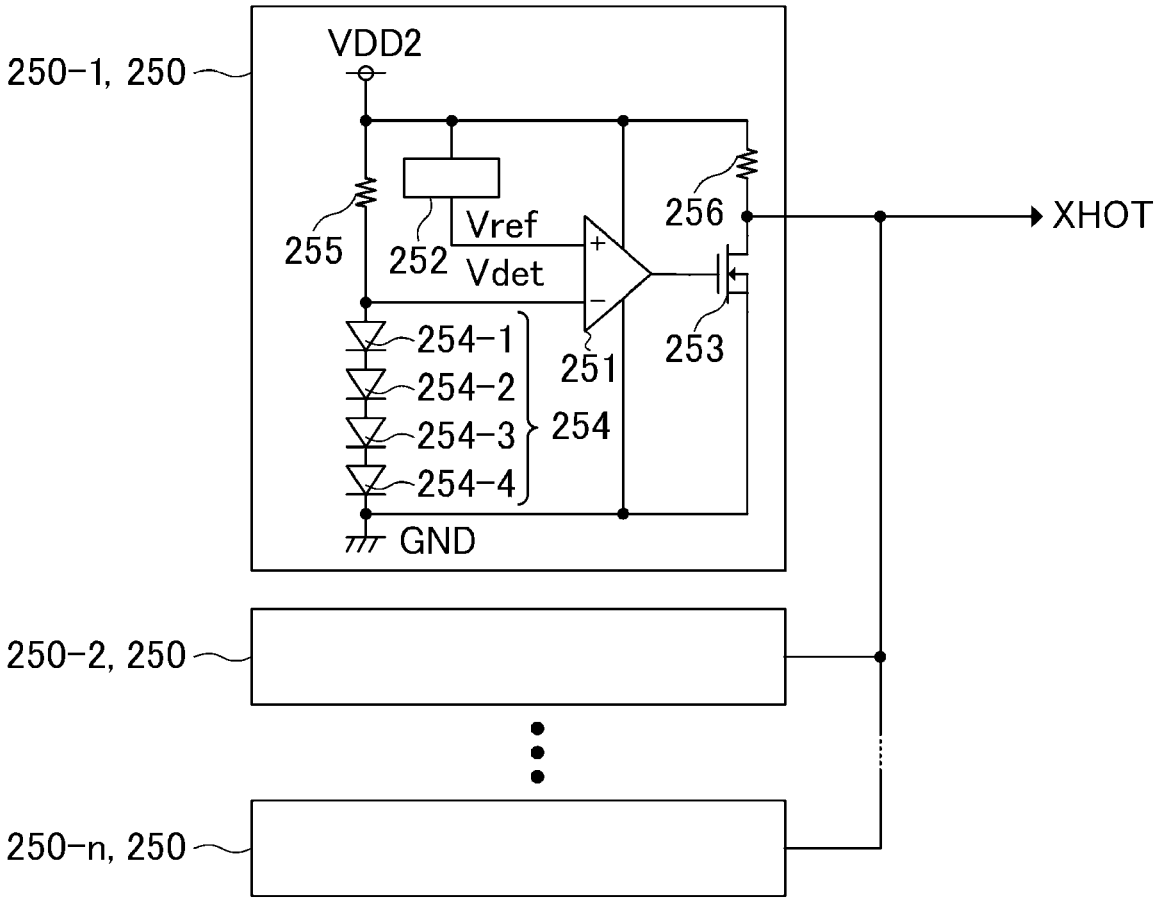

250-1, 250
VDD2
255
252
Vref
Vdet
256
XHOT
254-1
254-2
254-3
254-4
254
251
253
GND
250-2, 250
250-n, 250

FIG. 10

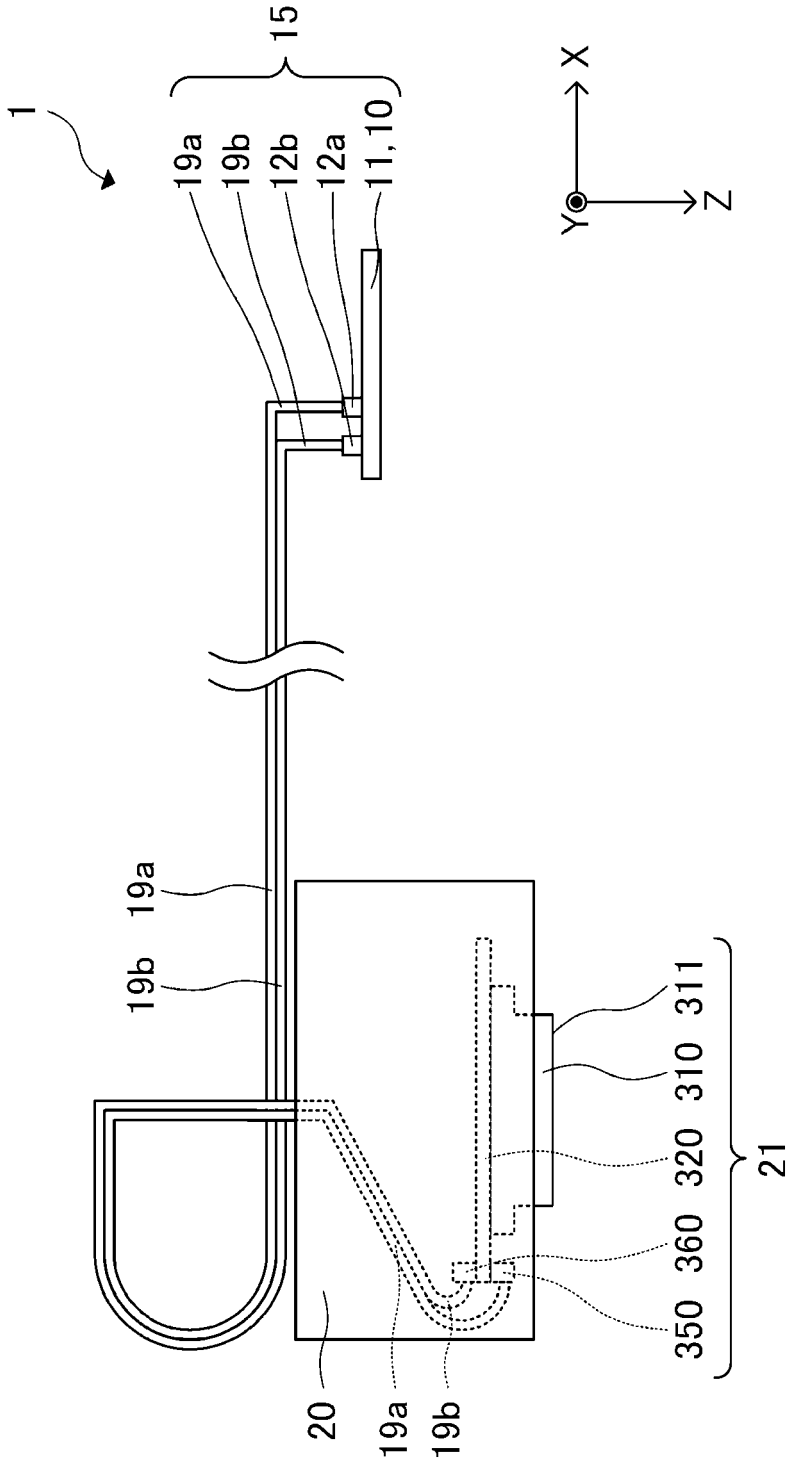

1
15
19a
19b
12b
12a
11,10
X
Y
Z
19a
19b
311
310
320
360
350
21
20
19a
19b

FIG. 11

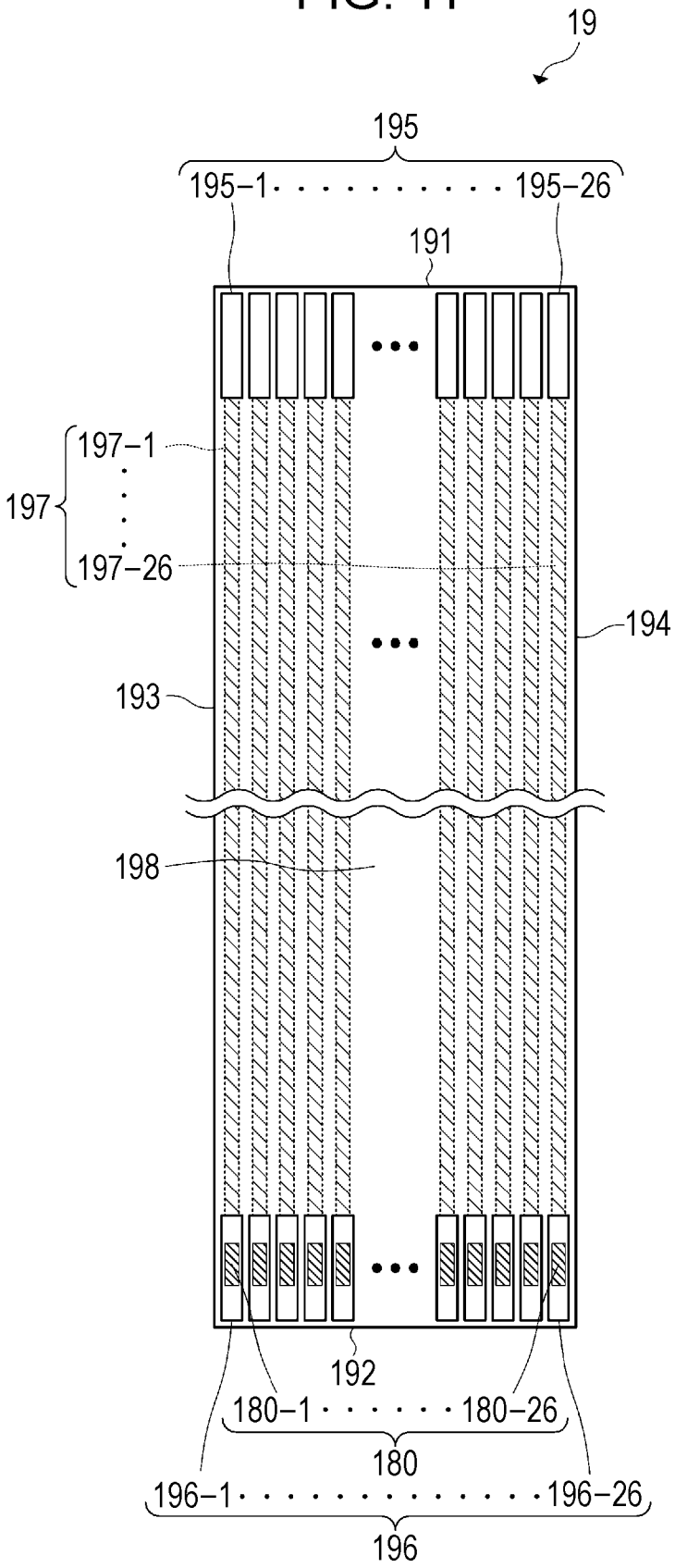
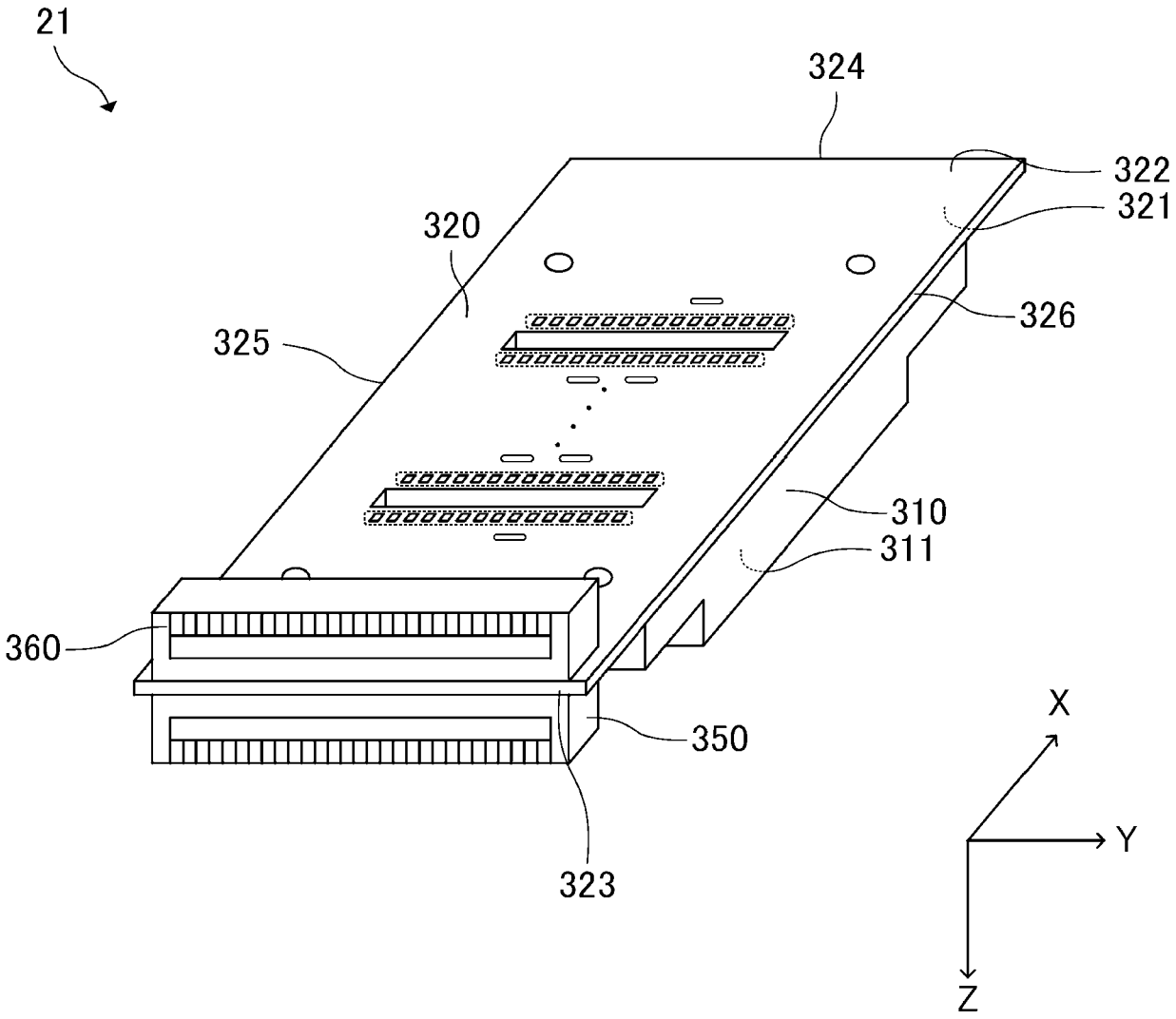

19
195
195-1
195-26
191
197-1
197
197-26
194
193
198
192
180-1
180-26
180
196-1
196-26
196

FIG. 12



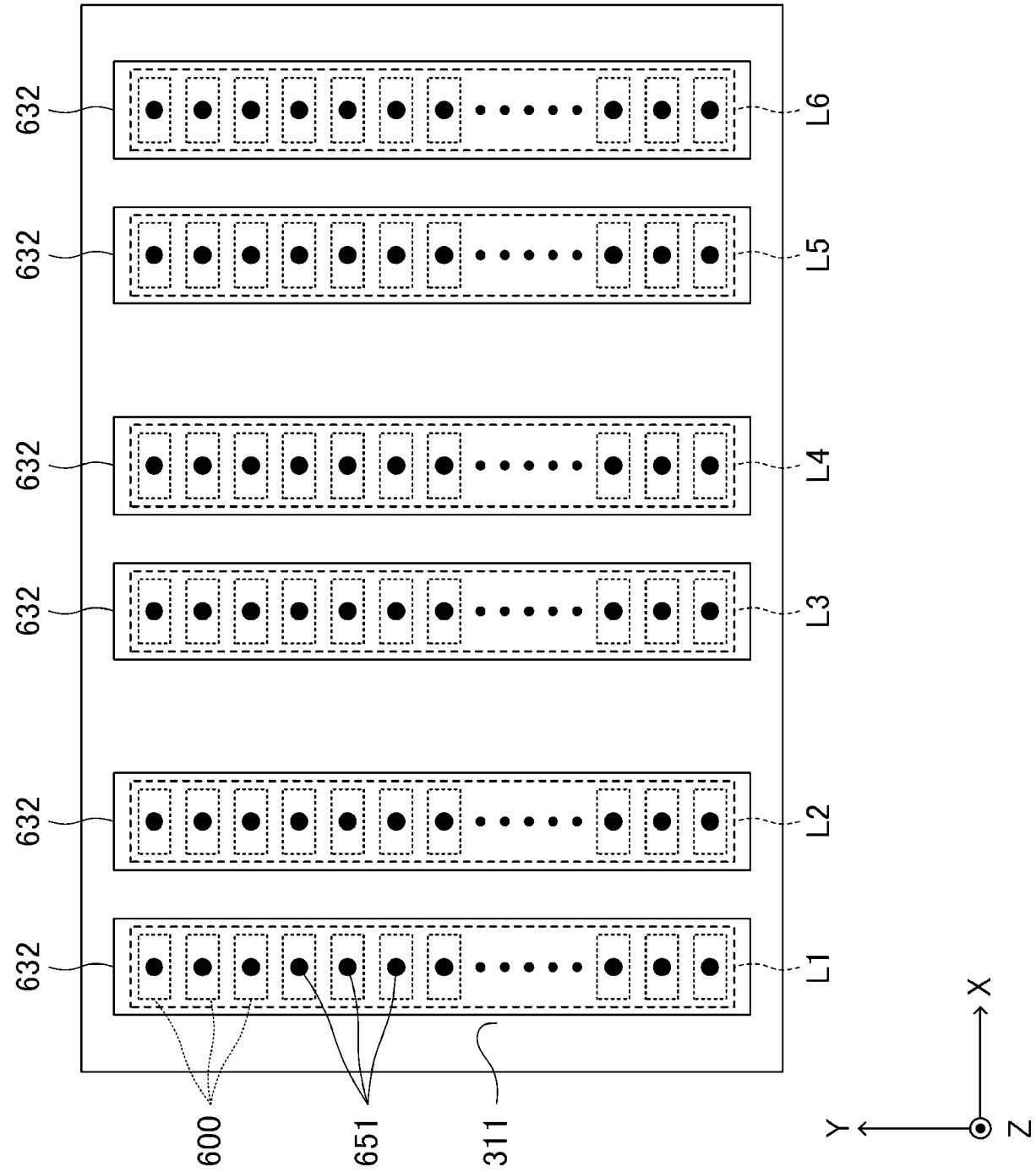


FIG. 13

FIG. 14

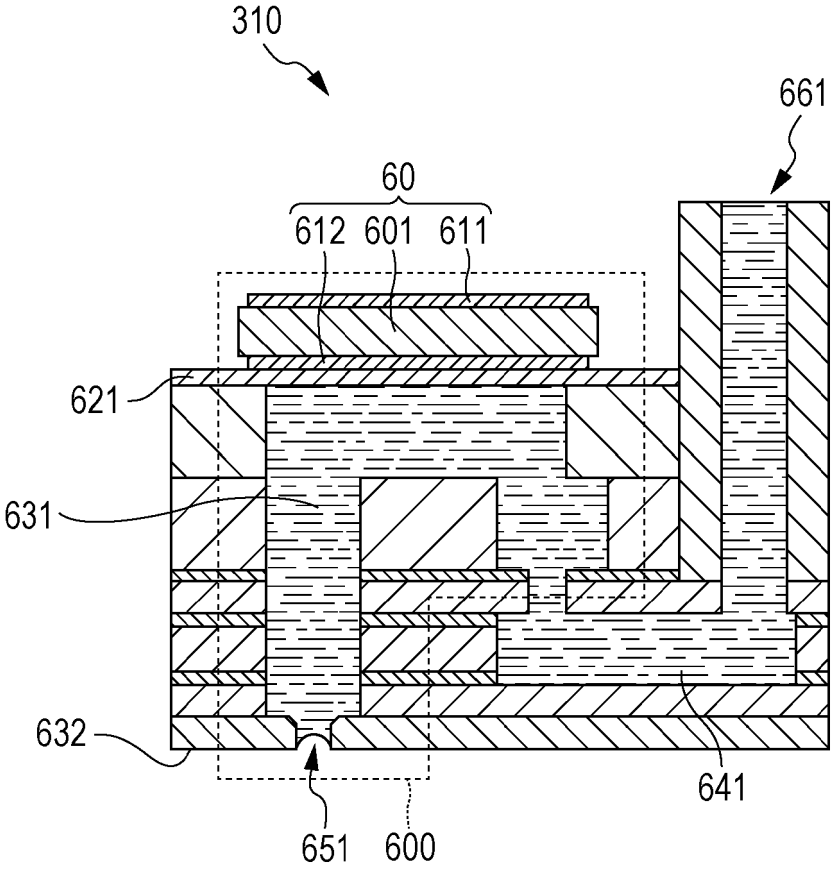


FIG. 15

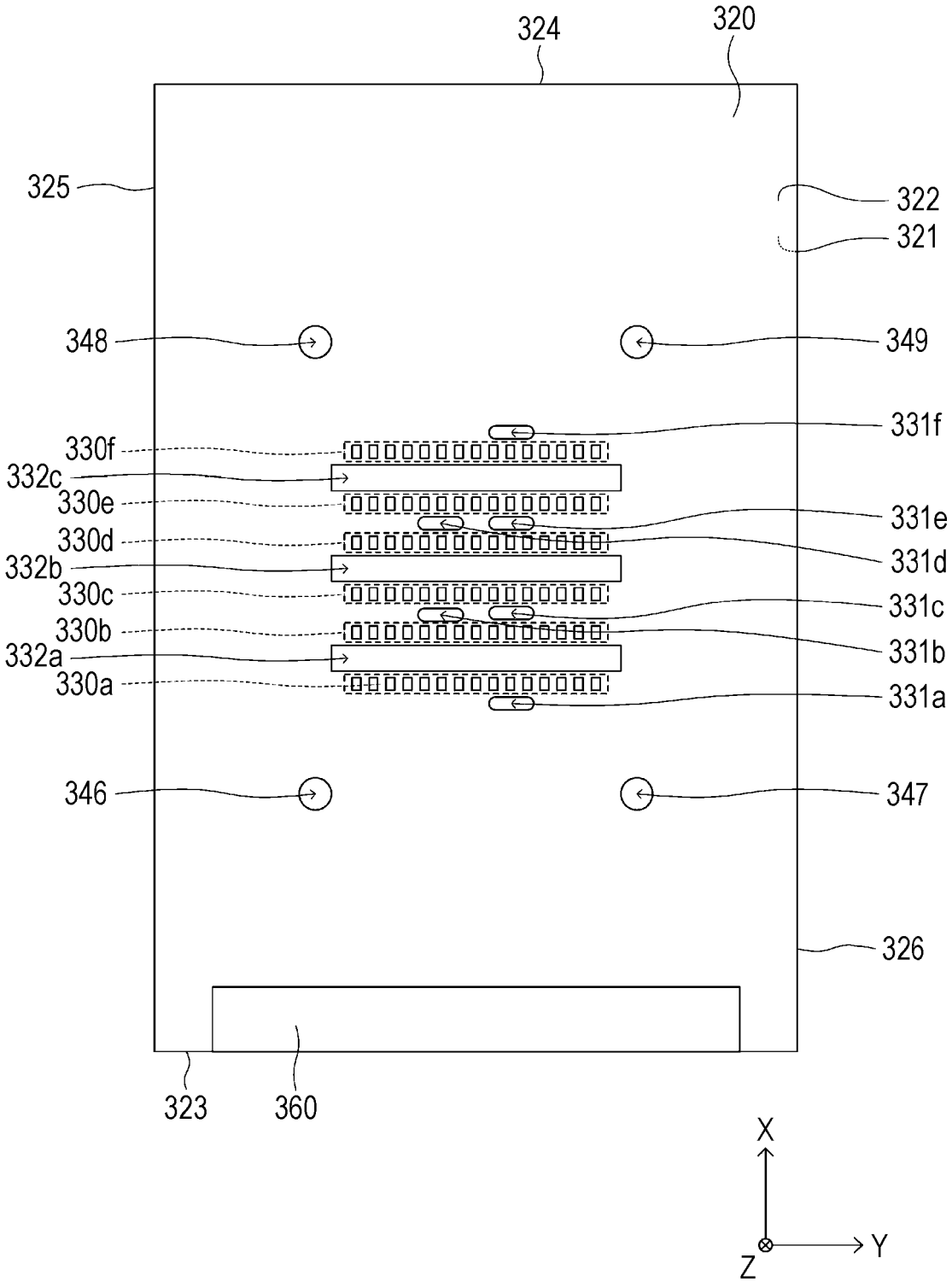

324
320
325
322
321
348
349
331f
330f
332c
330e
331e
330d
331d
332b
330c
331c
330b
331b
332a
330a
331a
346
347
326
323
360
X
Y
Z

FIG. 16

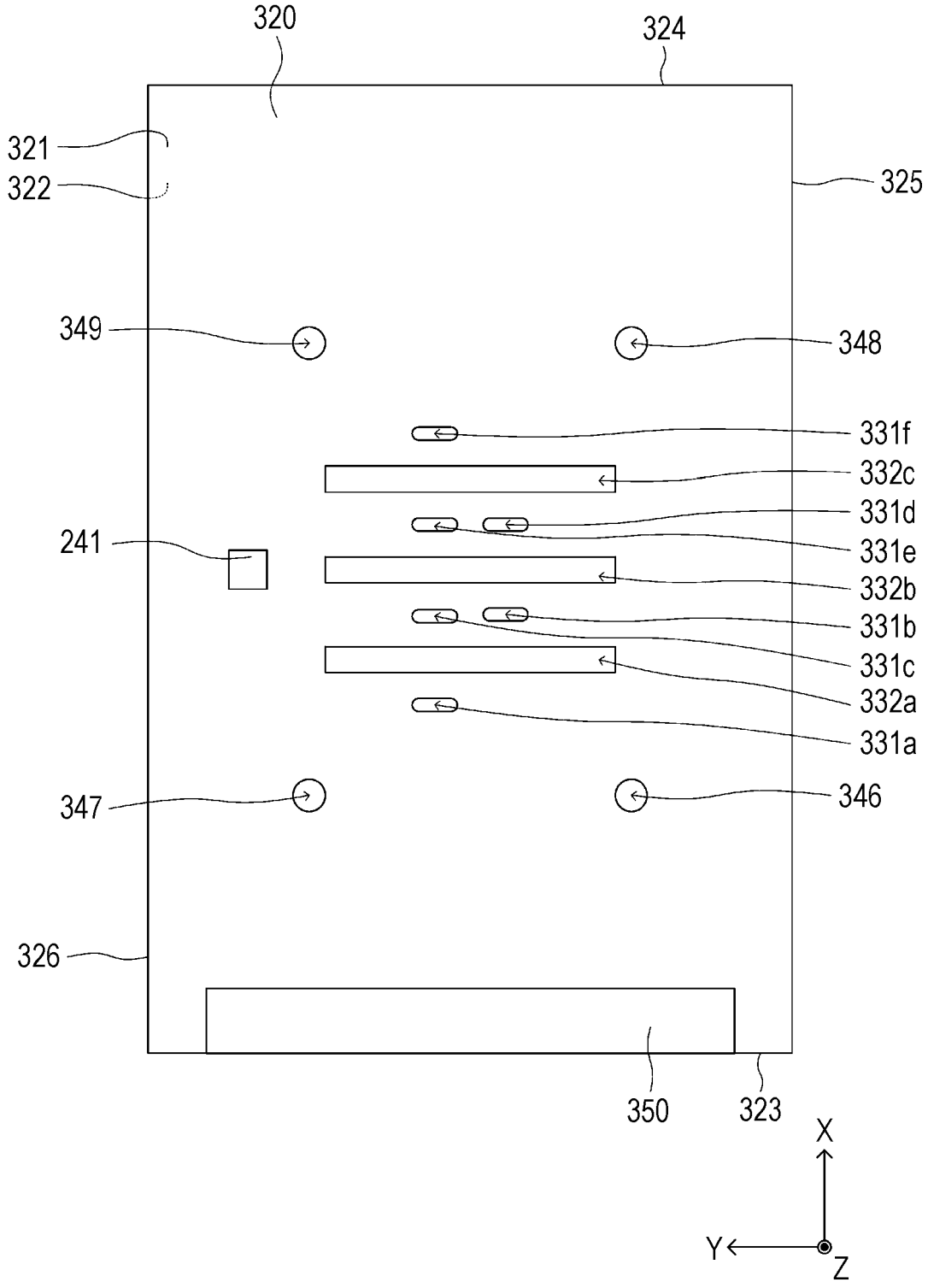

320
324
321
322
325
349
348
331f
332c
331d
241
331e
332b
331b
331c
332a
331a
347
346
326
350
323
X
Y
Z

FIG. 17

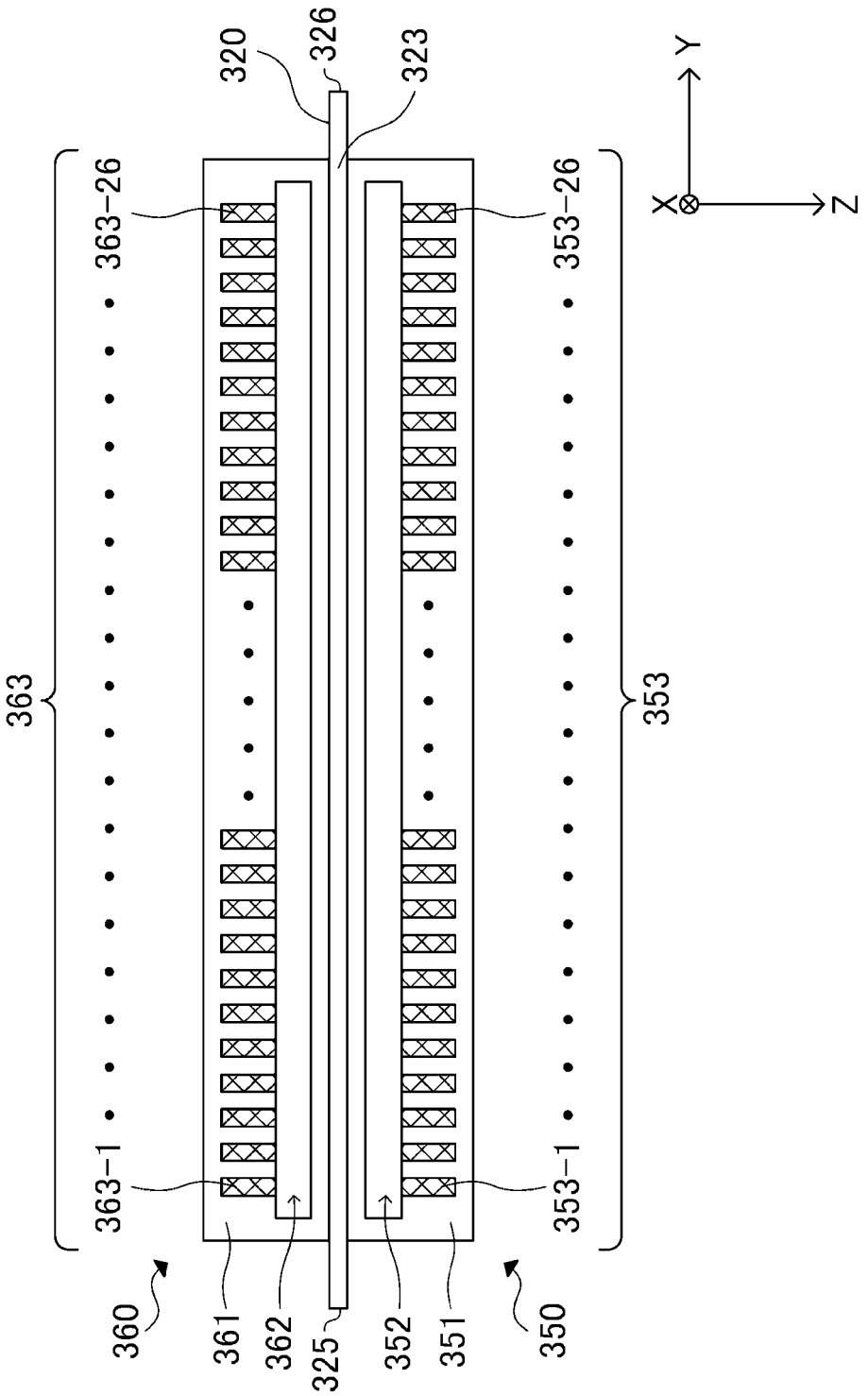

320
326
323
Y
X
Z
363
363-26
363-1
353
353-26
353-1
360
361
362
325
352
351
350

FIG. 18

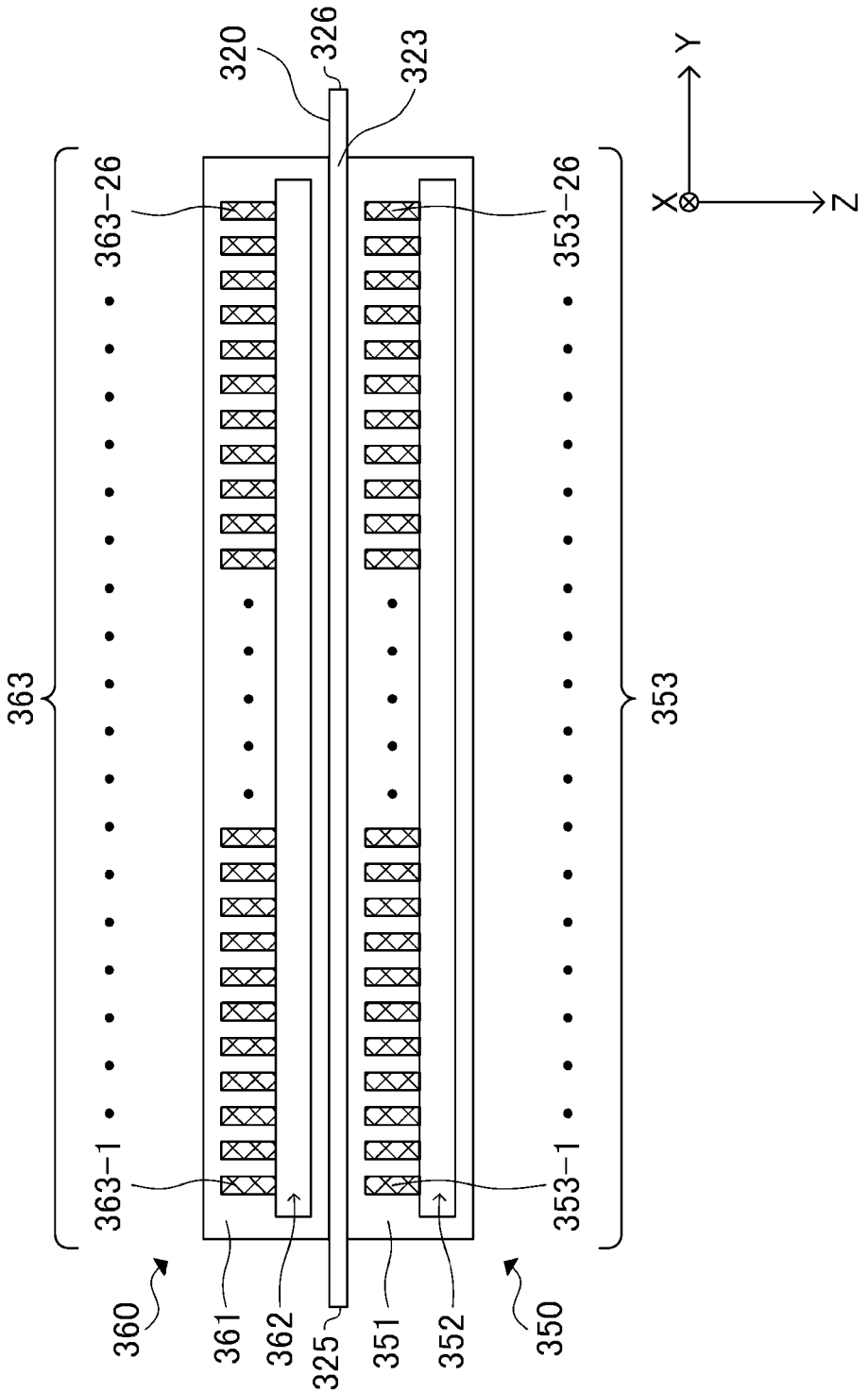

320
326
323
Y
X
Z
363
363-26
353-26
353
363-1
353-1
360
361
362
325
351
352
350

FIG. 19

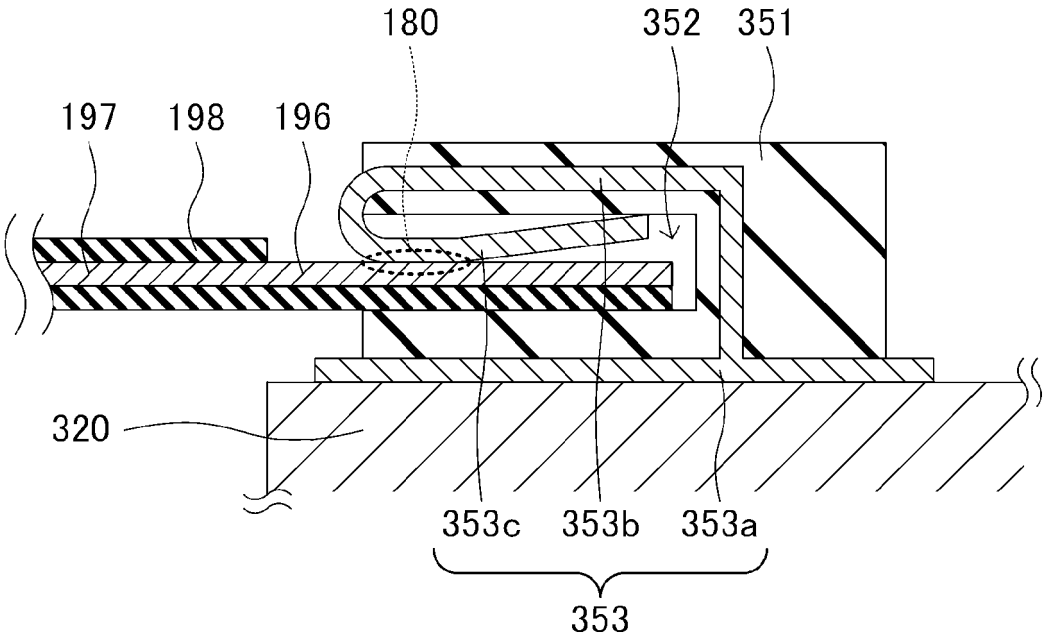


FIG. 20

CABLE 19a			CONTACT SECTION	CONNECTOR 350	SIGNAL
TERMINAL NUMBER	WIRING NUMBER	TERMINAL NUMBER		TERMINAL NUMBER	
195a-1	197a-1	196a-1	180a-1	353-1	COM6
195a-2	197a-2	196a-2	180a-2	353-2	CGND6
195a-3	197a-3	196a-3	180a-3	353-3	COM5
195a-4	197a-4	196a-4	180a-4	353-4	CGND5
195a-5	197a-5	196a-5	180a-5	353-5	COM4
195a-6	197a-6	196a-6	180a-6	353-6	CGND4
195a-7	197a-7	196a-7	180a-7	353-7	COM3
195a-8	197a-8	196a-8	180a-8	353-8	CGND3
195a-9	197a-9	196a-9	180a-9	353-9	COM2
195a-10	197a-10	196a-10	180a-10	353-10	CGND2
195a-11	197a-11	196a-11	180a-11	353-11	COM1
195a-12	197a-12	196a-12	180a-12	353-12	CGND1
195a-13	197a-13	196a-13	180a-13	353-13	VHV
195a-14	197a-14	196a-14	180a-14	353-14	GND
195a-15	197a-15	196a-15	180a-15	353-15	XHOT and DIG-E
195a-16	197a-16	196a-16	180a-16	353-16	GND
195a-17	197a-17	196a-17	180a-17	353-17	SI1 and DIG-D
195a-18	197a-18	196a-18	180a-18	353-18	GND
195a-19	197a-19	196a-19	180a-19	353-19	CH and DIG-C
195a-20	197a-20	196a-20	180a-20	353-20	GND
195a-21	197a-21	196a-21	180a-21	353-21	SCK and DIG-B
195a-22	197a-22	196a-22	180a-22	353-22	GND
195a-23	197a-23	196a-23	180a-23	353-23	LAT and DIG-A
195a-24	197a-24	196a-24	180a-24	353-24	GND
195a-25	197a-25	196a-25	180a-25	353-25	TH
195a-26	197a-26	196a-26	180a-26	353-26	GND

FIG. 21

CABLE 19b			CONTACT SECTION	CONNECTOR 360	SIGNAL
TERMINAL NUMBER	WIRING NUMBER	TERMINAL NUMBER		TERMINAL NUMBER	
195b-1	197b-1	196b-1	180b-1	363-1	CGND6
195b-2	197b-2	196b-2	180b-2	363-2	COM6
195b-3	197b-3	196b-3	180b-3	363-3	CGND5
195b-4	197b-4	196b-4	180b-4	363-4	COM5
195b-5	197b-5	196b-5	180b-5	363-5	CGND4
195b-6	197b-6	196b-6	180b-6	363-6	COM4
195b-7	197b-7	196b-7	180b-7	363-7	CGND3
195b-8	197b-8	196b-8	180b-8	363-8	COM3
195b-9	197b-9	196b-9	180b-9	363-9	CGND2
195b-10	197b-10	196b-10	180b-10	363-10	COM2
195b-11	197b-11	196b-11	180b-11	363-11	CGND1
195b-12	197b-12	196b-12	180b-12	363-12	COM1
195b-13	197b-13	196b-13	180b-13	363-13	GND
195b-14	197b-14	196b-14	180b-14	363-14	GND
195b-15	197b-15	196b-15	180b-15	363-15	GND
195b-16	197b-16	196b-16	180b-16	363-16	SI6
195b-17	197b-17	196b-17	180b-17	363-17	GND
195b-18	197b-18	196b-18	180b-18	363-18	SI5
195b-19	197b-19	196b-19	180b-19	363-19	GND
195b-20	197b-20	196b-20	180b-20	363-20	SI4
195b-21	197b-21	196b-21	180b-21	363-21	VDD2
195b-22	197b-22	196b-22	180b-22	363-22	SI3
195b-23	197b-23	196b-23	180b-23	363-23	GND
195b-24	197b-24	196b-24	180b-24	363-24	SI2
195b-25	197b-25	196b-25	180b-25	363-25	GND
195b-26	197b-26	196b-26	180b-26	363-26	VDD1

FIG. 22

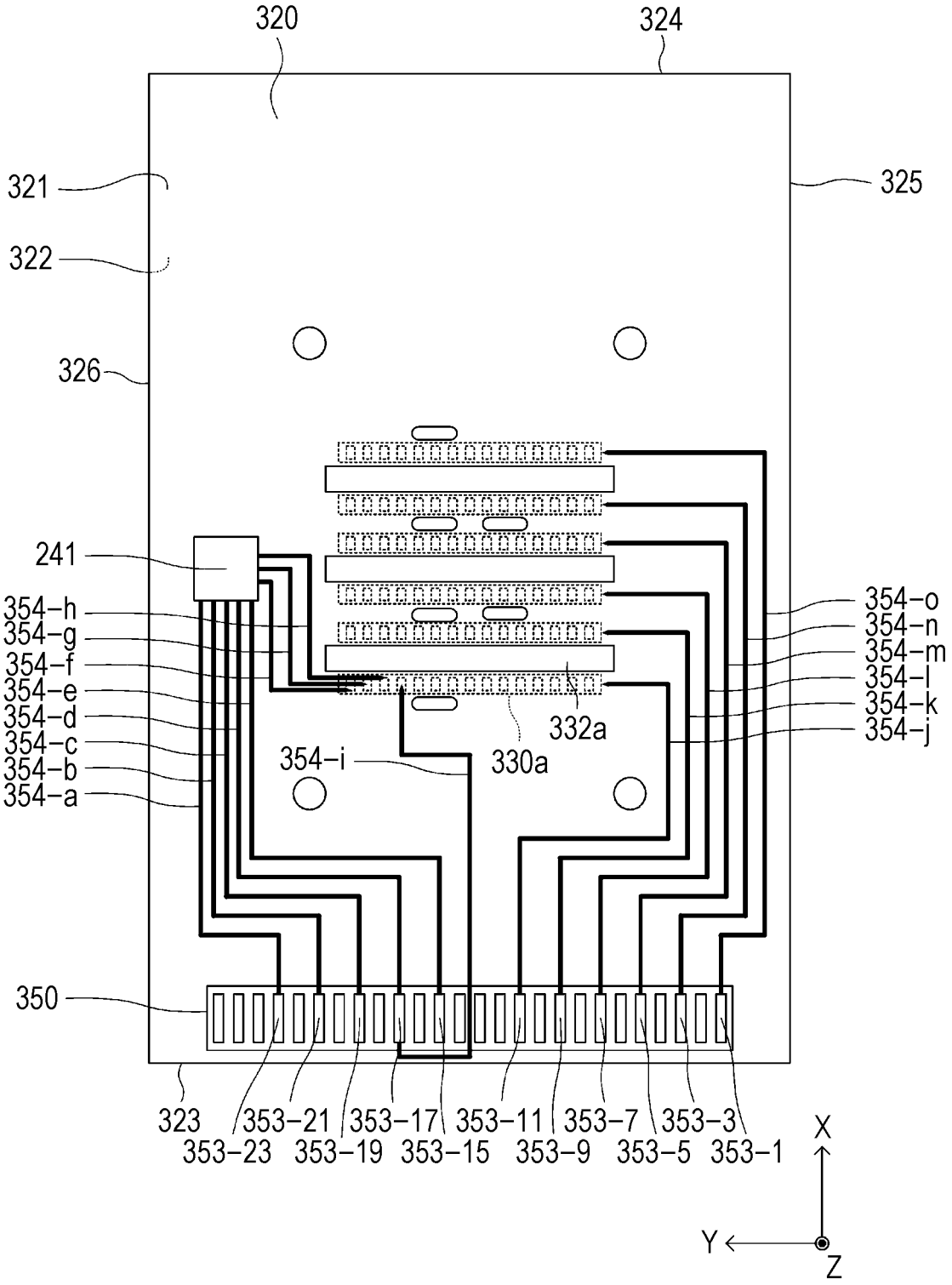

320
324
321
325
322
326
241
354-h
354-g
354-f
354-e
354-d
354-c
354-b
354-a
354-i
330a
332a
354-o
354-n
354-m
354-l
354-k
354-j
350
323
353-23
353-21
353-19
353-17
353-15
353-11
353-9
353-7
353-5
353-3
353-1
X
Y
Z

FIG. 23

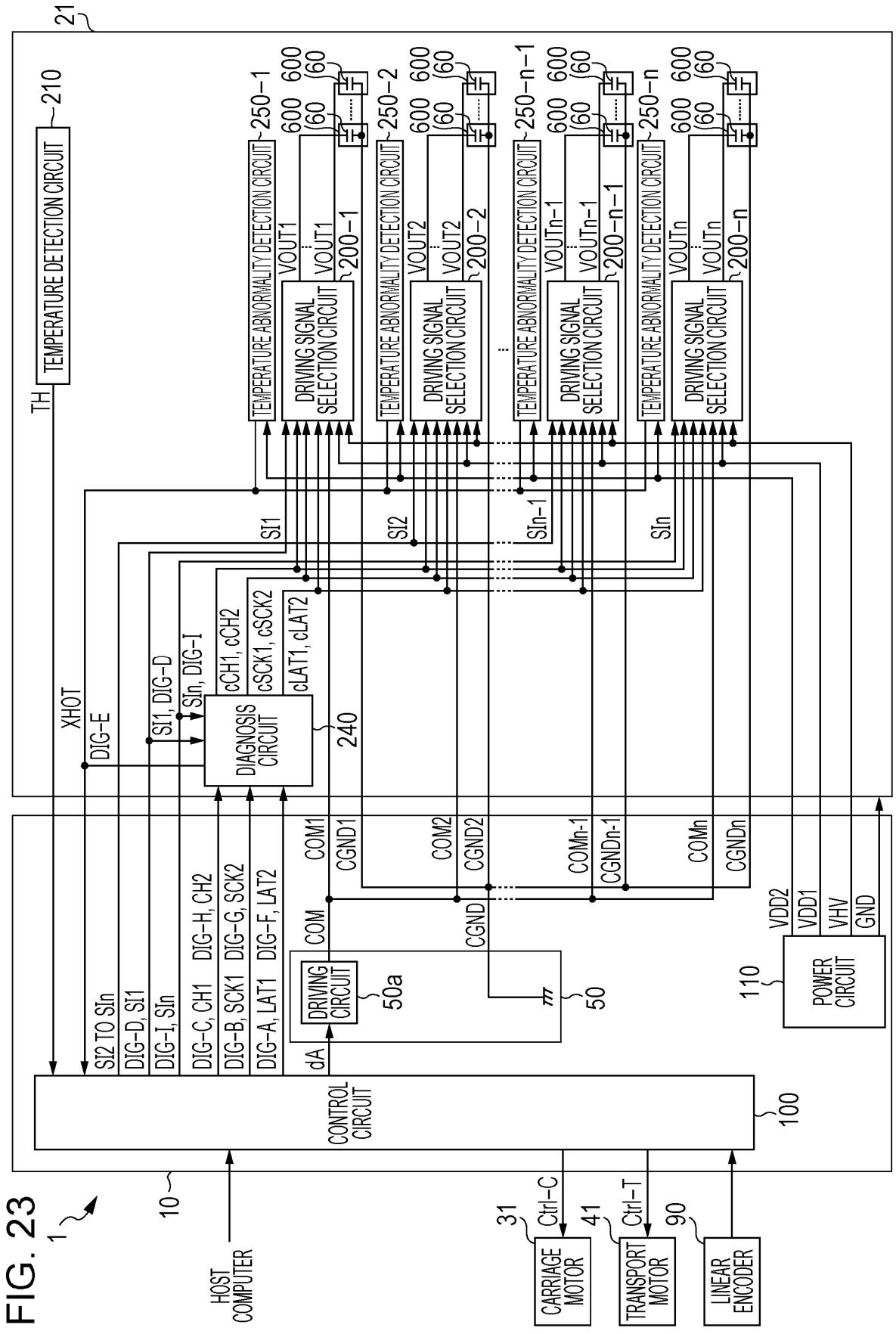

1
10
21
100
110
210
240
250-1
250-2
250-n-1
250-n
200-1
200-2
200-n-1
200-n
600
60
50
50a
31
41
90
TH
TEMPERATURE DETECTION CIRCUIT
TEMPERATURE ABNORMALITY DETECTION CIRCUIT
DRIVING SIGNAL SELECTION CIRCUIT
VOUT1
VOUT2
VOUTn-1
VOUTn
SI1
SI2
SIn-1
SIn
XHOT
DIG-E
SI1, DIG-D
SIn, DIG-I
DIAGNOSIS CIRCUIT
cCH1, cCH2
cSCK1, cSCK2
cLAT1, cLAT2
SI2 TO SIn
DIG-D, SI1
DIG-I, SIn
DIG-C, CH1
DIG-H, CH2
DIG-B, SCK1
DIG-G, SCK2
DIG-A, LAT1
DIG-F, LAT2
CONTROL CIRCUIT
dA
DRIVING CIRCUIT
COM
COM1
COM2
COMn-1
COMn
CGND
CGND1
CGND2
CGNDn-1
CGNDn
VDD2
VDD1
VHV
GND
POWER CIRCUIT
HOST COMPUTER
Ctrl-C
Ctrl-T
CARRIAGE MOTOR
TRANSPORT MOTOR
LINEAR ENCODER

FIG. 24

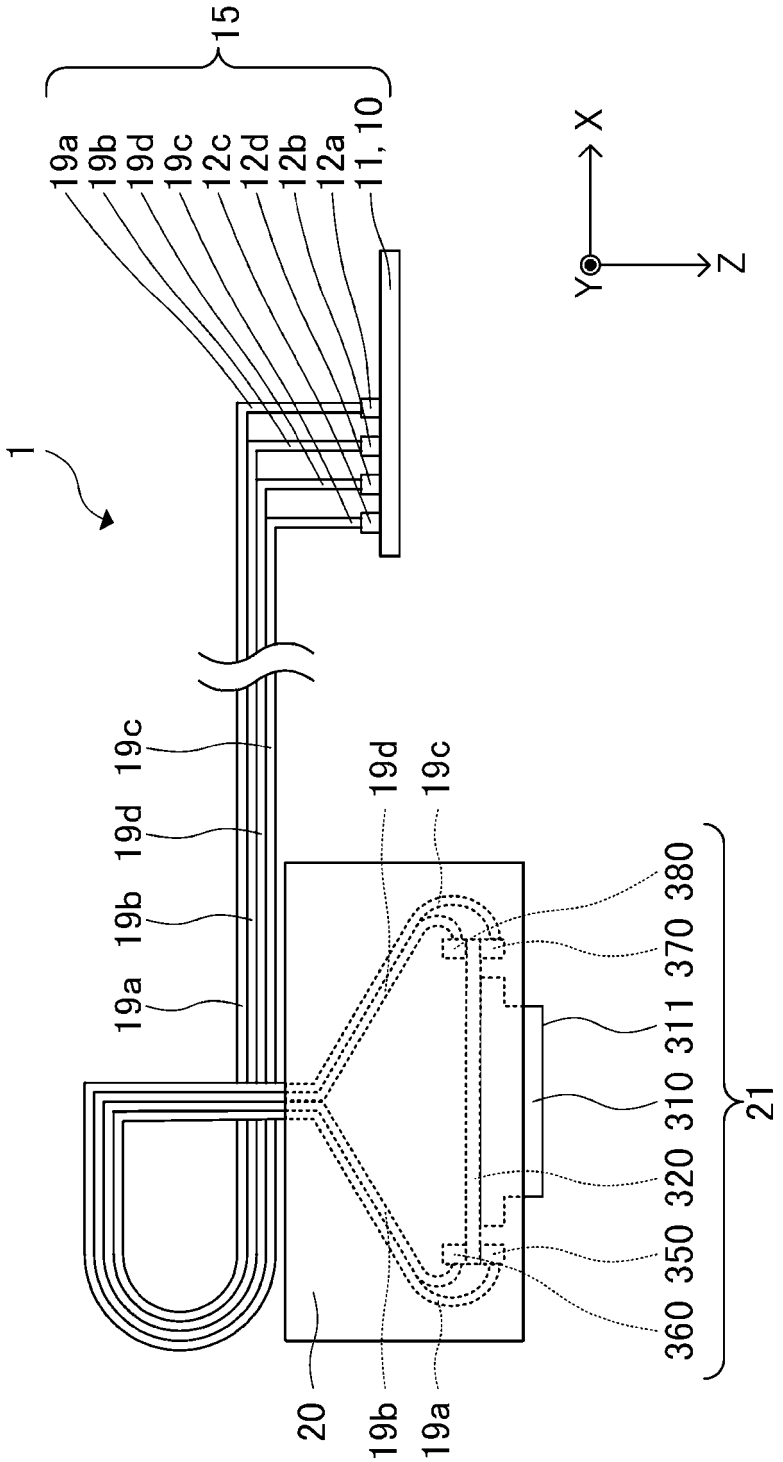

15
19a
19b
19d
19c
12c
12d
12b
12a
11, 10
X
Y
Z
1
19c
19d
19b
19a
19d
19c
380
370
311
310
320
350
360
21
20
19b
19a

FIG. 25

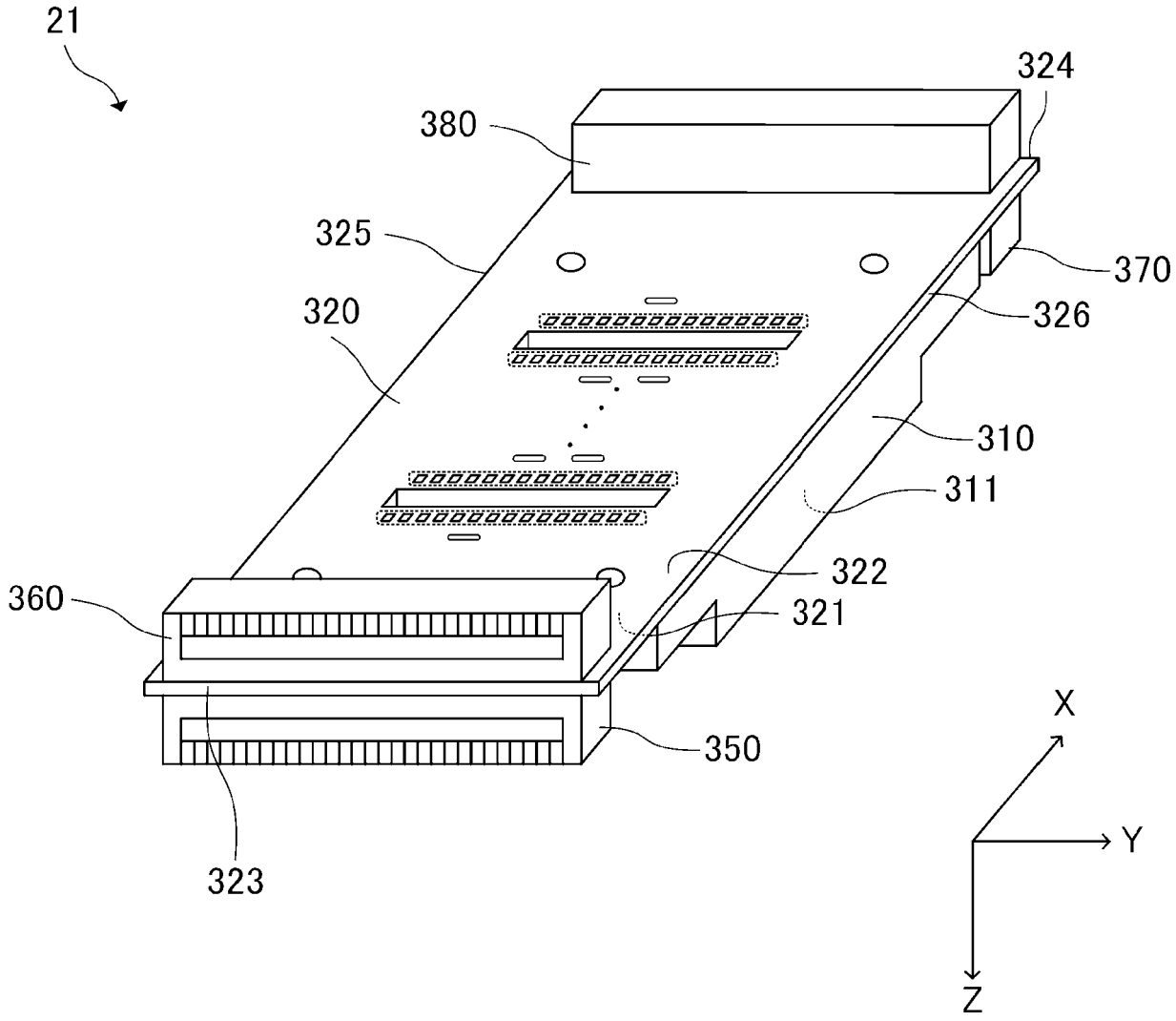


FIG. 26

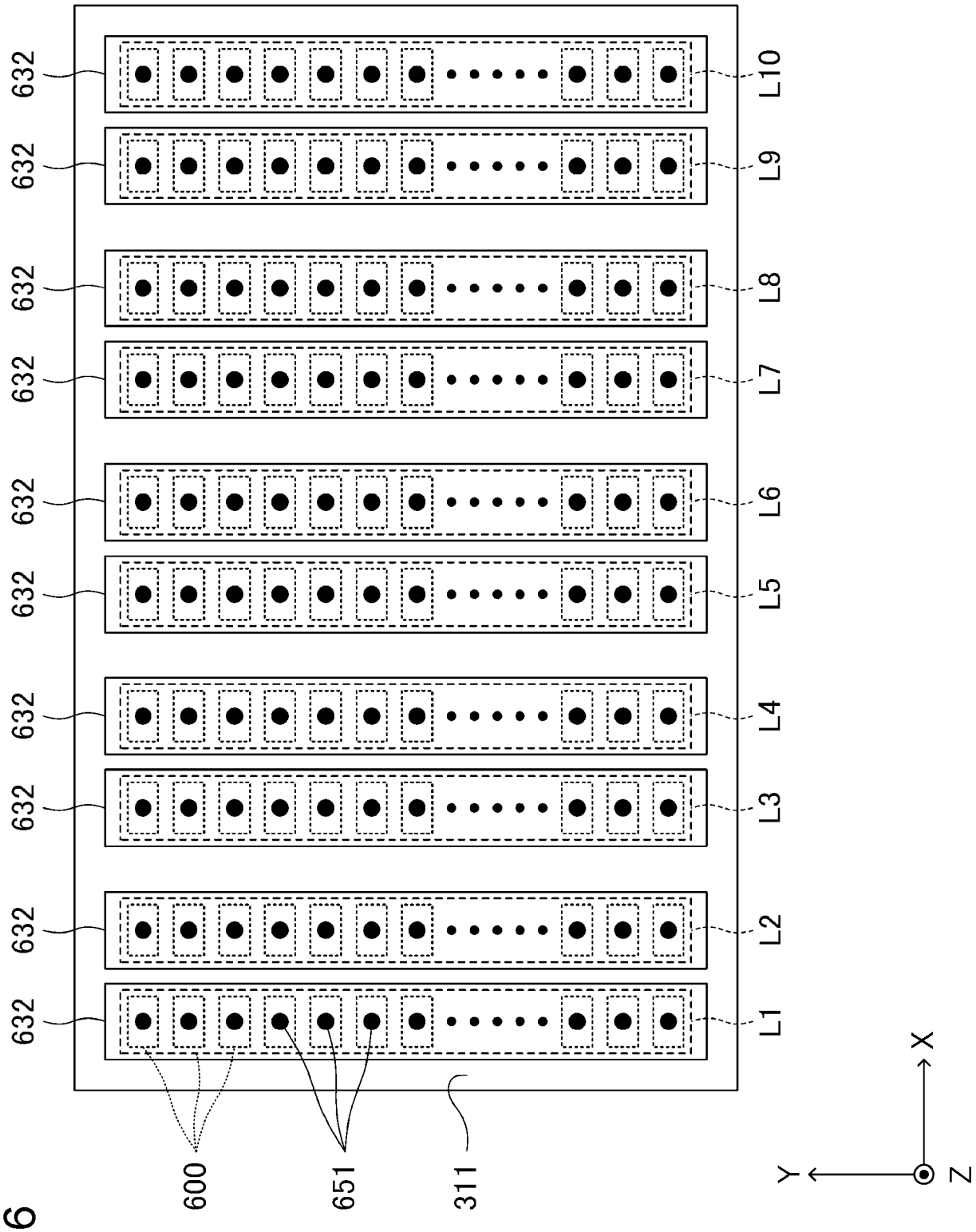


FIG. 27

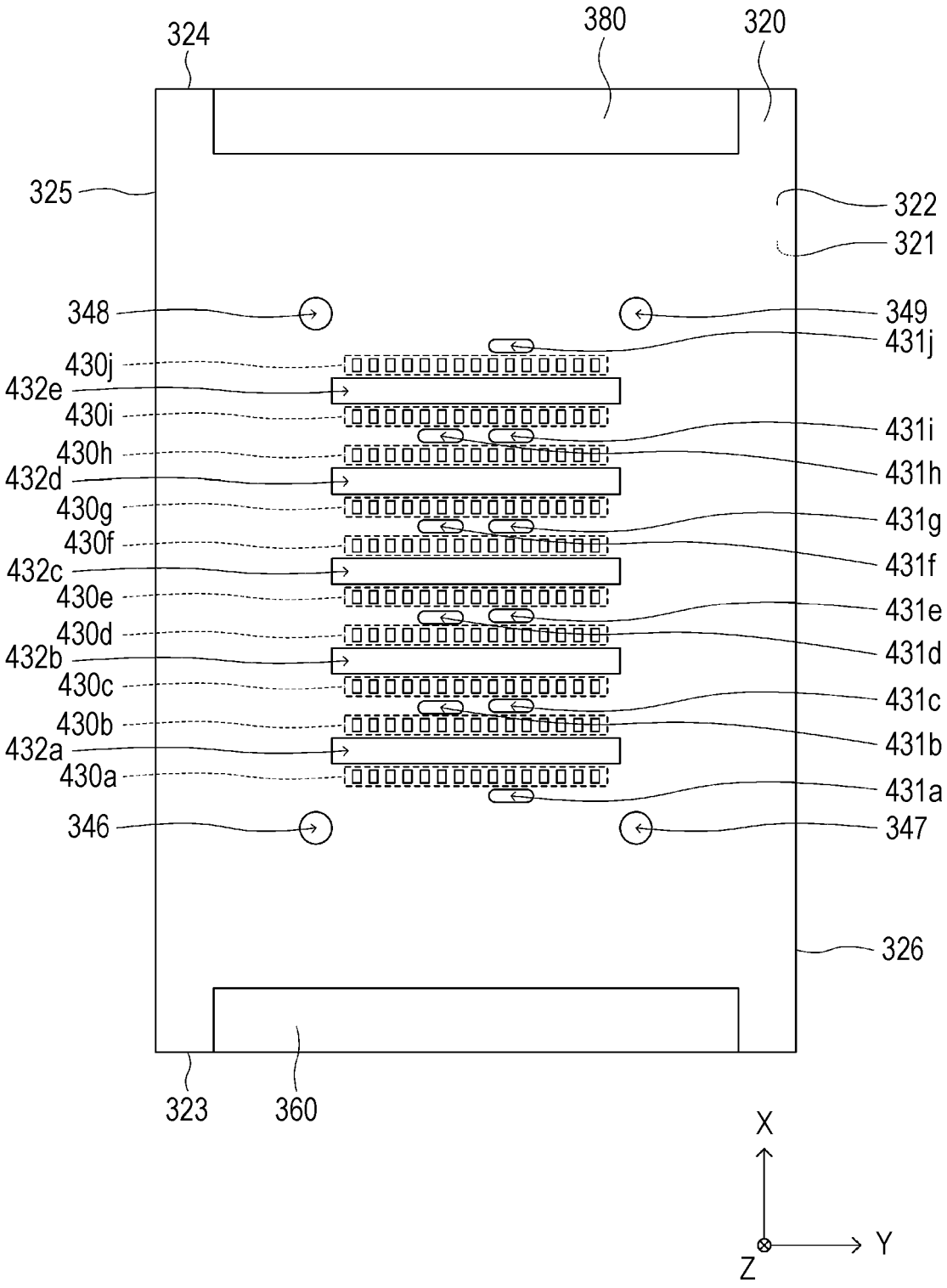

324
380
320
325
322
321
348
349
431j
430j
432e
430i
431i
430h
431h
432d
430g
431g
430f
431f
432c
430e
431e
430d
431d
432b
430c
431c
430b
431b
432a
430a
431a
346
347
326
323
360
X
Y
Z

FIG. 28

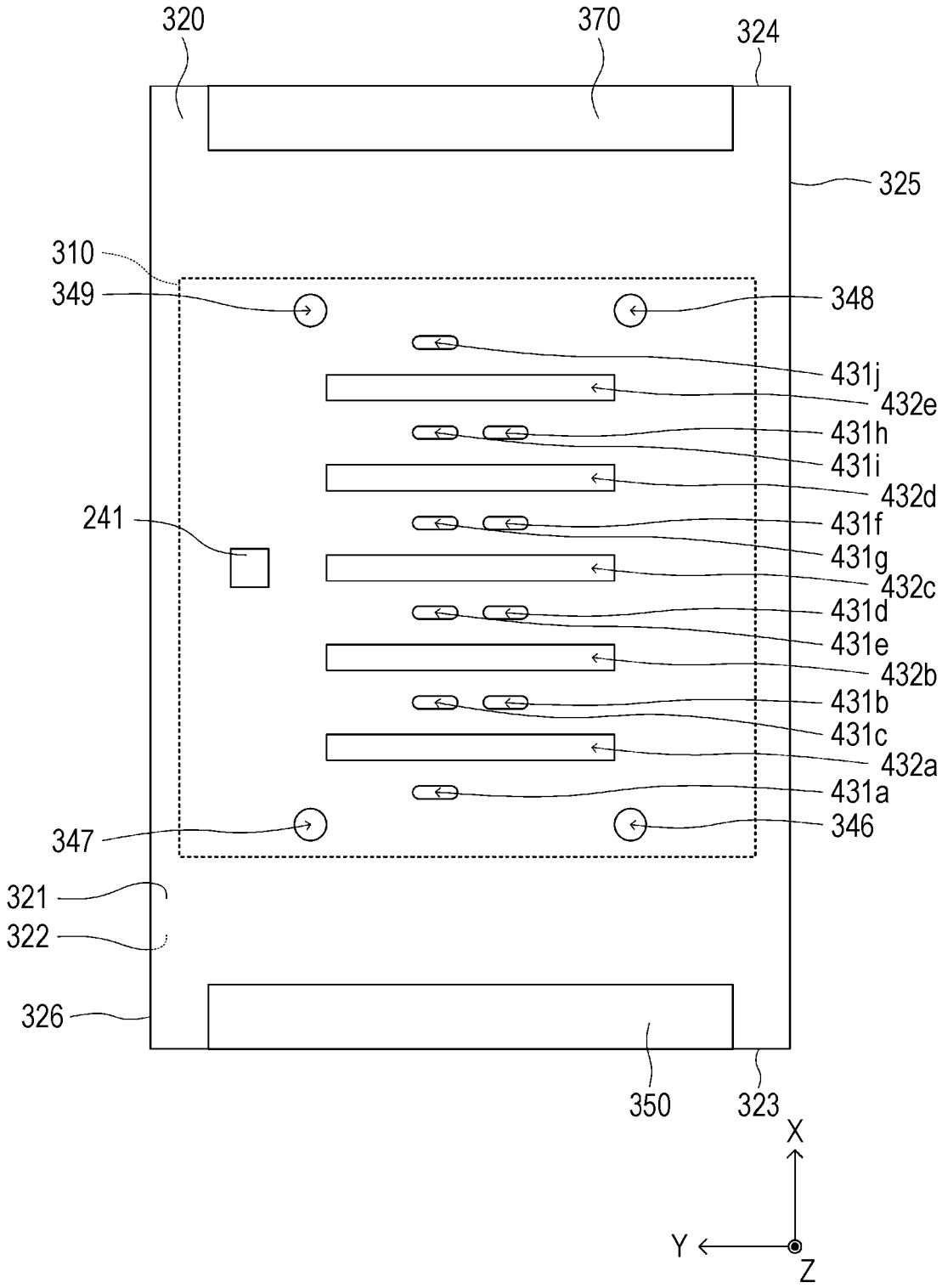

320
370
324
325
310
349
348
431j
432e
431h
431i
432d
241
431f
431g
432c
431d
431e
432b
431b
431c
432a
431a
347
346
321
322
326
350
323
X
Y
Z

FIG. 29

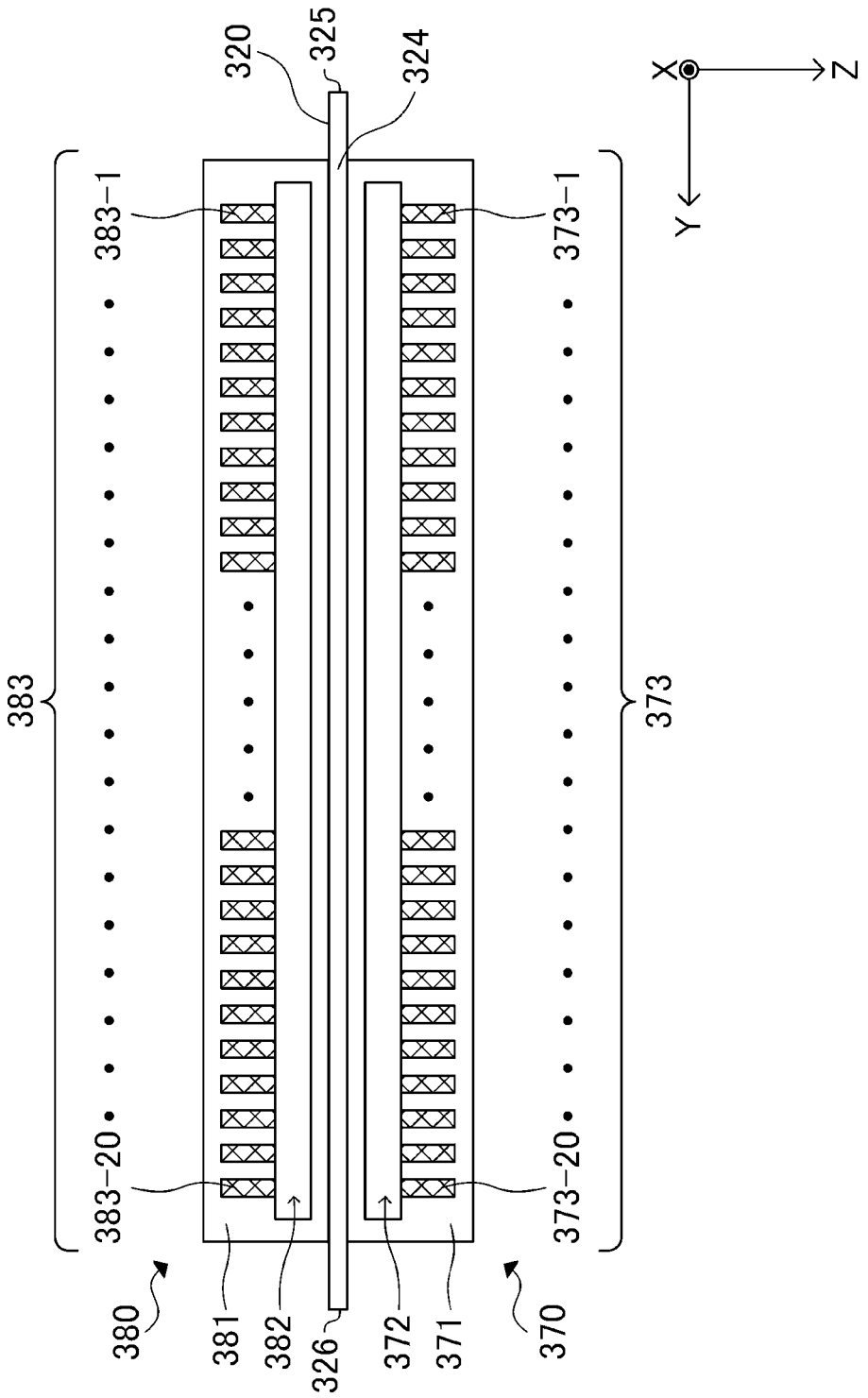

320
325
324
X
Z
Y
383
383-1
383-20
373
373-1
373-20
380
381
382
326
372
371
370

FIG. 30

CABLE 19a			CONTACT SECTION	CONNECTOR 350	SIGNAL
TERMINAL NUMBER	WIRING NUMBER	TERMINAL NUMBER		TERMINAL NUMBER	
195a-1	197a-1	196a-1	180a-1	353-1	COM5
195a-2	197a-2	196a-2	180a-2	353-2	CGND5
195a-3	197a-3	196a-3	180a-3	353-3	COM4
195a-4	197a-4	196a-4	180a-4	353-4	CGND4
195a-5	197a-5	196a-5	180a-5	353-5	COM3
195a-6	197a-6	196a-6	180a-6	353-6	CGND3
195a-7	197a-7	196a-7	180a-7	353-7	COM2
195a-8	197a-8	196a-8	180a-8	353-8	CGND2
195a-9	197a-9	196a-9	180a-9	353-9	COM1
195a-10	197a-10	196a-10	180a-10	353-10	CGND1
195a-11	197a-11	196a-11	180a-11	353-11	SI1 and DIG-D
195a-12	197a-12	196a-12	180a-12	353-12	GND
195a-13	197a-13	196a-13	180a-13	353-13	CH1 and DIG-C
195a-14	197a-14	196a-14	180a-14	353-14	GND
195a-15	197a-15	196a-15	180a-15	353-15	SCK1 and DIG-B
195a-16	197a-16	196a-16	180a-16	353-16	GND
195a-17	197a-17	196a-17	180a-17	353-17	LAT1 and DIG-A
195a-18	197a-18	196a-18	180a-18	353-18	GND
195a-19	197a-19	196a-19	180a-19	353-19	TH
195a-20	197a-20	196a-20	180a-20	353-20	GND

FIG. 31

CABLE 19b			CONTACT SECTION	CONNECTOR 360	SIGNAL
TERMINAL NUMBER	WIRING NUMBER	TERMINAL NUMBER		TERMINAL NUMBER	
195b-1	197b-1	196b-1	180b-1	363-1	CGND5
195b-2	197b-2	196b-2	180b-2	363-2	COM5
195b-3	197b-3	196b-3	180b-3	363-3	CGND4
195b-4	197b-4	196b-4	180b-4	363-4	COM4
195b-5	197b-5	196b-5	180b-5	363-5	CGND3
195b-6	197b-6	196b-6	180b-6	363-6	COM3
195b-7	197b-7	196b-7	180b-7	363-7	CGND2
195b-8	197b-8	196b-8	180b-8	363-8	COM2
195b-9	197b-9	196b-9	180b-9	363-9	CGND1
195b-10	197b-10	196b-10	180b-10	363-10	COM1
195b-11	197b-11	196b-11	180b-11	363-11	GND
195b-12	197b-12	196b-12	180b-12	363-12	SI5
195b-13	197b-13	196b-13	180b-13	363-13	GND
195b-14	197b-14	196b-14	180b-14	363-14	SI4
195b-15	197b-15	196b-15	180b-15	363-15	GND
195b-16	197b-16	196b-16	180b-16	363-16	SI3
195b-17	197b-17	196b-17	180b-17	363-17	GND
195b-18	197b-18	196b-18	180b-18	363-18	SI2
195b-19	197b-19	196b-19	180b-19	363-19	GND
195b-20	197b-20	196b-20	180b-20	363-20	VDD1

FIG. 32

CABLE 19c			CONTACT SECTION	CONNECTOR 370	SIGNAL
TERMINAL NUMBER	WIRING NUMBER	TERMINAL NUMBER		TERMINAL NUMBER	
195c-1	197c-1	196c-1	180c-1	373-1	CGND6
195c-2	197c-2	196c-2	180c-2	373-2	COM6
195c-3	197c-3	196c-3	180c-3	373-3	CGND7
195c-4	197c-4	196c-4	180c-4	373-4	COM7
195c-5	197c-5	196c-5	180c-5	373-5	CGND8
195c-6	197c-6	196c-6	180c-6	373-6	COM8
195c-7	197c-7	196c-7	180c-7	373-7	CGND9
195c-8	197c-8	196c-8	180c-8	373-8	COM9
195c-9	197c-9	196c-9	180c-9	373-9	CGND10
195c-10	197c-10	196c-10	180c-10	373-10	COM10
195c-11	197c-11	196c-11	180c-11	373-11	GND
195c-12	197c-12	196c-12	180c-12	373-12	XHOT and DIG-E
195c-13	197c-13	196c-13	180c-13	373-13	GND
195c-14	197c-14	196c-14	180c-14	373-14	LAT2 and DIG-F
195c-15	197c-15	196c-15	180c-15	373-15	GND
195c-16	197c-16	196c-16	180c-16	373-16	SCK2 and DIG-G
195c-17	197c-17	196c-17	180c-17	373-17	GND
195c-18	197c-18	196c-18	180c-18	373-18	CH2 and DIG-H
195c-19	197c-19	196c-19	180c-19	373-19	GND
195c-20	197c-20	196c-20	180c-20	373-20	SI10 and DIGI

FIG. 33

CABLE 19d			CONTACT SECTION	CONNECTOR 380	SIGNAL
TERMINAL NUMBER	WIRING NUMBER	TERMINAL NUMBER		TERMINAL NUMBER	
195d-1	197d-1	196d-1	180d-1	383-1	COM6
195d-2	197d-2	196d-2	180d-2	383-2	CGND6
195d-3	197d-3	196d-3	180d-3	383-3	COM7
195d-4	197d-4	196d-4	180d-4	383-4	CGND7
195d-5	197d-5	196d-5	180d-5	383-5	COM8
195d-6	197d-6	196d-6	180d-6	383-6	CGND8
195d-7	197d-7	196d-7	180d-7	383-7	COM9
195d-8	197d-8	196d-8	180d-8	383-8	CGND9
195d-9	197d-9	196d-9	180d-9	383-9	COM10
195d-10	197d-10	196d-10	180d-10	383-10	CGND10
195d-11	197d-11	196d-11	180d-11	383-11	VHV
195d-12	197d-12	196d-12	180d-12	383-12	GND
195d-13	197d-13	196d-13	180d-13	383-13	SI6
195d-14	197d-14	196d-14	180d-14	383-14	GND
195d-15	197d-15	196d-15	180d-15	383-15	SI7
195d-16	197d-16	196d-16	180d-16	383-16	VDD2
195d-17	197d-17	196d-17	180d-17	383-17	SI8
195d-18	197d-18	196d-18	180d-18	383-18	GND
195d-19	197d-19	196d-19	180d-19	383-19	SI9
195d-20	197d-20	196d-20	180d-20	383-20	GND

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20140247299 A **[0002]**
- US 20170173950 A **[0002]**
- WO 2017111065 A **[0002]**
- JP 2017114020 A **[0003] [0004]**