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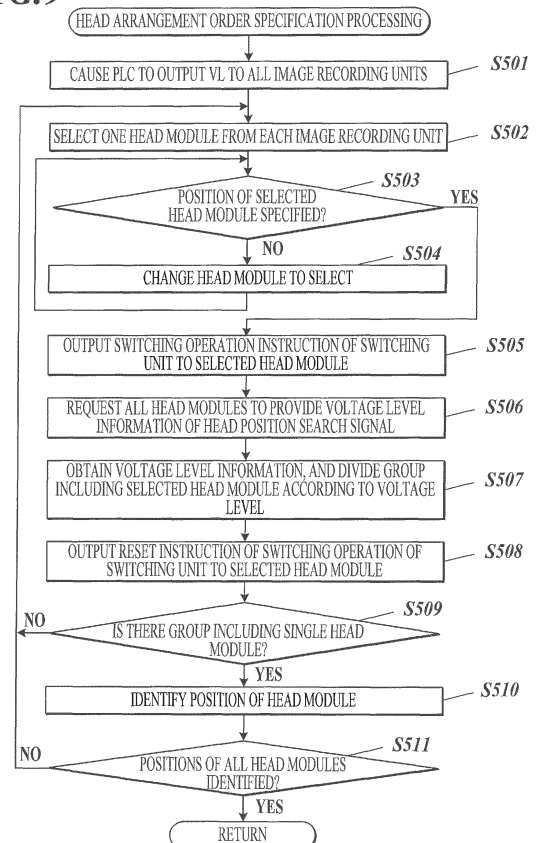
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(54) **IMAGE RECORDING CONTROL APPARATUS, IMAGE RECORDING APPARATUS, AND METHOD FOR IDENTIFYING ARRANGEMENT OF RECORDING OPERATION UNITS**

(57) Provided are an image recording control apparatus, an image recording apparatus, and a method for identifying the arrangement of recording operation units which make it possible to easily and appropriately make a setting concerning the operation control of a plurality of recording operation units. The image recording control apparatus is provided with: a prescribed number of driving units each of which drives a prescribed number of recording operation units, where said prescribed number is at least two; a control unit; a first signal path that connects the control unit and each of the driving units in parallel; and a second signal path via which a control signal input from an input end can be transmitted to the driving units in an arranged order of the recording operation units. The driving units other than the last driving unit in the arranged order have a switching unit that switches between whether or not the control signal input from the input end can be output to a downstream side. The control unit acquires from the first signal path an input status of the control signal to each of the driving units according to a switching state, identifies the arrangement of the recording operation units, and outputs a recording control signal based on the content of a recording operation according to the arrangement to the driving units through the first signal path.

FIG.9



Description

TECHNOLOGICAL FIELD

[0001] The present invention relates to an image recording control apparatus, an image recording apparatus, and a method for identifying arrangement of recording operation units.

DESCRIPTION OF THE RELATED ART

[0002] There have been conventionally image recording apparatuses which each arrange a plurality of recording elements and record an image on recording mediums by controlling the image recording operation of each of the recording elements. Such image recording apparatuses can improve the recording speed by increasing the number of recording elements and enabling the image recording operation for a wider range at once. For such image recording apparatuses, there is a technique of decreasing the trouble and cost caused by the generation of defects of recording elements and improving the efficiency by arranging a plurality of recording heads in each of which a predetermined number of recording elements are arranged, and enabling separate adjustment and replacement of each of the recording heads.

[0003] In order to record images at high speed in an image recording apparatus which arranges, in such a way, a plurality of recording heads or a plurality of recording operation units each of which is a unit of one or a plurality of recording heads, it is necessary to input image data, that is, a drive signal of each recording head to each of the recording operation units from a print server or the like at high speed. Patent document 1 discloses a technique of providing a bypass path of data to a plurality of drive substrates connected in series, inputting serial data including the drive signal of each drive substrate from a control substrate simultaneously in a parallel manner, and extracting the data part corresponding to the identification number of each drive substrate in the drive substrate to perform the drive operation.

[0004] On the other hand, a synchronization signal, a predetermined drive voltage, a ground voltage and the like, for which a same signal (voltage) is supplied to each recording operation unit and drive substrate, are transmitted from a single supply source to each recording operation unit and drive substrate separately.

PRIOR ART DOCUMENTS

PATENT DOCUMENT

[0005] Patent Document 1: Japanese Patent Application Laid Open Publication No. 2008-12909

SUMMARY

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] However, in order to extract image data for an appropriate portion corresponding to the arrangement of each recording operation unit in a plurality of recording operation units, it is necessary to have information regarding the relative positional relationship between each recording operation unit and the other recording operation units. This relative positional information such as the arrangement order of recording operation units and relative coordinates is obtained by using a DIP switch or the like for a user of the image recording apparatus to perform manual setting, and acquiring, with a print server, the signal corresponding to the setting of the DIP switch from the driver or the like which drives each recording operation unit. Since such setting bothers the user, there is a problem that error easily occurs especially in a case where a large number of recording operation units are provided and in a case where the recording operation units are partially replaced.

[0007] An object of the present invention is to provide an image recording control apparatus, an image recording apparatus and a method for identifying the arrangement of recording operation units which can perform setting regarding the operation control of a plurality of recording operation units easily and appropriately without requiring addition or change of a large configuration.

MEANS FOR SOLVING THE PROBLEM

[0008] In order to achieve the above object, the invention described in claim 1 is an image recording control apparatus, including: a predetermined number of driving units which respectively drive the predetermined number of recording operation units which perform a recording operation by a plurality of recording elements, the predetermined number being two or more; a control unit which performs a control operation of the predetermined number of driving units based on a content of the recording operation; a first signal path which connects the control unit and the predetermined number of driving units in parallel; and a second signal path through which a control signal is input from an input end to the driving unit that is uppermost in an order determined according to arrangement of the predetermined number of recording operation units among the predetermined number of driving units, and which connects the predetermined number of driving units to each other so that the control signal is transmitted in the order to the driving unit that is lowermost in the order, wherein at least an upstream side driving unit from the uppermost driving unit to the driving unit which is connected immediately above the lowermost driving unit among the predetermined number of driving units has a switching unit which switches whether or not to output the control signal transmitted through the second signal path from an input end side to a downstream

side opposite to the input end side, the control unit identifies the arrangement of the predetermined number of recording operation units by obtaining, through the first signal path, information regarding an input status of the control signal to at least the upstream side driving unit through the second signal path corresponding to a switching state of the switching unit, and the control unit outputs a recording control signal based on the content of the recording operation corresponding to the arrangement to each of the predetermined number of driving units through the first signal path.

[0009] The invention described in claim 2 is the image recording control apparatus described in claim 1, wherein the control unit sets and controls the switching state by the switching unit, and obtains the information regarding the input status of the control signal through the first signal path for each setting pattern of the switching state.

[0010] The invention described in claim 3 is the image recording control apparatus described in claim 1 or 2, wherein, when a first control signal input from the input end side is not output to the downstream side, the switching unit outputs a second control signal to the downstream side.

[0011] The invention described in claim 4 is the image recording control apparatus described in claim 3, wherein the control unit identifies the arrangement of the predetermined number of recording operation units by causing each of the switching unit to perform switching in order in a state in which the first control signal different from the second control signal determined in advance is input from the input end, and obtaining a type of the control signal input to each of at least the upstream side driving unit as the information regarding the input status from at least the upstream side driving unit through the first signal path.

[0012] The invention described in claim 5 is the image recording control apparatus described in claim 3 or 4, wherein the first control signal is a predetermined constant voltage signal, and the second control signal is a constant voltage signal of a voltage different from the first control signal.

[0013] The invention described in claim 6 is the image recording control apparatus described in claim 1 or 2, wherein, when a first control signal input from the input end side is not output to the downstream side, the switching unit does not output the control signal to the downstream side of the switching unit.

[0014] The invention described in claim 7 is the image recording control apparatus described in claim 6, wherein the control unit identifies the arrangement of the predetermined number of recording operation units by causing each of the switching unit to perform switching in order in a state in which the first control signal is input from the input end, and obtaining whether or not the first control signal is input to each of at least the upstream side driving unit as the information regarding the input status from at least the upstream side driving unit through the first signal path.

[0015] The invention described in claim 8 is the image recording control apparatus described in claim 1, when a first control signal is input from the input end side, the switching unit changes the switching state after a predetermined time elapses.

[0016] The invention described in claim 9 is the image recording control apparatus described in claim 8, wherein the control unit obtains information corresponding to an input period of the first control signal as the information regarding the input status from at least the upstream side driving unit.

[0017] The invention described in claim 10 is the image recording control apparatus described in claim 8 or 9, wherein the first control signal is a signal which changes a content of the signal each the predetermined time, and the control unit identifies the arrangement of the predetermined number of recording operation units by obtaining the content of the first control signal until elapse of the predetermined time from input of the first control signal as the information regarding the input status from at least the upstream side driving unit through the first signal path.

[0018] The invention described in claim 11 is the image recording control apparatus described in any one of claims 8 to 10, wherein the driving unit having the switching unit has a switching control unit which causes the switching unit to change the switching state based on the input control signal.

[0019] The invention described in claim 12 is the image recording control apparatus described in any one of claims 1 to 11, wherein each of the predetermined number of driving units has the switching unit.

[0020] The invention described in claim 13 is the image recording control apparatus described in any one of claims 1 to 12, wherein the second signal path is provided along a signal line which is used for transmission of a predetermined control signal regarding whether or not to perform the recording operation.

[0021] The invention described in claim 14 is the image recording control apparatus described in any one of claims 1 to 13, including a signal output unit which inputs a control signal to the input end, wherein the signal output unit determines the control signal to be input to the input end based on control of the control unit.

[0022] The invention described in claim 15 is the image recording control apparatus described in claim 14, wherein the signal output unit is a programmable logic controller.

[0023] The invention described in claim 16 is the image recording control apparatus described in any one of claims 1 to 15, wherein the second signal path is subjected to termination processing at an end on the downstream side.

[0024] The invention described in claim 17 is the image recording control apparatus described in any one of claims 1 to 16, wherein the first signal path has a hub and a network cable which connects the control unit and the predetermined number of driving units via the hub,

and the predetermined number of driving units have a communication unit which performs communication by identifying each of the driving units.

[0025] The invention described in claim 18 is the image recording control apparatus described in any one of claims 1 to 17, including a plurality of arrangements each of which is the arrangement of the predetermined number of recording operation units, wherein the second signal path is provided to each of the plurality of arrangements, and allows the control signal to be selectively output for each of the plurality of arrangements, and the control unit determines the arrangement to which the recording operation unit corresponding to the driving unit belongs by obtaining, from the driving unit through the first signal path, the information regarding the input status of the control signal which is input to the driving unit for each of the plurality of arrangements.

[0026] The invention described in claim 19 is an image recording apparatus, including; the image recording control apparatus according to any one of claims 1 to 18; and the predetermined number of recording operation units.

[0027] The invention described in claim 20 is a method for identifying arrangement of recording operation units by an image recording control apparatus that includes: a predetermined number of driving units which respectively drive the predetermined number of the recording operation units that are provided in a predetermined arrangement and perform a recording operation corresponding to the arrangement by a plurality of recording elements, the predetermined number being two or more; a control unit which performs a control operation of the predetermined number of driving units based on a content of the recording operation; a first signal path which connects the control unit and the predetermined number of driving units in parallel; and a second signal path through which a control signal is input from an input end to the driving unit that is uppermost in an order corresponding to the arrangement of the predetermined number of recording operation units among the predetermined number of driving units, and which connects the predetermined number of driving units to each other so that the control signal is transmitted in the order to the driving unit that is lowermost in the order, wherein at least an upstream side driving unit from the uppermost driving unit to the driving unit which is connected immediately above the lowermost driving unit among the predetermined number of driving units has a switching unit which switches whether or not to output the control signal transmitted through the second signal path from an input end side to a downstream side opposite to the input end side, the control unit outputs a recording control signal based on the content of the recording operation corresponding to the arrangement to each of the predetermined number of driving units through the first signal path, the method including an identification step of identifying the arrangement of the predetermined number of recording operation units by obtaining, through the first signal path, informa-

tion regarding an input status of the control signal to at least the upstream side driving unit through the second signal path corresponding to a switching state of the switching unit.

EFFECTS OF THE INVENTION

[0028] According to the present invention, there is an effect that it is possible to obtain setting regarding the operation control of a plurality of recording operation units easily and appropriately without requiring addition or change of a large configuration.

BRIEF DESCRIPTION OF DRAWINGS

[0029]

[FIG. 1] This is an entire perspective view showing an inkjet recording apparatus in an embodiment of the present invention.

[FIG. 2] This is a block diagram showing a functional configuration of the inkjet recording apparatus.

[FIG. 3] This is a schematic view for explaining signal wiring to each head module.

[FIG. 4] This is a view for explaining signal wiring in the head module.

[FIG. 5A] This is a view for explaining the specification operation of the position of head module.

[FIG. 5B] This is a view for explaining the specification operation of the position of head module.

[FIG. 6A] This is a view for explaining the specification operation of the position of head module.

[FIG. 6B] This is a view for explaining the specification operation of the position of head module.

[FIG. 7] This is a flowchart showing a control procedure of head position specification processing executed by the inkjet recording apparatus.

[FIG. 8] This is a flowchart showing a control procedure of image recording unit specification processing.

[FIG. 9] This is a flowchart showing a control procedure of head arrangement order specification processing.

[FIG. 10] This is a schematic view for explaining signal wiring to each head module in an inkjet recording apparatus in a second embodiment.

[FIG. 11A] This is a view for explaining signal wiring in the head module in the inkjet recording apparatus in the second embodiment.

[FIG. 11B] This is a view for explaining signal wiring in the head module in the inkjet recording apparatus in the second embodiment.

[FIG. 12] This is a flowchart showing a control procedure of head arrangement order specification processing invoked in the inkjet recording apparatus in the second embodiment.

[FIG. 13A] This is a view for explaining input/output levels of a signal through a chain cable and changes

in the switching state of the switching unit in an inkjet recording apparatus in a third embodiment.

[FIG. 13B] This is a view for explaining a modification example of input/output levels of a signal through a chain cable and changes in the switching state of the switching unit in the inkjet recording apparatus in the third embodiment.

[FIG. 14] This is a flowchart showing a control procedure of head arrangement order specification processing invoked in the inkjet recording apparatus in the third embodiment.

[FIG. 15] This is a flowchart showing a control procedure of head arrangement order specification processing in position specification operation in a modification example.

DETAILED DESCRIPTION OF EMBODIMENTS

[0030] Hereinafter, an embodiment of the present invention will be described on the basis of the drawings.

[First Embodiment]

[0031] FIG. 1 is an entire perspective view of an inkjet recording apparatus 1 in a first embodiment.

[0032] The inkjet recording apparatus 1 (image recording apparatus) includes a conveyance unit 10, image recording units 20 and the like.

[0033] The conveyance unit 10 moves a recording medium P at a predetermined conveyance speed in a predetermined conveyance direction while making the recording medium P face the ink ejection surface in a range where the image recording units 20 perform the image recording operation (ink ejection operation). The conveyance unit 10 includes an endless conveyance belt, a motor and the like, for example, places the recording medium P on the outer circumferential surface of the conveyance belt and rotates the conveyance belt by the motor.

[0034] Though the number (number of colors) of image recording units 20 is not especially limited, the image recording units 20 in the embodiment are formed of four image recording units 20C, 20M, 20Y and 20K which respectively eject ink of four (a plurality of) colors of C (cyan), M (magenta), Y (yellow) and K (black). These four image recording units 20C, 20M, 20Y and 20K are provided at positions which are different from each other in the conveyance direction. The arrangement order of the image recording units 20C, 20M, 20Y and 20K is determined as needed so that the optimum color expression can be made when the ink ejection positions overlap each other.

[0035] Each of the image recording units 20 includes a predetermined number of (seven in the embodiment) head modules 21a to 21g (driving units) (hereinafter, also collectively described as head modules 21), the predetermined number being two or more, and a predetermined number of sets of recording heads 23 (see FIG. 2, recording operation units) among which a prescribed

number of recording heads 23 are provided at a position (conveyance surface side of the head module 21) corresponding to each of the predetermined number of head modules 21 and facing the conveyance surface (recording medium P). By ejecting ink from the openings of a plurality of nozzles (recording elements) in the recording heads 23 (by causing the recording heads 23 to perform recording operation), the image recording unit 20 makes ink land on the recording medium P conveyed while facing the nozzle openings (ink ejection surface), and records an image on the recording medium P.

[0036] The recording heads 23 are attached to carriages 22 at different positions in the width direction orthogonal to the conveyance direction in the conveyance surface. The head module 21 corresponding to each set of recording heads 23 is provided at a position on the carriage 22 corresponding to the set of the recording heads 23. Each of the head modules 21 has a driving circuit 42 (see FIG. 2) which drives the corresponding recording heads 23, and the entire recording heads 23 included in all of the head modules 21 belonging to one image recording unit 20 are provided so that the width direction component of arrangement range providing the nozzle openings in a predetermined arrangement pattern is a predetermined width in the width direction. The number (above prescribed number) of recording heads 23 which are provided so as to correspond to each of the head modules 21a to 21g is not especially limited as long as the driving circuit 42 can perform driving all at once.

[0037] Four rows of such arrangement of recording heads 23 (arrangement of recording operation units) are respectively provided for image recording units 20C, 20M, 20Y and 20K.

[0038] Each of the image recording units 20 is fixed at the time of image recording, and forms a line head which records a two-dimensional image by one-pass method by ejecting ink at once over the above-mentioned predetermined width to the recording medium P while moving the recording medium P in the conveyance direction. The predetermined width is determined according to the recordable width of the recording medium P of the maximum width which is the conveyance target by the conveyance unit 10.

[0039] FIG. 2 is a block diagram showing the functional configuration of the inkjet recording apparatus 1 in the embodiment.

[0040] The inkjet recording apparatus 1 includes a control unit 40, an encoder 11 and a conveyance driving unit 41 of the conveyance unit 10, a driving circuit 42 and a module control unit 211 (communication unit, switching control unit) of the head module 21, a carriage driving unit 43, a communication unit 44, a storage unit 45, an operation display unit 46, a bus 49, a PLC 56 (Programmable Logic Controller) (signal output unit) and the like.

[0041] The control unit 40 integrally controls the operation of the inkjet recording apparatus 1, and performs control operation of causing each component such as the head modules 21 to perform various operations

(based on the contents of recording operation). The control unit 40 includes a CPU 401 (Central Processing Unit), a ROM 402 (Read Only Memory), a RAM 403 (Random Access Memory) and the like, and the CPU 401 performs various types of arithmetic processing in the RAM 403 as a working memory space. The ROM 402 stores initial setting data, various types of control programs, and the like. The CPU 401 reads them as needed, loads them in the RAM 403 and uses the data and executes the programs.

[0042] The conveyance driving unit 41 has a conveyance member of the conveyance unit 10, for example, a motor which moves the endless belt and the like, and moves the belt at a desired speed.

[0043] The encoder 11 is attached to the rotation shaft of this motor, and outputs a pulse signal each time the belt moves for a predetermined movement amount. The pulse signal is used for identifying the movement speed, the position and the like of the belt.

[0044] The driving circuit 42 and the module control unit 211 are provided to each of the head modules 21. In the embodiment, the module control unit 211 transmits/receives a signal to and from the control unit 40 via the communication unit 44.

[0045] The driving circuit 42 performs the driving operation for ink ejection from each recording head 23 on the basis of image data of the recording target in each head module 21. In the embodiment, for example, each of the recording heads 23 has a configuration of deforming the wall surface of the ink chamber connecting to the nozzle, thereby changing the pressure of ink in the ink chamber and ejecting ink from the nozzle. The driving circuit 42 performs output operation of a voltage waveform so as to apply the voltage in a predetermined pattern (voltage waveform) to the piezoelectric element provided along the wall surface of the ink chamber. Thus, the piezoelectric element deforms according to the voltage waveform, and the wall surface of the ink chamber deforms according to this deformation.

[0046] The module control unit 211 controls the operation of the driving circuit 42 in each of the head modules 21. The module control unit 211 receives control data corresponding to the image of the recording target from the control unit 40 and outputs the data to the driving circuit 42 at an appropriate timing. The module control unit 211 performs switching control of an after-mentioned switching unit 2121 (see FIG. 4) and transmission/reception of information with the control unit 40 for specification of the position of the head module 21.

[0047] As the module control unit 211, a microcomputer having a CPU, a RAM and a storage unit is used.

[0048] The carriage driving unit 43 moves the carriage 22 of each of the image recording units 20, and moves the recording heads 23 attached to the carriage 22 together. The carriage driving unit 43 performs the operation of moving back the recording heads 23 (head modules 21) from the position facing the conveyance surface in a case where adjustment of the head module 21 or the

recording heads 23 is performed, or a trouble occurs for cleaning or conveyance of the recording medium, and the like.

[0049] The communication unit 44 performs communication with a computer such as an external data server and a printer server through a network cable (LAN cable or the like). The control unit 40 obtains a recording instruction of an image, image data targeted by the recording, setting information regarding the recording operation and the like through the communication unit 44, and outputs status information of the image recording operation and the like. The communication unit 44 can communicate with the module control unit 211 of each of the head modules 21 which is connected to the network through hubs 51 to 55 (see FIG. 3) as mentioned later. The control unit 40 outputs the driving control signal of the head module 21, image recording data and the like (recording control signal) for image recording through the communication unit 44. The communication path for communication with an external computer and the communication path for communication with the head module 21 may be provided independently.

[0050] The storage unit 45 stores image data processed for image recording operation and the like. As the storage unit 45, for example, a DRAM used for temporary storage, a nonvolatile memory or the like is used. The storage unit 45 stores head arrangement information 451 regarding actual arrangement order of the plurality of head modules 21. When the control signal for image recording operation is distributed and output to each of the head modules 21, the head arrangement information 451 is loaded in the RAM 403 to be used by the CPU 401 as needed.

[0051] The operation display unit 46 receives user's input operation to output the operation signal to the control unit 40, and displays the menu screen regarding received contents and the status display screen regarding the image recording operation and the like. As the operation display unit 46, for example, a liquid display screen or the like on which a touch panel is overlaid is used. The operation display unit 46 may include a push button switch, an LED lamp or the like.

[0052] The bus 49 is a communication path connecting the control unit 40 with each component.

[0053] The PLC 56 (Programmable Logic Controller) outputs the control signal to each of the head modules 21. The PLC 56 has a microcomputer, for example, directly connected to the control unit 40 and the encoder 11, and performs the signal output operation based on the control signal from the control unit 40.

[0054] Next, the connection of the signal line in the inkjet recording apparatus 1 in the first embodiment will be described.

[0055] FIG. 3 is a schematic view for explaining the signal wiring to each of the head modules 21.

[0056] In the inkjet recording apparatus 1, the module control units 211 (see FIG. 4) in the respective head modules 21 are connected in parallel through the network to

the control unit 40 which controls the image recording via the hubs 51 to 55 through network cables 61 such as LAN cables. The head modules 21 are specified by setting respective IP addresses, and can communicate with the control unit 40 individually and in parallel. The control unit 40 transmits the recording control signal for ink ejection from each nozzle corresponding to image data to each of the head modules 21 through this network connection.

[0057] The hubs 51 to 55 and the network cables 61 form a first signal path.

[0058] The control unit 40 is directly connected with the PLC 56 as mentioned above, and a control signal is output to the PLC 56 from the control unit 40.

[0059] The PLC 56 outputs the signal to the image recording units 20Y, 20M, 20C and 20K by chain cables 62 (second signal path) through the signal distributor 57. In the image recording unit 20, each of the chain cables 62 connects a plurality of head modules 21 (driving units) to each other in series in the order which is determined according to the arrangement of the recording heads 23 on the carriage 22, and can transmit the signal to all the head modules 21 in the order. A termination unit 58 (terminator) is provided to the end on the output side (downstream side) of the head module 21 which is lowermost in the order, and termination processing is performed to prevent problems such as reflection of the signal. The PLC 56 in the embodiment outputs each of three types of signals which are a print enable signal (predetermined control signal regarding whether or not to perform the recording operation), an encoder signal and a head position search signal by a high voltage signal VH or a low voltage signal VL. The chain cables 62 transmit these three types of signals by respective independent signal lines (that is, the signal line of head position search signal is along the signal line of the print enable signal).

[0060] The encoder signal input from the encoder 11 of the conveyance unit 10 is input to the PLC 56. The encoder signal is a signal which is output according to the conveyance amount (movement distance) of the recording medium P by the conveyance unit 10, and the signal is output each time the motor moving the conveyance belt rotates by a predetermined rotation angle, for example. By the encoder signal being output to each of the image recording units 20 through the PLC 56 and the signal distributor 57, the difference in position along the conveyance direction between the head modules 21 is reflected, and timings of driving operation for ink ejection are respectively set.

[0061] The signal distributor 57 can output a predetermined signal from an end (input end) of the chain cable 62 corresponding to the head module 21 which is the uppermost in the above-mentioned order (that is, head) in any of the image recording units 20 of C, M, Y and K colors selectively.

[0062] FIG. 4 is a view for explaining the signal wiring in the head module 21.

[0063] In the head module 21, the above-mentioned

module control unit 211, the FPGA 212 (Field-Programmable Gate Array) and the driving circuit 42 are provided. The head module 21 also includes a communication connection terminal 215, an input terminal 216 and an output terminal 217.

[0064] The network cables 61 connected to the hubs 52 to 55 are connected to module control units 211 through communication connection terminals 215, and transmit signals which are transmitted and received by the module control units 211. Each of the module control units 211 includes a CPU (Central Processing Unit), a RAM (Random Access Memory) and the like, and performs, at appropriate timings, output to the driving circuit 42 which applies voltage to a load which determines whether or not to eject ink from each nozzle, that is, the piezoelectric element for deforming the ink chamber connected to the nozzle and generating pressure change of ink inside the ink chamber, or the like on the basis of the input driving data.

[0065] The FPGA 212 outputs the print enable signal determining whether or not to operate the driving circuit 42 and the encoder signal to the driving circuit through the chain cable 62 from the PLC 56. Such a signal is input to the input terminal 216, and then branched before input to the FPGA 212. The branched signal is output from the output terminal 217 directly, and transmitted to the head module 21 (or termination unit 58 when the signal is output from the output terminal 217 of the head module 21 which is lowermost in the order, the same applies hereinafter) which is immediately below the head module 21 in the arrangement order among the plurality of head modules 21 which are connected in series.

[0066] The chain cable 62 also transmits an after-mentioned head position search signal. The head position search signal is input to the FPGA 212 and branched. One of the branched signals is input to the switching unit 2121, and the other is input to the module control unit 211. The switching unit 2121 includes a switching element for example, a MOSFET (CMOS) or the like, which switches the connection (performs switching operation) according to the control signal from the module control unit 211. The switching unit 2121 switches whether or not to output the head position search signal input from the input terminal 216 (input end side of the chain cable 62) to the output terminal 217 (downstream side of the chain cable 62). Specifically, according to the switching state, the switching unit 2121 outputs, without change, the head position search signal input from the input terminal 216 or interrupts the head position search signal and outputs the input voltage from a constant voltage source Vcc, which supplies the voltage equal to the above-mentioned high voltage signal VH, to the output terminal 217.

[0067] Next, the position specification operation of the head module 21 in the inkjet recording apparatus 1 in the first embodiment will be described.

[0068] As mentioned above, in order to output image data (driving data) individually to each of the head mod-

ules 21 from the control unit 40, the control unit 40 needs to recognize the relative positional relationship between the head modules 21, that is, the arrangement order and the color of ink ejected by the recording heads 23 which are operated by each of the head modules 21.

[0069] In the inkjet recording apparatus 1, the relative positional relationship between heads is narrowed down by the control unit 40 obtaining information on the signal level of the head position search signal which was input from each of the module control units 211 in a state in which the control unit 40 causes the PLC 56 to output the head position search signal.

[0070] FIGS. 5A, 5B, 6A and 6B are views for explaining the position specification operation of head module 21.

[0071] As shown in FIG 5A, in a state in which the high voltage signal VH is output to only a single image recording unit 20 by the signal distributor 57 and a low voltage signal VL is output to the other image recording units 20, the control unit 40 causes all the module control units 211 to output, without change, the head position search signal, which was input from the input terminal 216, to the downstream side from the output terminal 217 by the switching unit 2121, and respond the voltage level (information regarding input status) of the input head position search signal. By switching the image recording unit 20 to output the high voltage signal VH in order for all the image recording units 20 (four times in the embodiment) or for image recording units other than the last image recording unit (three times) and executing the above process, as shown in FIG 5B, the control unit 40 specifies the ink color ejected by the image recording unit 20 to which the head module 21 indicated by each IP address (last three digits are displayed in the embodiment) belongs.

[0072] Next, as shown in FIG 6A, while the control unit 40 causes the PLC 56 to output the low voltage signal VL (first control signal, predetermined constant voltage signal) as the head position search signal to each of the image recording units 20, the control unit 40 outputs a control signal to the module control unit 211 of any one head module 21 among the head modules 21 belonging to each of the image recording units 20 to change the switching state by the switching unit 2121 and output the voltage (that is, high voltage signal VH) of the constant voltage source Vcc instead of the input low voltage signal VL. Then, the control unit 40 transmits a request to notify the voltage level of input head position search signal (information regarding input status) to each of the module control units 211.

[0073] The voltage level of the head position search signal notified from each of the module control units 211 is the low voltage signal VL as for the head module 21 which caused the above-mentioned switching unit 2121 to perform the switching operation and the head module(s) 21 on the upstream side (input end side) of the head module 21, and the voltage level of the head position search signal is the high voltage signal VH (second

control signal, constant voltage signal of a voltage different from the first control signal) as for the head module(s) 21 on the downstream side (termination unit 58 side) of the head module 21 which caused the switching unit 2121 to perform the switching operation. That is, as shown in FIG 6B, the head modules 21 can be divided into two groups of the upstream side groups 20Ca, 20Ma, 20Ya and 20Ka and the downstream side groups 20Cb, 20Mb, 20Yb and 20Kb by the arrangement order in each of the image recording units 20. When there is only one head module 21 forming the group as in the No. 010 of the head module 21 in the downstream side group 20Kb, the arrangement position of the head module 21 is identified uniquely.

[0074] The arrangement order of all the head modules 21 are finally determined by repeating the similar operation for each group classified in such a way.

[0075] FIG. 7 is a flowchart showing a control procedure by the control unit 40 of the head position specification processing executed by the inkjet recording apparatus 1 in the first embodiment.

[0076] The head position specification processing is activated and executed by the user at the time of assembly inspection of the inkjet recording apparatus 1, installing, replacement of the head module 21 and the like.

[0077] When the head position specification processing is started, the control unit 40 invokes and executes image recording unit specification processing (step S101). Then, the control unit 40 invokes and executes head arrangement order specification processing (step S102).

[0078] On the basis of the specified head position information, the control unit 40 stores the relative positional information of each of the head modules 21 in association with specification information of the module control unit 211 by the control unit 40 such as the IP address (step S103). The control unit 40 ends the head position specification processing.

[0079] FIG. 8 is a flowchart showing a control procedure by the control unit 40 of the image recording unit specification processing invoked in the head position specification processing.

[0080] When the image recording unit specification processing is invoked, the control unit 40 causes the PLC 56 to output a high voltage signal VH as the head position search signal through the chain cable 62 to the image recording unit 20C which ejects ink of C color, and causes the PLC 56 to output a low voltage signal VL as the head position search signal through the chain cables 62 to the image recording units 20M, 20Y and 20K which eject ink of the other colors (step S301). The control unit 40 requests all the module control units 211 to provide the voltage level information (that is, information regarding the input status of the head position search signal (control signal)) of the head position search signal (step S302). The control unit 40 obtains the voltage level information which was output from each of the module control units 211, and identifies the IP addresses of the head modules

21 to which the high voltage signal VH was input, that is, the head modules 21 belonging to the image recording unit 20C (step S303).

[0081] The control unit 40 causes the PLC 56 to output the high voltage signal VH as the head position search signal through the chain cable 62 to the image recording unit 20M which ejects ink of M color, and causes the PLC 56 to output the low voltage signal VL as the head position search signal through the chain cables 62 to the image recording units 20C, 20Y and 20K which eject ink of the other colors (step S304). The control unit 40 requests all the module control units 211 to provide the voltage level information of the head position search signal (step S305). The control unit 40 obtains the voltage level information which was output from each of the module control units 211, and identifies the IP addresses of the head modules 21 to which the high voltage signal VH was input, that is, the head modules 21 belonging to the image recording unit 20M (step S306).

[0082] The control unit 40 causes the PLC 56 to output the high voltage signal VH as the head position search signal through the chain cable 62 to the image recording unit 20Y which ejects ink of Y color, and causes the PLC 56 to output the low voltage signal VL as the head position search signal through the chain cables 62 to the image recording units 20C, 20M and 20K which eject ink of the other colors (step S307). The control unit 40 requests all the module control units 211 to provide the voltage level information of the head position search signal (step S308). The control unit 40 obtains the voltage level information which was output from each of the module control units 211, and identifies the IP addresses of the head modules 21 to which the high voltage signal VH was input, that is, the head modules 21 belonging to the image recording unit 20Y (step S309).

[0083] The control unit 40 causes the PLC 56 to output the high voltage signal VH as the head position search signal through the chain cable 62 to the image recording unit 20K which ejects ink of K color, and causes the PLC 56 to output the low voltage signal VL as the head position search signal through the chain cables 62 to the image recording units 20C, 20M and 20Y which eject ink of the other colors (step S310). The control unit 40 requests all the module control units 211 to provide the voltage level information of the head position search signal (step S311). The control unit 40 obtains the voltage level information which was output from each of the module control units 211, and identifies the IP addresses of the head modules 21 to which the high voltage signal VH was input, that is, the head modules 21 belonging to the image recording unit 20K (step S312).

[0084] Then, the control unit 40 ends the image recording unit specification processing, and returns the processing to the head position specification processing.

[0085] The processing of steps S310 to S312 may be omitted and the control unit 40 may simply identify, among the head modules 21, the remaining head modules 21 which are not identified as belonging to any of

the image recording units 20C, 20M and 20Y in each processing of steps S303, S306 and S309 as the head modules 21 belonging to the image recording unit 20K.

[0086] FIG. 9 is a flowchart showing a control procedure by the control unit 40 of the head arrangement order specification processing invoked in the head position specification processing.

[0087] Each process of the head arrangement order specification processing forms an identification step of the present invention.

[0088] When the head arrangement order specification processing is invoked, the control unit 40 outputs a control signal to the PLC 56 to output a low voltage signal VL as the head position search signal through the chain cables 62 to all the image recording units 20 (step S501). The control unit 40 selects one of the head modules 21 belonging to each of the image recording units 20 (step S502). The control unit 40 determines whether or not the selected head modules 21 include a head module 21 which has the arrangement order (position) already identified (step S503). If it is determined that the selected head modules 21 include a head module 21 which has the arrangement order already identified (step S503; YES), the control unit 40 changes the head module 21 to be selected from the identified head module 21 (step S504), and returns the processing to step S503.

[0089] If it is determined that the selected head modules 21 do not include a head module 21 which has the arrangement order already identified (step S503; NO), the control unit 40 outputs a switching operation instruction of switching unit 2121 to the module control unit 211 of each of the selected head modules 21 to change the switching state, and causes each of the module control units 211 to output a high voltage signal VH (output voltage of constant voltage source Vcc) from the output terminal 217 instead of the input head position search signal (step S505). The control unit 40 requests all the head modules 21 to provide the voltage level information of the input head position search signal (step S506). The control unit 40 obtains the voltage level information from the module control unit 211 of each of the head modules 21, and divides, according to high/low of the voltage level, the group including the selected head modules 21 (for the first time, a single group including all the head modules 21 in each of the image recording units 20) (step S507). The control unit 40 outputs a reset instruction of the switching operation of switching unit 2121 to the module control unit 211 of each of the selected head modules 21 to return the switching state, leading to a state of outputting the input head position search signal without change from the output terminal 217 (state of making the head position search signal pass through) (step S508).

[0090] The control unit 40 determines, for the divided groups, whether or not there is generated a group including only one head module 21 (step S509). If it is determined that such a group is generated (step S509; YES), the control unit 40 identifies the arrangement order of the head module 21 of the group (step S510). The control

unit 40 determines whether or not the positions (arrangement order) of all the head modules 21 are identified (step S511). If it is determined that the positions of all the head modules 21 are not identified (step S511; NO), the processing of the control unit 40 returns to step S502. If it is determined that the positions of all the head modules 21 are identified (step S511; YES), the control unit 40 ends the head arrangement order specification processing and returns the processing to the head position specification processing.

[0091] In the determination processing of step S509, if it is determined that the group including only one head module 21 is not newly generated (step S509; NO), the processing of the control unit 40 returns to step S502.

[0092] In the determination processing of step S509, if the group including two head modules 21 is divided into two, both of the positions (arrangement order) of the two head modules 21 are identified.

[0093] In a case where the IP address is dynamically assigned to each of the head modules 21 by using DHCP or the like, it is preferable that various settings such as a lease period are maintained so that the IP address is not changed when the inkjet recording apparatus 1 is activated again after the period during which the power supply to the inkjet recording apparatus 1 is stopped. Alternatively, for a case where the IP address is changed, the MAC address (physical address) and the arrangement of each of the head modules 21 may be stored so as to be associated with each other by obtaining an ARP table or the like, and when the apparatus is activated again, the association between the IP address and the arrangement of the head module 21 may be updated with only the operation of the control unit 40 by updating the ARP table.

[0094] Alternatively, the arrangement information of the identified head module 21 may be transmitted to each of the head modules 21 from the control unit 40 and stored, and when the apparatus is activated again, the information may be obtained in association with the IP address from each of the head modules 21.

[0095] As described above, an inkjet recording apparatus 1 in the first embodiment includes: seven head modules 21 that respectively drive a predetermined number (seven in the embodiment) of sets of recording heads 23 each set of which includes a prescribed number of recording heads 23 and performs recording operation, the predetermined number being two or more; a control unit 40 which performs control operation of seven head modules 21 on the basis of the contents of the recording operation; network cables 61 and hubs 51 to 55 as a first signal path connecting the control unit 40 and the seven head modules 21 in parallel; and chain cable 62 as a second signal path through which a control signal is input to the head module 21 which is uppermost (on the side closest to the PLC 56) in the order determined according to the arrangement of the seven sets of recording heads 23 among the seven head modules 21 from the input end connected to the signal distributor 57, and which con-

nects the seven head modules 21 to each other so that the control signal can be transmitted in the order to the head module 21 which is lowermost (on the side closest to the termination unit 58) in the order at least. Each of at least six head modules 21 (upstream side driving unit) (all the seven head modules 21 in the embodiment) from the uppermost head module 21 to the head module 21 connected immediately above the lowermost head module 21 among the seven head modules 21 has a switching unit 2121 which switches whether or not to output the control signal transmitted through the second signal path from the PLC 56 side (input terminal 216) to the downstream side (output terminal 217) which is on the opposite side (the termination unit 58 side) to the PLC 56 side. The control unit 40 obtains, through the first signal path, information regarding the input status (that is, whether or not the low voltage signal VL was input) of the control signal to each of at least six head modules 21 (all the seven head modules 21 in a case where the six upstream side driving units are not identified in advance as in the embodiment) other than the lowermost head module 21 in the arrangement order by the chain cable 62 corresponding to the switching state of the switching unit 2121 in each of the seven head modules 21, identifies the arrangement of the seven sets of recording heads 23, and outputs the recording control signal based on the content of the recording operation corresponding to the arrangement of the recording heads 23 to each of the seven head modules 21 through the first signal path.

[0096] In such a way, by using the network cables 61 and chain cable 62 two-dimensionally connected to the head modules 21 and obtaining information on the input control signal corresponding to the switching state of the switching unit 2121 of each of the head modules 21, the actual arrangement positions of the recording heads 23 and each corresponding head module 21 are specified even in a case where the actual arrangement of each (set of) recording heads 23 is not known and an arbitrary identification number is assigned to each head module 21 corresponding to the recording heads 23. At this time, each of the head modules 21 (module control units 211) does not need to perform the setting processing operation of the identification number or the identification mark considering the arrangement position, and, by only the simple switching operation, the control unit 40 which requires the information on the arrangement order can perform processing and management regarding the setting of the arrangement order all together at the time of transmitting image data. Accordingly, in this inkjet recording apparatus 1, it is possible to avoid setting management errors without requiring addition or change of a large configuration, and obtain the arrangement information of the recording heads 23 and the head module 21 corresponding to the recording heads 23 easily and appropriately, perform setting regarding control of the image recording operation and use the information for the image recording operation.

[0097] The control unit 40 controls the setting of the

switching state by the switching unit 2121, and obtains the information regarding the input status of the control signal through the first signal path (network connection) for each setting pattern of the switching state. Accordingly, the control unit 40 intensively sets an appropriate switching pattern of the switching unit 2121 and obtains the arrangement information of the head module 21 efficiently.

[0098] In a case where the switching state of the switching unit 2121 changes and the control signal (low voltage signal VL) input from the PLC 56 side (input terminal 216) is not output to the downstream side (output terminal 217), the switching unit 2121 outputs the voltage signal from the constant voltage source Vcc to the downstream side. Accordingly, the detection signal (voltage level) on the downstream side of the switching unit 2121 is determined appropriately, and can be more clearly and surely distinguished from the signal on the upstream side (PLC 56 side).

[0099] The control unit 40 causes each of the switching units 2121 to perform switching in order (the order mentioned here is not fixed but determined as needed according to the state of group division as mentioned above) in a state in which the low voltage signal VL different from the high voltage signal VH output by the constant voltage source Vcc determined in advance is input from the input end (PLC 56 side) of the chain cable 62 of the second signal path. The control unit 40 then obtains the type of the control signal which was input to each of the seven head modules 21 as the information regarding the input status from each of the seven head modules 21 through the first signal path, and thereby identifies the arrangement of the seven sets of recording heads 23.

[0100] In such a way, the arrangement order of each of the head modules 21 (that is, arrangement positions of the recording heads 23) is specified by only the simple switching operation of switching the input voltage signal and the voltage signal from the constant voltage source Vcc which supplies the voltage different from the input voltage signal. Thus, it is possible to obtain the arrangement information of the recording heads 23 and the head module 21 corresponding to the recording heads 23 easily and appropriately and use the information for the image recording operation.

[0101] The first control signal input from the PLC 56 side is a predetermined constant voltage signal (low voltage signal VL), and the second control signal output to the downstream side instead of the first control signal by the switching unit 2121 is a constant voltage signal (high voltage signal VH) of the voltage different from the first control signal. Since such a signal makes it possible to identify the signal type easily only by the determination of signal level, the processing such as reading determination of the signal waveform pattern is not necessary, and especially, it is possible to more simplify the contents of processing operation in the head module 21.

[0102] Each of the seven head modules 21 has a switching unit 2121. In such a way, by using the head

module 21 of a same configuration, it is possible to provide the head module 21 at an arbitrary arrangement order position with respect to the control unit 40 and the recording heads 23 as needed, and reduce the cost and trouble for manufacturing and replacement work (especially, in a case where the head module 21 is replaced together with the recording heads 23). Even by such a same configuration, it is possible to surely identify the arrangement order by the chain cable 62 of each of the head modules 21 in the inkjet recording apparatus 1 in the embodiment.

[0103] The chain cable 62 of the second signal path is provided along the signal line used for transmission of the print enable signal regarding whether or not to perform the recording operation. By providing a similar dedicated line additionally to the conventional line in such a way, it is possible to easily obtain the arrangement information of the recording heads 23 and the head module 21 corresponding to the recording heads 23.

[0104] The inkjet recording apparatus 1 includes a PLC 56 which inputs a control signal such as a low voltage signal VL through the signal distributor 57 to the input end of the chain cable 62 of the second signal path. The PLC 56 determines the control signal to be input to the chain cable 62 on the basis of the control by the control unit 40.

[0105] In such a way, it is possible to stably output the appropriate voltage signal to each of the head modules 21 by the configuration in which the control unit 40 does not directly perform the signal output to the chain cable 62 of the second signal path.

[0106] Since the low voltage signal VL and the like can be output as the head position search signal by using the PLC 56 (programmable logic controller), it is possible to identify the arrangement of the recording heads 23 and the arrangement order of the head module 21 corresponding to the recording heads 23 without complicating the configuration and the processing by using (multiple uses) the PLC 56 which is provided for the output control of important signals such as a print enable signal.

[0107] The end on the downstream side of the second signal path (chain cable 62) is subjected to the termination processing by the termination unit 58. As mentioned above, since information is directly obtained from each of the head modules 21 through the first signal path (network cables 61 and hubs 51 to 55), the control unit 40 does not need to perform confirmation and processing of the signal from the chain cable 62, and especially does not need to perform processing of confirming which head module 21 performed the data changing processing or the like from the data that is input in series.

[0108] The first signal path has hubs 51 to 55 and network cables 61 which connect the control unit 40 and the seven head modules 21 via the hubs 51 to 55, and each of the seven head modules 21 has a module control unit 211 which identifies the head module 21 and performs communication.

[0109] Thus, since the image data, command data and

the like which are output separately to each of the head modules 21 from the control unit 40 side can be distributed and transmitted to each of the head modules 21 at a high speed efficiently by a normal network connection, it is possible to increase the speed of the image recording operation easily. Since the IP address does not represent the actual arrangement positions of the recording heads 23 in such a network connection, by identifying the arrangement order of the head module 21 as mentioned above, it is possible to easily associate the IP address with the information on the arrangement position of the recording heads 23 and enable appropriate image data transmission.

[0110] The inkjet recording apparatus 1 includes four rows of arrangements of seven sets of recording heads 23 according to the respective colors of C, M, Y and K. The chain cables 62 of the second signal path are provided to the respective arrangements of four rows, and can selectively output the control signal for each arrangement. The control unit 40 obtains information regarding the input status (type) of the control signal input to the head module 21 for each arrangement of four rows from the head module 21 through the first signal path, and thereby determines the arrangement (that is, the color of ejected ink) to which the recording heads 23 corresponding to the head module 21 belong.

[0111] In such a way, in this inkjet recording apparatus 1, it is possible to easily and separately identify the head modules 21 for the image recording unit corresponding to ink of each of the plurality of colors. Accordingly, after identifying the image recording unit 20, the arrangement order of the head module 21 (arrangement positions of recording heads 23) belonging to each of the image recording units 20 can be easily identified as mentioned above.

[0112] The inkjet recording apparatus 1 in the embodiment includes each configuration (which includes a control unit 40, a head module 21, hubs 51 to 55, network cables 61 and chain cable 62, and may include the PLC 56, the termination unit 58 and the like) for the above-mentioned image recording control as the image recording control apparatus, and seven sets of recording heads 23. By easily identifying and using the arrangement order of the head modules 21 corresponding to the arrangement positions of respective recording heads 23 in such an inkjet recording apparatus 1, it is possible to easily and accurately identify the arrangement of the head modules 21 (recording heads 23 and the corresponding driving circuits 42) in the image recording unit 20 of the inkjet recording apparatus 1, and transmit the image data and the like. Thus, there is no trouble of setting for the user at the time of assembly inspection of the inkjet recording apparatus 1, replacement of the head module 21 and the like, and it is possible to prevent the generation of errors at the time of manual setting.

[0113] By identifying the arrangement of the plurality of recording heads 23 and the corresponding head module 21 with the above-mentioned arrangement identifica-

tion method of the recording heads 23, it is possible to avoid setting errors and management errors, easily and appropriately obtain the arrangement information of the recording heads 23 and the head module 21 corresponding to the recording heads 23, perform setting for control of the image recording operation, and use this for the image recording operation, without requiring addition or change of a large configuration.

10 [Second Embodiment]

[0114] Next, an inkjet recording apparatus 1 in a second embodiment will be described.

[0115] The outer appearance and the functional configuration of the inkjet recording apparatus 1 in the second embodiment will be respectively same as those shown in FIG 1 and FIG 2, and the explanation thereof is omitted by using same reference numerals.

[0116] FIG. 10 is a schematic view for explaining the signal wiring to each of the head modules 21 in the inkjet recording apparatus 1 in the second embodiment.

[0117] In the inkjet recording apparatus 1 in the embodiment, the control signal is not output from the head modules 21 which are the lowermost head modules in the connection orders among the head modules 21 connected by the chain cables 62, that is, located on the most downstream side, and termination processing is performed by the termination units 218 included in the respective head modules 21.

[0118] FIGS. 11A and 11B are views for explaining the signal wiring in the head module 21 of the inkjet recording apparatus 1 in the second embodiment.

[0119] In the inkjet recording apparatus 1 in the embodiment, the configuration is different between the head module 21 which is the lowermost head module in the connection order and the other head modules (six head modules) among the head modules 21 connected through the chain cable 62.

[0120] As shown in FIG 11A, in each of the head modules 21 other than the lowermost head module 21 in the connection order, there is provided a switching unit 2121a to the FPGA 212a instead of the switching unit 2121 in the FPGA 212 of the head module 21 in the inkjet recording apparatus 1 in the first embodiment. The switching unit 2121a simply switches whether or not to output, from the output terminal 217, the control signal input from the input terminal 216 on the basis of the control of the module control unit 211. Accordingly, in a case where the switching element (for example, MOSFET) of the switching unit 2121a is turned off (released), the control signal is not output from the output terminal 217.

[0121] As shown in FIG 11B, in the head module 21 which is the lowermost in the connection order, as mentioned above, the termination unit 218 is provided instead of the output terminal 217, and the control signal is not output to the downstream side. Further, in this head module 21, the FPGA212b does not have the switching unit 2121a, the head position search signal input from the

input terminal 216 is simply divided into two similarly to the other signals transmitted through the chain cable 62 (print enable signal and encoder signal). One of the divided signals is input to the termination unit 218 and the other is input to the module control unit 211.

[0122] Next, the position specification operation of the recording heads 23 and the head module 21 corresponding to the recording heads 23 in the inkjet recording apparatus 1 in the second embodiment will be described.

[0123] In the inkjet recording apparatus 1 in the embodiment, the arrangement of the head module 21, that is, the recording heads 23 is identified by using information regarding whether or not there was input to each head module 21 (presence/absence of input) of the control signal (low voltage signal VL) which was input from the PLC 56 according to the switching state of the switching unit 2121a.

[0124] FIG. 12 is a flowchart showing a control procedure by the control unit 40 of head arrangement order specification processing invoked when the head position specification processing is executed in the inkjet recording apparatus 1 in the embodiment.

[0125] The head arrangement order specification is same as the head arrangement order specification in the first embodiment except for that the processing of step S501 is divided into steps S501a and S501b which are respectively arranged at the head of processing and after processing of step S505. The explanation is omitted by providing same reference numerals to same processing contents.

[0126] When the head arrangement order specification processing is invoked, the control unit 40 causes the PLC 56 to output a high voltage signal VH to all the image recording units 20 to initialize the input signal to each of the head modules 21 (step S501a). The processing of the control unit 40 then proceeds to step S502.

[0127] The control unit 40 causes the PLC 56 to output a low voltage signal VL to all the image recording units 20 after changing the switching unit 2121a of the selected head module 21 to the switching state, that is, the turning off (released state) of the switching element in the embodiment in the processing of step S505 (step S501b). The processing of the control unit 40 then proceeds to step S506.

[0128] In a case where the head module 21 not having the switching unit 2121a is selected in the processing of step S503, this head module 21, to which the instruction was input in the processing of step S505, may return an error signal indicating not having the switching unit 2121a to the control unit 40. In this case, the head module 21 is identified as the head module which is the lowermost in the order for not having the switching unit 2121a (identified as the only one head module 21 in the group on the lower side of the group including the head module 21). Thus, the control unit 40 may omit the processing of steps S501b to S508.

[0129] Alternatively, before executing (invoking) the head arrangement order specification processing, the

control unit 40 may request each of the head modules 21 to provide information regarding whether or not the head module 21 has the switching unit 2121a in advance, and identify the head module 21 returning the information of not having the switching unit 2121a, that is, the head module 21 which is the lowermost in the arrangement order. In this case, in the head arrangement order specification processing, the lowermost head module 21 may be excluded from the selection target for switching of the switching unit 2121a from first, and may be excluded from the target to request to provide the voltage level information of the head position search signal.

[0130] In such a way, in a case where the switching unit 2121a is a switching element which switches on and off, by using that the downstream side of the switching element in the released state is maintained in a floating state, it is possible to obtain presence/absence of input of the control signal (low voltage signal VL) to each of the head modules 21 on the basis of the switching state of voltage level after initialization, and obtain the positional relationship (arrangement order) of the head module 21. In a case of a circuit which easily gets grounded due to the electric charges running away from the downstream side of the switching element in the released state, initialization may be performed with a ground voltage or a low voltage signal VL close to the ground voltage and a high voltage signal VH may be output after the selective switching of the switching element so that the position of the head module 21 (recording heads 23) corresponding to the switching element (switching unit 2121a) is obtained.

[0131] As described above, in the inkjet recording apparatus 1 in the second embodiment, in a case where the switching unit 2121a does not output the first control signal (low voltage signal VL) input from the input end side (PLC 56 side, input terminal 216) to the downstream side (output terminal 217), the switching element is released and the control signal is not output to the downstream side of the switching unit 2121a.

[0132] Thus, it is not necessary to supply the voltage from the constant voltage source Vcc to each of the switching units 2121a (FPGA 212a). Thus, it is possible to reduce the circuit design, size and cost of the head module 21, for example, reduce the number of wiring, and reduce the operation power and the like.

[0133] The control unit 40 causes each of the switching units 2121a to perform switching in order in a state in which the first control signal (low voltage signal VL) is input from the input end (PLC 56), and identifies the arrangement of the seven recording heads 23 by obtaining the presence/absence of input of the first control signal to each of at least the six head modules 21 (upstream side driving units) from the uppermost head module 21 to the head module 21 which is immediately above the lowermost head module 21 in the arrangement order as the information regarding input status from these six (or all of the seven) head modules 21 through the first signal path.

[0134] In such a way, even in a configuration not outputting any control signal in a case where the switching unit 2121a does not output the input first control signal, it is possible to identify the arrangement order of the head module 21 on the basis of the presence/absence of input of the first control signal to each of the head modules 21 similarly to the first embodiment. Thus, it is not necessary to supply the voltage from the constant voltage source Vcc to each of the head modules 21, and the configuration of the head module 21 is simplified.

[0135] The switching unit 2121a may not be provided to the head modules 21 each of which is the lowermost in the arrangement order. In this case, the arrangement order of each of the head modules 21 can be identified similarly. If it is possible to identify in advance that the head module 21 not provided with the switching unit 2121a is the head module 21 which is the lowermost in the arrangement order, the head module 21 can be excluded from the identification processing of the arrangement order by the above-mentioned method, and the processing can be omitted one time.

[Third Embodiment]

[0136] Next, an inkjet recording apparatus in a third embodiment will be described.

[0137] Since the configuration of the inkjet recording apparatus 1 in the third embodiment is same as that of the inkjet recording apparatus 1 in the first embodiment, the detailed explanation thereof is omitted by using same reference numerals.

[0138] Next, the position specification operation of the recording heads 23 and the head module 21 corresponding to the recording heads 23 in the inkjet recording apparatus 1 in the third embodiment will be described.

[0139] In the inkjet recording apparatus 1 in the embodiment, the module control unit 211 of the head module 21 not only changes the switching state of the switching unit 2121 at the timing when the instruction is obtained from the control unit 40, but also performs switching of the switching unit 2121 based on the control signal which was input through the chain cable 62.

[0140] FIGS. 13A and 13B are views for explaining the change in the switching states of switching unit 2121 and the input/output levels of the signal through the chain cable 62 in the inkjet recording apparatus 1 in the embodiment.

[0141] As shown in FIG 13A, in the inkjet recording apparatus 1 in the embodiment, when a low voltage signal VL is input as an input signal Vin in a case where the switching state is set (changed) so as to output the supplied voltage from the constant voltage source Vcc, each of the switching units 2121 returns the switching state with delay of a predetermined time, to a state in which the input signal Vin is transmitted and output as the output signal Vout. As a result, the head modules 21 have different timings (input periods) of switching the voltage level of the output signal Vout to the low voltage signal VL

in accordance with the connection order of the head modules 21 through the chain cable 62. Accordingly, the differences of the timings directly indicate the connection orders through the chain cable 62.

[0142] FIG. 14 is a flowchart showing a control procedure by the control unit 40 of the head arrangement order specification processing invoked in the head position specification processing in the inkjet recording apparatus 1 in the embodiment.

[0143] When the head arrangement order specification processing is invoked, the control unit 40 causes the PLC 56 to output the high voltage signal VH to all the image recording units 20 (step S521). The control unit 40 outputs a control signal to all the head modules 21 to cause all the switching units 2121 to switch to the output state of the supplied voltage (that is, high voltage signal VH) from the constant voltage source Vcc (step S522).

[0144] The control unit 40 outputs, to all the head modules 21, the instruction to return the switching state of the switching unit 2121 after elapse of the predetermined time from detection of the low voltage signal VL, into a state of outputting the signal input from the input terminal 216 to the output terminal 217 (step S523). The module control unit 211 of the head module 21 may hold the setting of operating the switching unit 2121 in such a way from start, or may have a circuit enabling the switching unit 2121 to perform such switching automatically. In this case, the processing of step S523 is omitted.

[0145] The control unit 40 causes the PLC 56 to output a low voltage signal VL to all the image recording units 20 (step S524). The control unit 40 requests all the head modules 21 to provide the voltage level information of the head position search signal (step S525). The control unit 40 identifies the position (order) of the head module 21 in accordance with the order of switching of the head position search signal to the low voltage signal VL (step S526). When the information indicating that the signal was changed to the low voltage signal VL was once obtained for a head module 21, it is not necessary to further repeat the request of voltage level information from the head module 21.

[0146] The control unit 40 determines whether the voltage level of the head position search signal obtained from every head module 21 switched to the low voltage signal VL (step S527). If it is determined that the voltage level was not switched (step S527; NO), the processing of the control unit 40 returns to step S525. If it is determined that the voltage level was switched (step S527; YES), the control unit 40 ends the head arrangement order specification processing, and returns the processing to the head position specification processing.

[0147] If the processing of step S527 proceeds to NO, the timing to execute the processing of step S525 may be after the elapse of the above-mentioned predetermined time from the processing of previous step S525.

[Modification Example]

[0148] Next, a modification example of the position specification operation of the recording heads 23 and the head module 21 corresponding to the recording heads 23 in the inkjet recording apparatus 1 in the third embodiment will be described.

[0149] FIG. 13B is a view for explaining the change in the switching states of switching unit 2121 and the input/output levels of the signal through the chain cable 62 in the modification example.

[0150] In the position specification operation of the modification example, the control unit 40 causes the PLC 56 to output the head position search signal changing the voltage value in a step manner each predetermined time. In this case, the PLC 56 may output signals obtained by pulse width modulation (PWM) between the high voltage signal VH and the low voltage signal VL instead of actually outputting direct current signals (constant voltage signals) of voltage values which are different from each other. In this modification example, the minimum required number of steps of the voltage value is the number smaller than the number of head modules 21 by 1. Alternatively, the output voltage from the PLC 56 may be simply gradually decreased continuously.

[0151] With respect to the head position search signal, in each of the head modules 21, the switching unit 2121 operates with a delay of predetermined time from detection of the input signal Vin of the voltage other than the high voltage signal VH, and outputs the input signal Vin as the output signal Vout. Thereby, the voltage level (average voltage value in a case of PWM control) of the input signal Vin from the detection of the voltage value other than the high voltage signal VH until the operation of the switching unit 2121 is different for each of the head modules 21. The control unit 40 can identify the arrangement order of the head module 21 and the recording heads 23 by obtaining the information regarding the voltage level.

[0152] FIG. 15 is a flowchart showing a control procedure by the control unit 40 of the head arrangement order specification processing for the position specification operation in the modification example.

[0153] The head arrangement order specification processing is same as the head arrangement order specification processing in the third embodiment except for that the processing of steps S525 and S527 is omitted and the processing of steps S523, S524 and S526 are replaced with steps S523a, S524a and S526a, and the explanation thereof is omitted by providing same reference numerals to the same processing contents.

[0154] After the head arrangement order specification processing is invoked and the processing of steps S521 and S522 are executed in order, the control unit 40 outputs, to all the head modules 21, an instruction to change the switching state of the switching unit 2121 after elapse of a predetermined time from detection of the signal other than the high voltage signal VH (less than the high voltage

signal VH in the modification example), into a state of outputting the head position search signal, which was input to the input terminal 216, to the output terminal 217. The control unit 40 obtains a voltage value (average voltage) in the predetermined time from detection of the signal other than the high voltage signal VH, and requests output of the voltage level information to the control unit 40 (step S523a).

[0155] The control unit 40 causes the PLC 56 to output the head position search signal decreasing the voltage value in a step manner each above-mentioned predetermined time (step S524a). The control unit 40 receives information of the voltage value input from each of the head modules 21, and identifies the arrangement order of the head module 21 and the recording heads 23 in accordance with the order of the voltage value (decreasing order in the modification example) (step S526a). The control unit 40 ends the head arrangement order specification processing and returns the processing to the head position specification processing.

[0156] As described above, in the inkjet recording apparatus 1 in the third embodiment, when the first control signal (low voltage signal VL) is input from the input end side, the switching unit 2121 changes the state of switching after a predetermined time elapsed by the control of the module control unit 211. By having a configuration in which the voltage level to output is changed according to the arrangement order in each of the head modules 21 in such a way, it is possible to identify the arrangement order of all the head modules 21 by inputting the first control signal one time. Accordingly, the processing can be simplified. Since such processing does not need to cause each of the head modules 21 to hold the arrangement order itself or perform complicated processing, it is not necessary to greatly complicate the configuration of the head module 21 or the contents of the processing operation.

[0157] The control unit 40 obtains the data of the input timing (information corresponding to the input period) of the first control signal as the information regarding the input status from each of the head modules 21.

[0158] Thus, it is sufficient that each of the head modules 21 (module control units 211) outputs the signal indicating that the first control signal was detected to the control unit 40 at the detection timing of the first control signal (or request timing from the control unit 40 immediately after the detection timing), and changes the switching state of the switching unit 2121 after elapse of the predetermined time from the detection timing. Thus, it is possible to easily and surely identify the arrangement order of each of the head modules 21 by the control unit 40 without requiring the complicated processing in the head module 21.

[0159] The head module 21 having the switching unit 2121 has a module control unit 211 which causes the switching unit 2121 to change the switching state on the basis of the input control signal. Thus, in comparison to forming and using an electrical electronic circuit which

causes the switching unit 2121 to perform the switching operation after a predetermined delay time in each of the head modules 21, such processing can be performed more easily. As the module control unit 211, there can be directly used a unit which is used for reception of the recording control signal for the driving operation of the recording head 23 by the driving circuit 42 and the operation for output of information regarding the switching state of the switching unit 2121 to the control unit 40, and the processing load thereon is not greatly increased. Thus, it is possible to suppress the increase of cost and size of the head module 21.

[0160] In the modification example of the inkjet recording apparatus 1 in the embodiment, the first control signal is a signal changing the signal contents each predetermined time, and the control unit 40 identifies the arrangement of the seven recording heads 23 by obtaining, as the information regarding the input status, the contents of the first control signal until the elapse of the predetermined time from input of the first control signal, from each of the head modules 21 through the first signal path.

[0161] In such a way, it is sufficient that the voltage level in the first period when the first control signal was detected is obtained from each of the head modules 21 one time. Thus, in the inkjet recording apparatus 1, it is possible to surely obtain the information regarding the arrangement order of the head module 21 while more decreasing the processing of the control unit 40. Furthermore, as the contents of signal to change, there is only performed changing the duty ratio by the PWM control between the low voltage signal VL and the high voltage signal VH, and thereby it is possible to obtain necessary information by easy processing without applying a large load.

[0162] The present invention is not limited to the above embodiments, and various modifications can be made.

[0163] For example, in the above embodiments, though identification of each of the head modules 21 using the IP address was performed by using the LAN cable, the USB cable may be used to connect each of the head modules 21 to the control unit 40 directly or through a USB hub or the like.

[0164] In the above embodiments, the module control unit 211 of the head module 21 which caused the switching operation is classified to a set in which the head position search signal is a low voltage signal VL, and the processing is repeated until all the head modules 21, including the head module 21, are divided into separate groups each of which has a single component. This head module 21 is on the most downstream side in the set in which the head position search signal is the low voltage signal VL. Accordingly, the arrangement order of the head module 21 which caused the switching operation may be determined in order by counting the number of the other head modules 21 to which the low voltage signal VL was input and the number of head modules 21 to which the high voltage signal VH was input.

[0165] In the above embodiments, the print enable sig-

nal, the encoder signal and the head position search signal are transmitted through respective independent signal lines. However, as a part of them, especially as the signal line transmitting the head position search signal, the signal line transmitting the print enable signal or the encoder signal may be used and the operation may be performed by switching which signal is to be supplied from the PLC 56 by control of the control unit 40 or the like.

[0166] In the embodiments, in a case where the switching unit 2121 performs the switching operation, the switching is performed so that the high voltage signal VH is output from the constant voltage source Vcc. However, the input signal may be inverted between the high voltage and the low voltage by providing an inverter or the like to the switching side. The switching unit 2121 may not be provided to the last head module 21 connected in order by the chain cable 62. That is, the switching unit 2121 is provided to the head modules 21 from the head module 21 at the head in the connection order (PLC 56 side) to the head module 21 which is connected immediately ahead of the last (termination unit 58) head module 21 among the head modules 21 connected by the chain cable 62.

[0167] In the above embodiments, the switching unit 2121 has a hardware configuration having the switching element. However, the module control unit 211 may determine whether or not to output (invert to other signal), to downstream side, the head position search signal which was input according to the control signal from the control unit 40 so that, when the head position search signal is input, whether to output the head position search signal is switched (the inverted head position search signal or the head position search signal which is not changed is output) on the basis of the determination.

[0168] The head position search signal is not limited to the signal of a constant voltage shown in the embodiments. The head position search signal may be a predetermined period signal or a signal differentiating the phase such as sine wave or pulse wave or a signal inverting the positive/negative of the voltage. In a case of such a signal including an alternating current component, the alternating current component attenuates promptly on the downstream side by the termination unit 58 even if the switching unit 2121 merely switches whether or not to output the head position search signal to the downstream side as in the inkjet recording apparatus 1 in the second embodiment. Thus, it is not necessary to initialize, in advance, the signal input to the head modules 21 on the chain cable 62, that is, all the head modules 21 as in the processing of step S501a.

[0169] In the third embodiment, each of the head modules 21 returns the switching state of the switching unit 2121 by counting the predetermined delay time spontaneously on the basis of the control signal input. However, each of the head modules 21 may not count the delay time, and the switching state of the switching unit 2121 may be returned in a case where the output voltage level is a low voltage signal VL at the same time as or imme-

diately after output of the voltage level information (before the next request by the control unit 40 to provide the voltage level information) when the voltage level information is requested at a predetermined time interval by the control unit 40.

[0170] Even in the inkjet recording apparatus 1 in the third embodiment, the switching unit 2121 may not switch to the output of the voltage signal supplied from the constant voltage source Vcc, and the output (transmission) of the voltage signal input from the input terminal 216 may be switched on/off.

[0171] Similarly, in the inkjet recording apparatus 1 in the third embodiment, the head module 21 which is not provided with the switching unit 2121 may be used as the head module 21 which is the last in the order. In this case, by executing the head arrangement order specification processing shown in FIGS. 14 and 15, it is possible to obtain the arrangement order of all the head modules 21. As described in the specification operation of the head position for the inkjet recording apparatus 1 in the second embodiment, in a case where the IP address of the head module 21 is identified in advance, the head module 21 may be excluded from the output target of each instruction in the processing of steps S523 and S523a, request in the processing of step S525, and the like.

[0172] In the embodiments, the head position search signal is output from the PLC 56. However, the control unit 40 may control other voltage generation circuits or the like to output the head position search signal.

[0173] In the embodiments, the termination processing is performed by providing the termination unit 58 to the end on the downstream side of the chain cable 62. However, the end on the downstream side of the chain cable 62 may be connected to the control unit 40 to input the head position search signal and the like to the control unit 40. Even in a case where the end on the downstream side of the chain cable 62 is not connected to the control unit 40, if there is no problem in signal reflection since only the direct current voltage is applied to the chain cable 62 for the head position search signal, for example, the termination unit 58 may not be provided to the end on the downstream side of the chain cable 62, and the insulating member or the like may be simply used into a released state.

[0174] In the embodiments, the head modules 21 corresponding to respective recording heads 23 which eject ink of four colors of C, M, Y and K are connected through respective different chain cables 62. However, all the head modules 21 may be connected through the chain cable 62 in a line in a case where all the recording head 23 are attached to a same carriage 22, for example.

[0175] In the above embodiments, the inkjet recording apparatus arranging a plurality of nozzles which eject ink is described as an example. However, the present invention can also be applied to other image recording apparatuses such as an LED printer which arranges a plurality of LED light emitting elements, as long as the apparatus has a similar configuration.

[0176] As for the other specific details such as the configuration, wiring, control contents and the procedure shown in the embodiments, modification can be made as needed within the scope of the present invention.

INDUSTRIAL APPLICABILITY

[0177] The present invention can be used for an image recording control apparatus, an image recording apparatus and a method for identifying arrangement of recording operation units.

EXPLANATION OF REFERENCE NUMERALS

[0178]

- 1 inkjet recording apparatus
- 10 conveyance unit
- 11 encoder
- 20, 20C, 20M, 20Y, 20K image recording unit
- 20Ca, 20Ma, 20Ya, 20Ka upstream side group
- 20Cb, 20Mb, 20Yb, 20Kb downstream side group
- 21 head module
- 211 module control unit
- 212 FPGA
- 2121 switching unit
- 215 communication connection terminal
- 216 input terminal
- 217 output terminal
- 21a-21g head module
- 22 carriage
- 23 recording head
- 40 control unit
- 401 CPU
- 402 ROM
- 403 RAM
- 41 conveyance driving unit
- 42 driving circuit
- 43 carriage driving unit
- 44 communication unit
- 45 storage unit
- 451 head arrangement information
- 46 operatio display unit
- 49 bus
- 51-55 hub
- 56 PLC
- 57 signal distributor
- 58 termination unit
- 61 network cable
- 62 chain cable
- P recording medium

Claims

1. An image recording control apparatus, comprising:
 - a predetermined number of driving units which

- respectively drive the predetermined number of recording operation units which perform a recording operation by a plurality of recording elements, the predetermined number being two or more;
- a control unit which performs a control operation of the predetermined number of driving units based on a content of the recording operation;
- a first signal path which connects the control unit and the predetermined number of driving units in parallel; and
- a second signal path through which a control signal is input from an input end to the driving unit that is uppermost in an order determined according to arrangement of the predetermined number of recording operation units among the predetermined number of driving units, and which connects the predetermined number of driving units to each other so that the control signal is transmitted in the order to the driving unit that is lowermost in the order, wherein at least an upstream side driving unit from the uppermost driving unit to the driving unit which is connected immediately above the lowermost driving unit among the predetermined number of driving units has a switching unit which switches whether or not to output the control signal transmitted through the second signal path from an input end side to a downstream side opposite to the input end side,
- the control unit identifies the arrangement of the predetermined number of recording operation units by obtaining, through the first signal path, information regarding an input status of the control signal to at least the upstream side driving unit through the second signal path corresponding to a switching state of the switching unit, and the control unit outputs a recording control signal based on the content of the recording operation corresponding to the arrangement to each of the predetermined number of driving units through the first signal path.
2. The image recording control apparatus according to claim 1, wherein the control unit sets and controls the switching state by the switching unit, and obtains the information regarding the input status of the control signal through the first signal path for each setting pattern of the switching state.
 3. The image recording control apparatus according to claim 1 or 2, wherein, when a first control signal input from the input end side is not output to the downstream side, the switching unit outputs a second control signal to the downstream side.
 4. The image recording control apparatus according to claim 3, wherein the control unit identifies the arrangement of the predetermined number of recording operation units by causing each of the switching unit to perform switching in order in a state in which the first control signal different from the second control signal determined in advance is input from the input end, and obtaining a type of the control signal input to each of at least the upstream side driving unit as the information regarding the input status from at least the upstream side driving unit through the first signal path.
 5. The image recording control apparatus according to claim 3 or 4, wherein the first control signal is a predetermined constant voltage signal, and the second control signal is a constant voltage signal of a voltage different from the first control signal.
 6. The image recording control apparatus according to claim 1 or 2, wherein, when a first control signal input from the input end side is not output to the downstream side, the switching unit does not output the control signal to the downstream side of the switching unit.
 7. The image recording control apparatus according to claim 6, wherein the control unit identifies the arrangement of the predetermined number of recording operation units by causing each of the switching unit to perform switching in order in a state in which the first control signal is input from the input end, and obtaining whether or not the first control signal is input to each of at least the upstream side driving unit as the information regarding the input status from at least the upstream side driving unit through the first signal path.
 8. The image recording control apparatus according to claim 1, wherein, when a first control signal is input from the input end side, the switching unit changes the switching state after a predetermined time elapses.
 9. The image recording control apparatus according to claim 8, wherein the control unit obtains information corresponding to an input period of the first control signal as the information regarding the input status from at least the upstream side driving unit.
 10. The image recording control apparatus according to claim 8 or 9, wherein the first control signal is a signal which changes a content of the signal each the predetermined time, and the control unit identifies the arrangement of the predetermined number of recording operation units by obtaining the content of the first control signal until elapse of the predetermined time from input of the first control signal as the information regarding the

input status from at least the upstream side driving unit through the first signal path.

11. The image recording control apparatus according to any one of claims 8 to 10, wherein the driving unit having the switching unit has a switching control unit which causes the switching unit to change the switching state based on the input control signal. 5
12. The image recording control apparatus according to any one of claims 1 to 11, wherein each of the predetermined number of driving units has the switching unit. 10
13. The image recording control apparatus according to any one of claims 1 to 12, wherein the second signal path is provided along a signal line which is used for transmission of a predetermined control signal regarding whether or not to perform the recording operation. 15 20
14. The image recording control apparatus according to any one of claims 1 to 13, comprising a signal output unit which inputs a control signal to the input end, wherein the signal output unit determines the control signal to be input to the input end based on control of the control unit. 25
15. The image recording control apparatus according to claim 14, wherein the signal output unit is a programmable logic controller. 30
16. The image recording control apparatus according to any one of claims 1 to 15, wherein the second signal path is subjected to termination processing at an end on the downstream side. 35
17. The image recording control apparatus according to any one of claims 1 to 16, wherein the first signal path has a hub and a network cable which connects the control unit and the predetermined number of driving units via the hub, and the predetermined number of driving units have a communication unit which performs communication by identifying each of the driving units. 40 45
18. The image recording control apparatus according to any one of claims 1 to 17, comprising a plurality of arrangements each of which is the arrangement of the predetermined number of recording operation units, wherein the second signal path is provided to each of the plurality of arrangements, and allows the control signal to be selectively output for each of the plurality of arrangements, and the control unit determines the arrangement to which the recording operation unit corresponding to the driving unit belongs by obtaining, from the driving 50 55

unit through the first signal path, the information regarding the input status of the control signal which is input to the driving unit for each of the plurality of arrangements.

19. An image recording apparatus, comprising; the image recording control apparatus according to any one of claims 1 to 18; and the predetermined number of recording operation units.
20. A method for identifying arrangement of recording operation units by an image recording control apparatus that includes: a predetermined number of driving units which respectively drive the predetermined number of the recording operation units that are provided in a predetermined arrangement and perform a recording operation corresponding to the arrangement by a plurality of recording elements, the predetermined number being two or more; a control unit which performs a control operation of the predetermined number of driving units based on a content of the recording operation; a first signal path which connects the control unit and the predetermined number of driving units in parallel; and a second signal path through which a control signal is input from an input end to the driving unit that is uppermost in an order corresponding to the arrangement of the predetermined number of recording operation units among the predetermined number of driving units, and which connects the predetermined number of driving units to each other so that the control signal is transmitted in the order to the driving unit that is lowermost in the order, wherein at least an upstream side driving unit from the uppermost driving unit to the driving unit which is connected immediately above the lowermost driving unit among the predetermined number of driving units has a switching unit which switches whether or not to output the control signal transmitted through the second signal path from an input end side to a downstream side opposite to the input end side, the control unit outputs a recording control signal based on the content of the recording operation corresponding to the arrangement to each of the predetermined number of driving units through the first signal path, the method comprising an identification step of identifying the arrangement of the predetermined number of recording operation units by obtaining, through the first signal path, information regarding an input status of the control signal to at least the upstream side driving unit through the second signal path corresponding to a switching state of the switching unit.

FIG.1

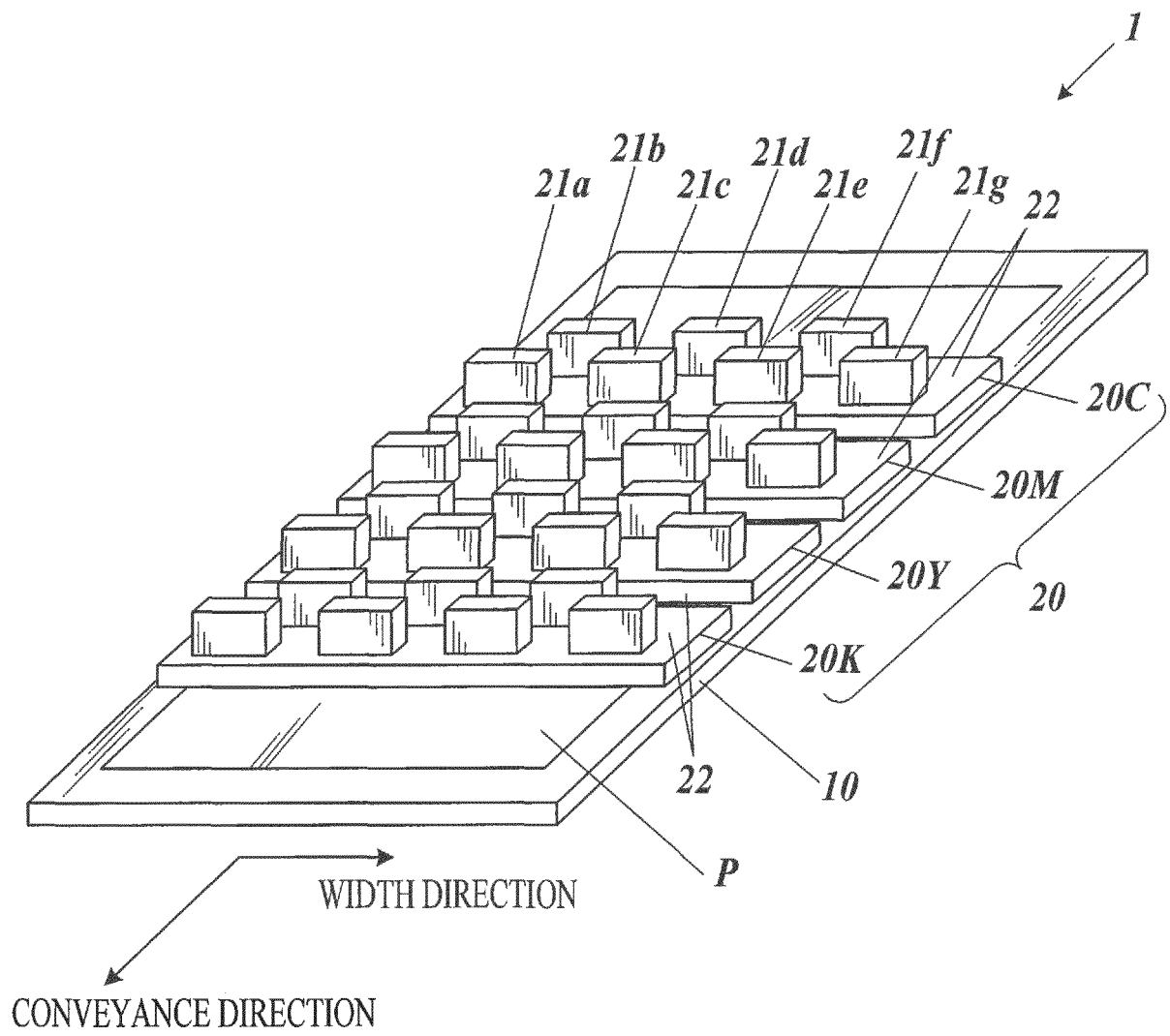


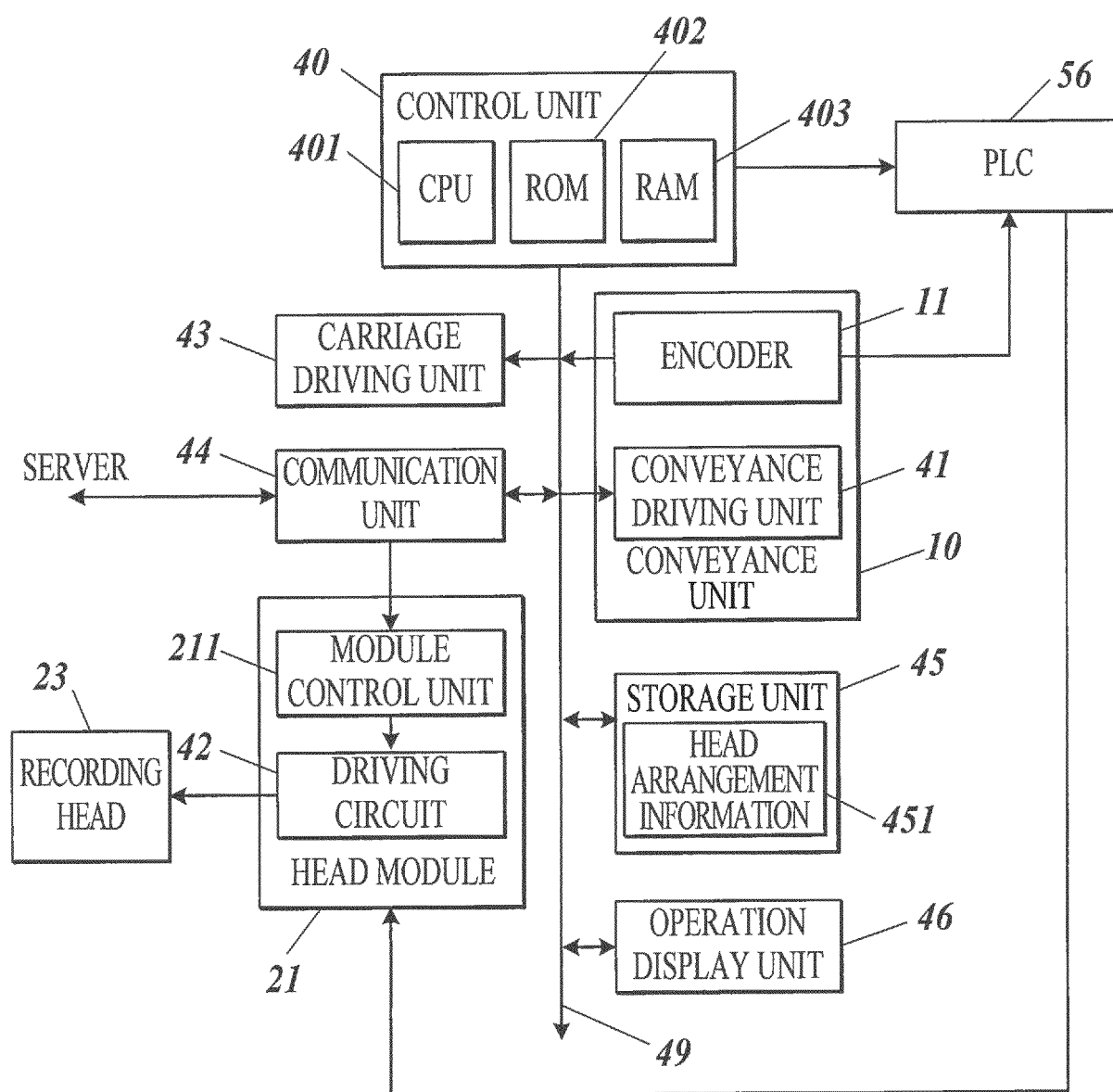
FIG.2

FIG.3

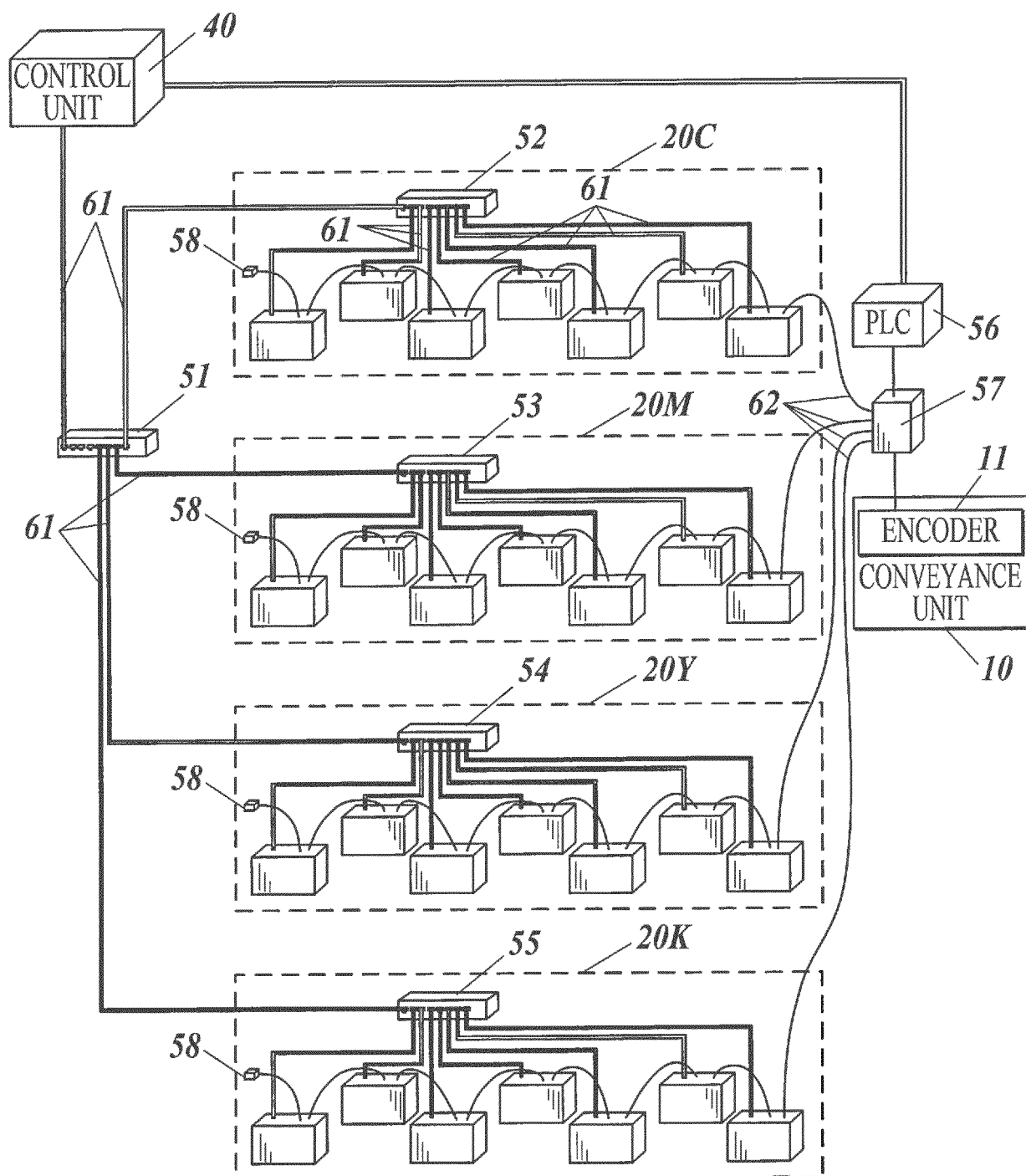


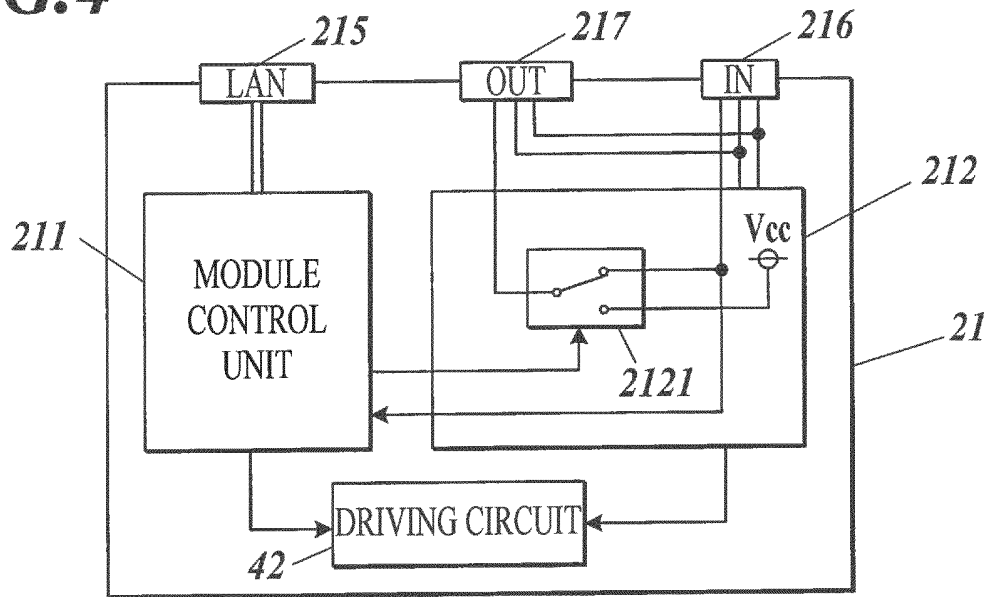
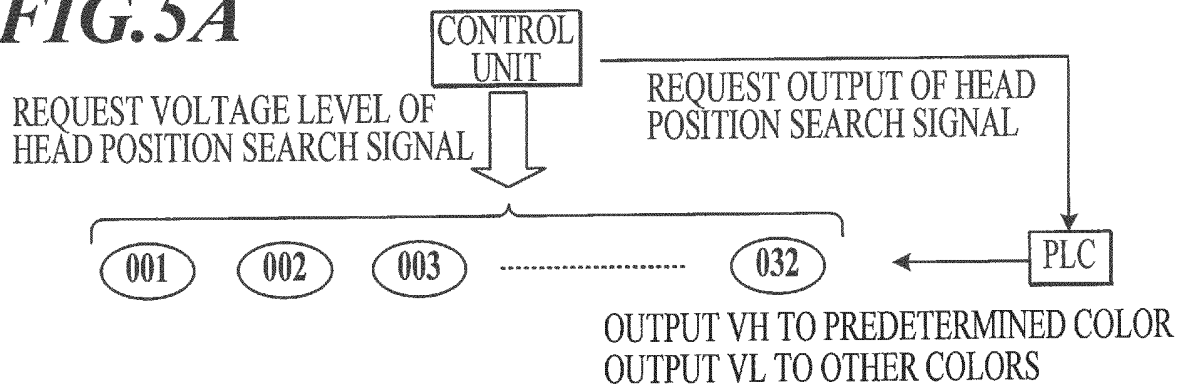
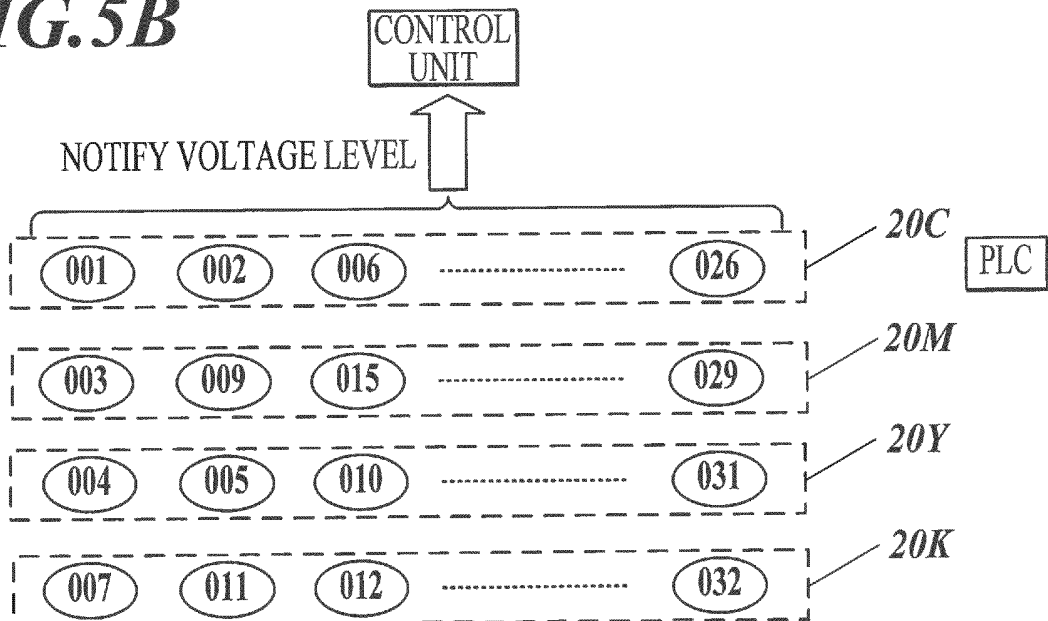
FIG.4**FIG.5A****FIG.5B**

FIG. 6A

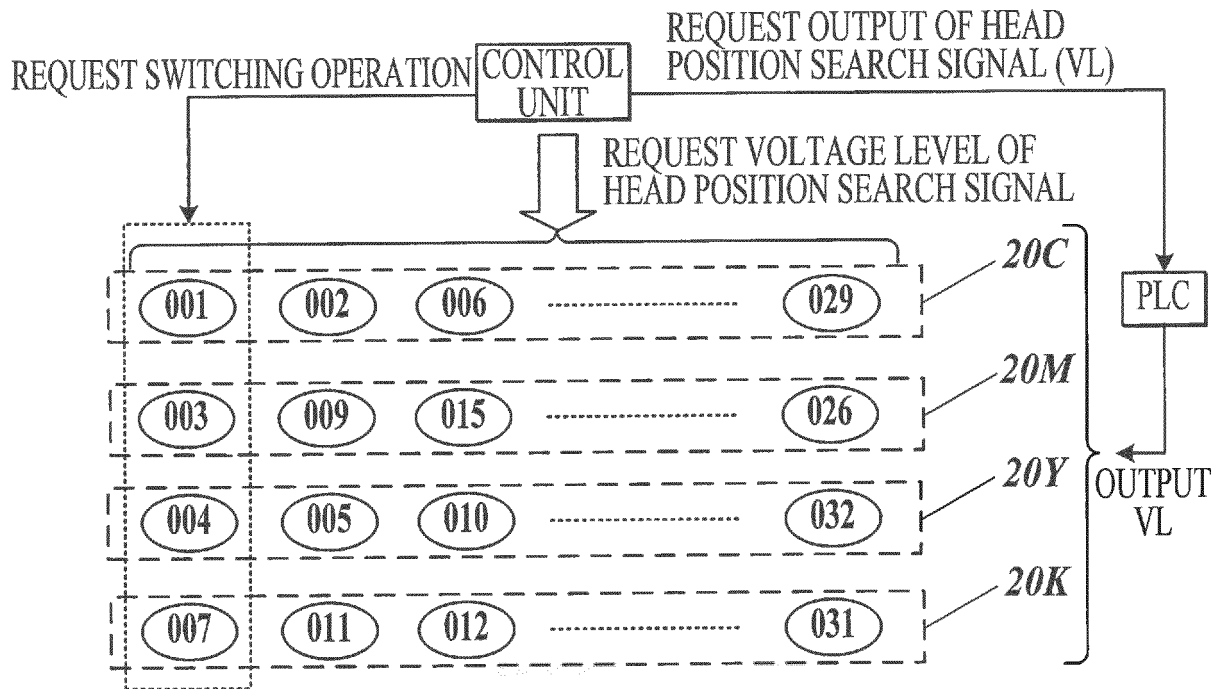


FIG. 6B

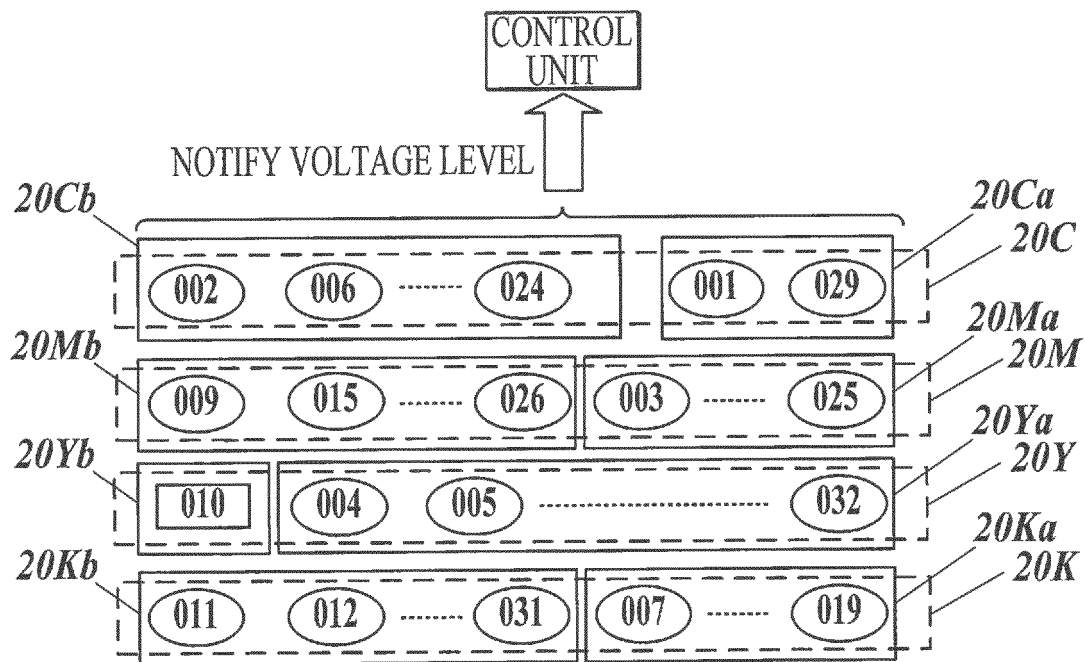


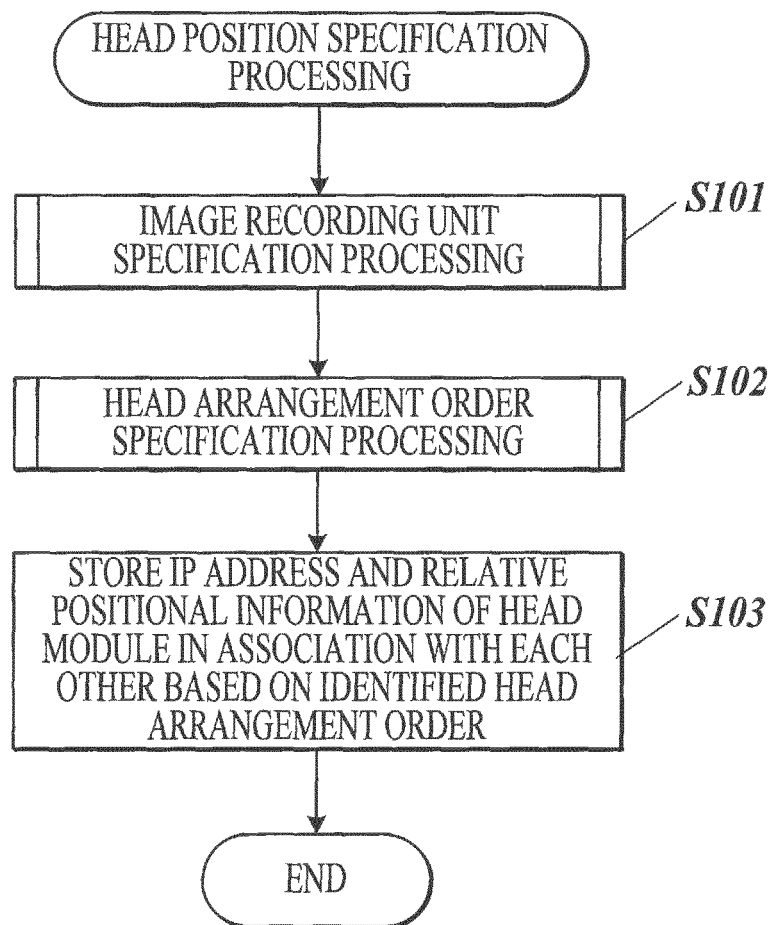
FIG. 7

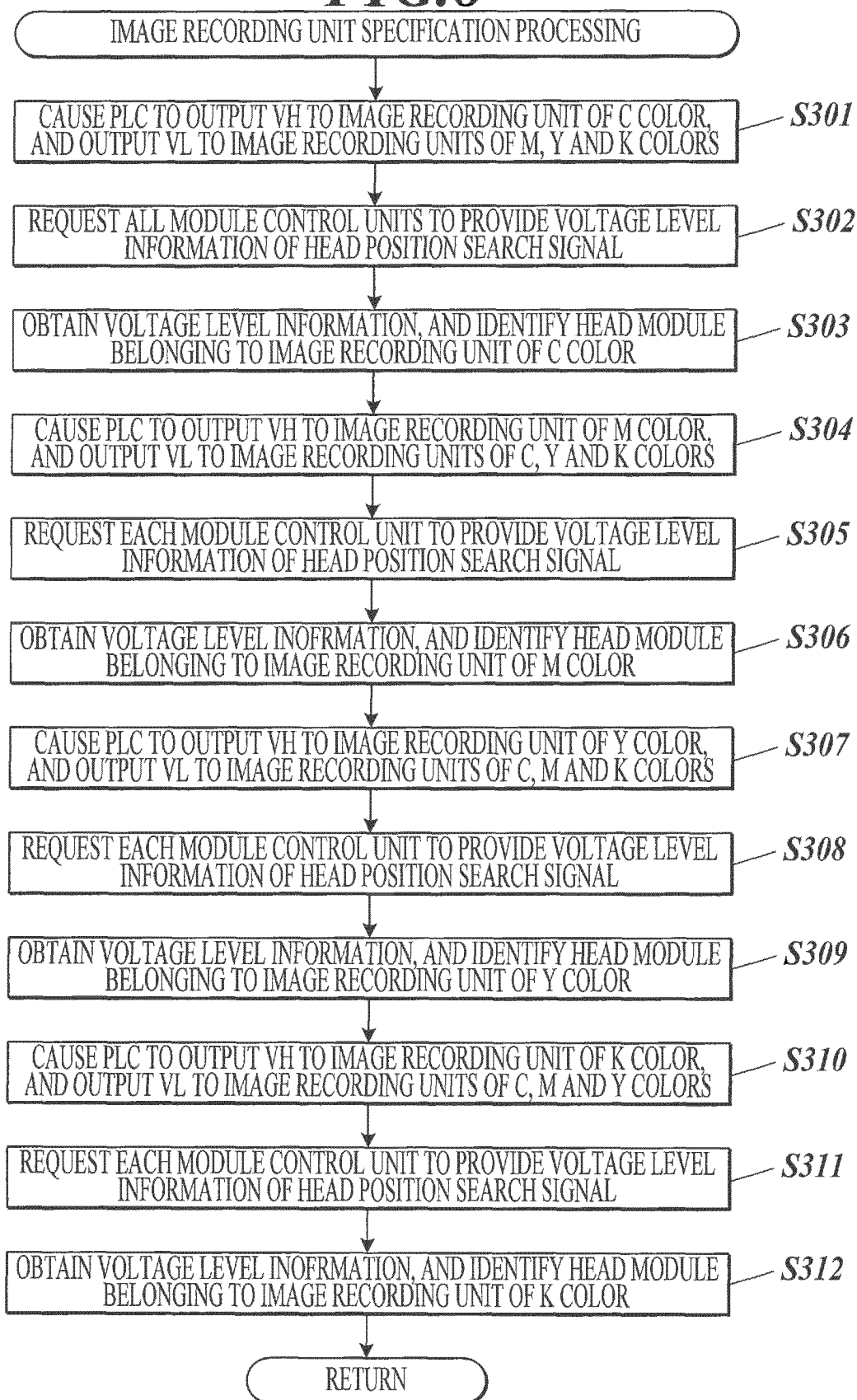
FIG.8

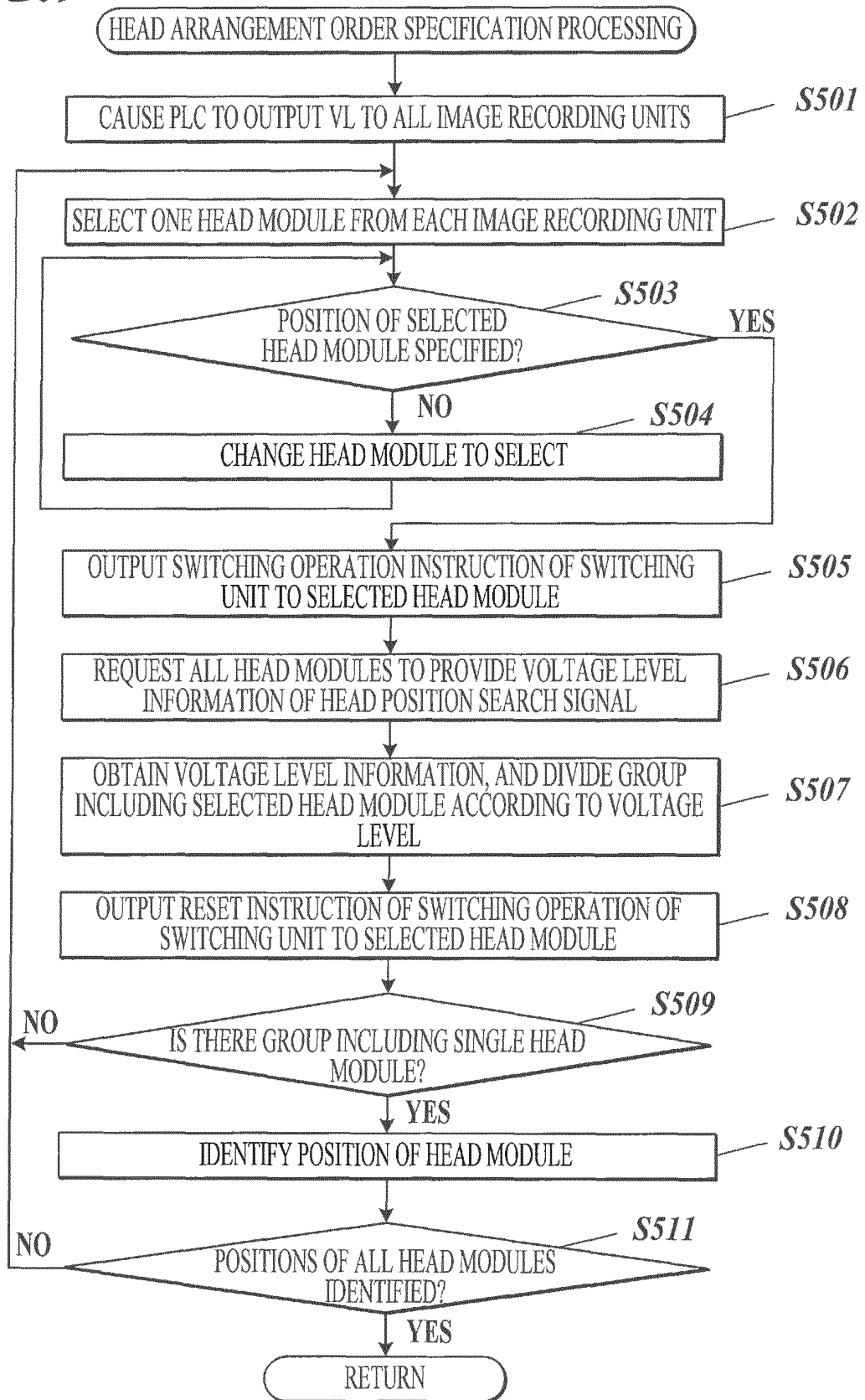
FIG.9

FIG.10

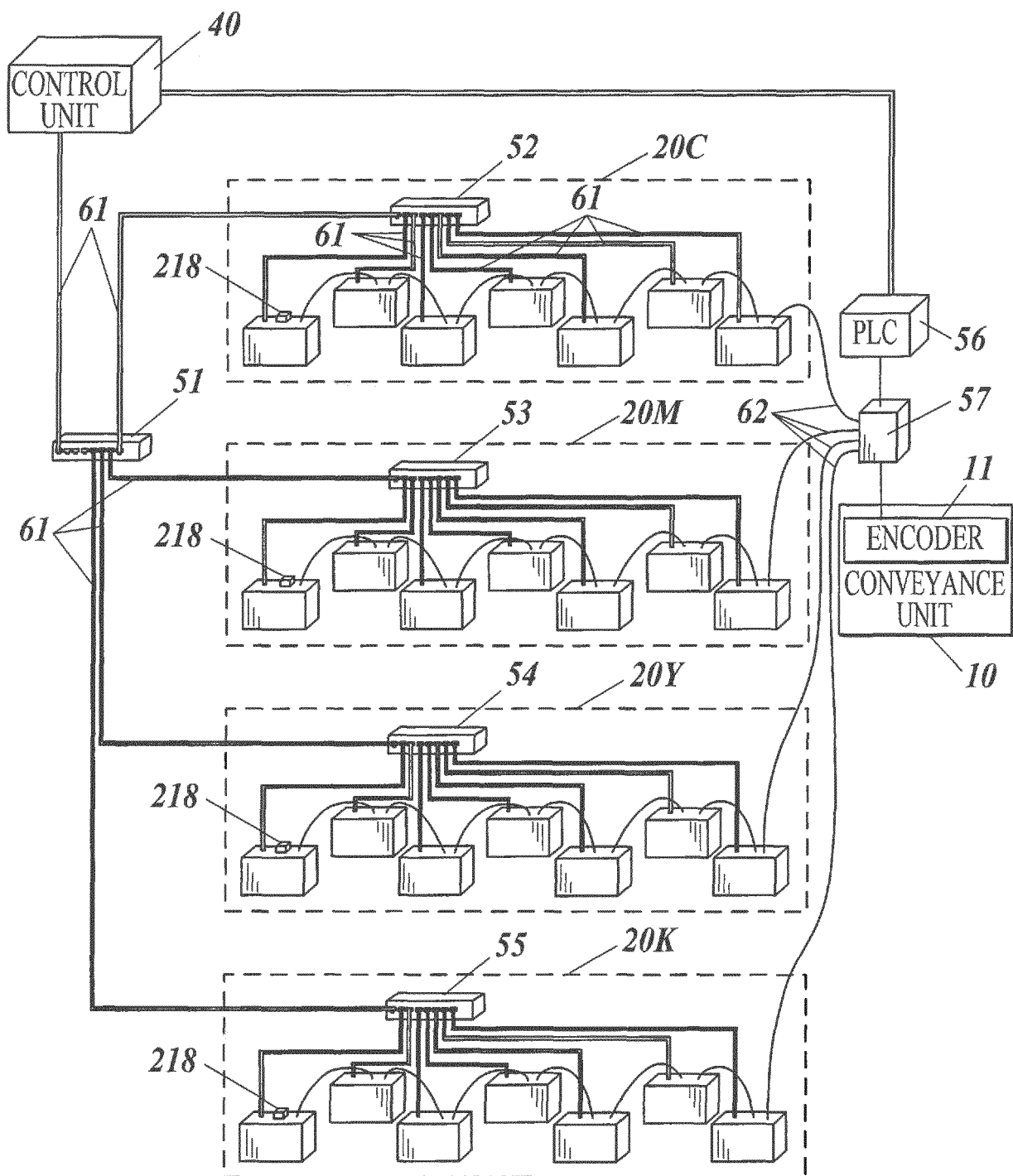


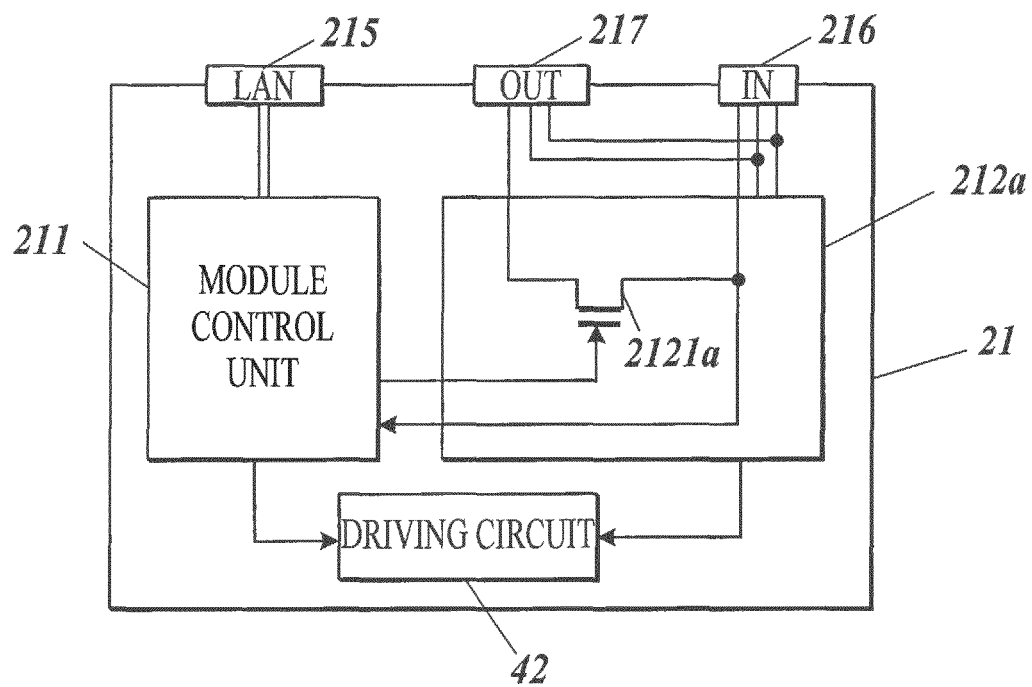
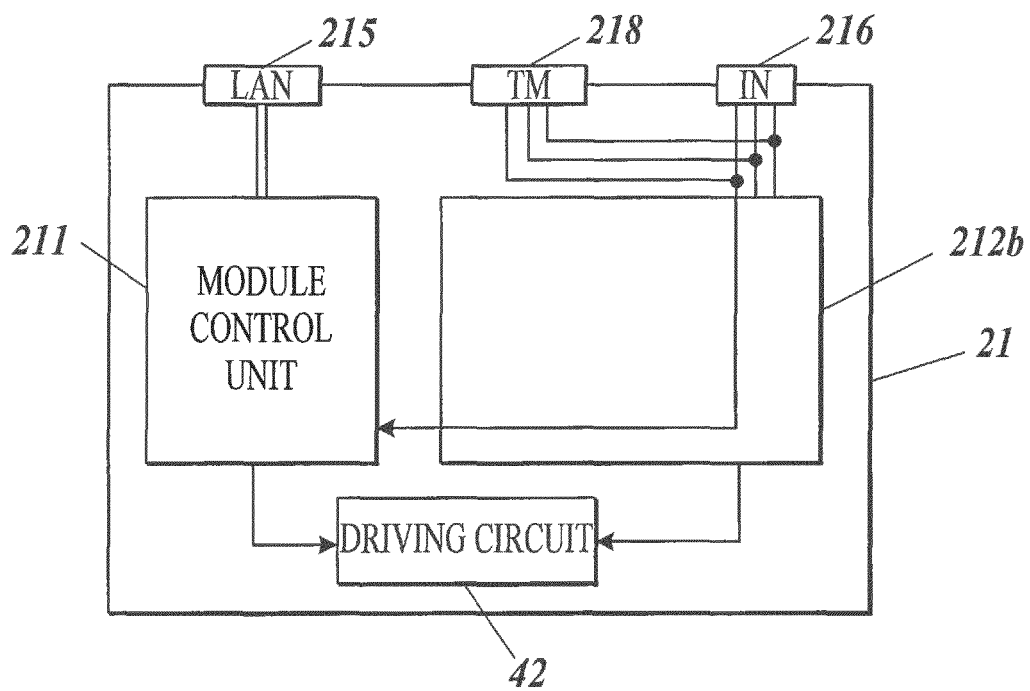
FIG.11A**FIG.11B**

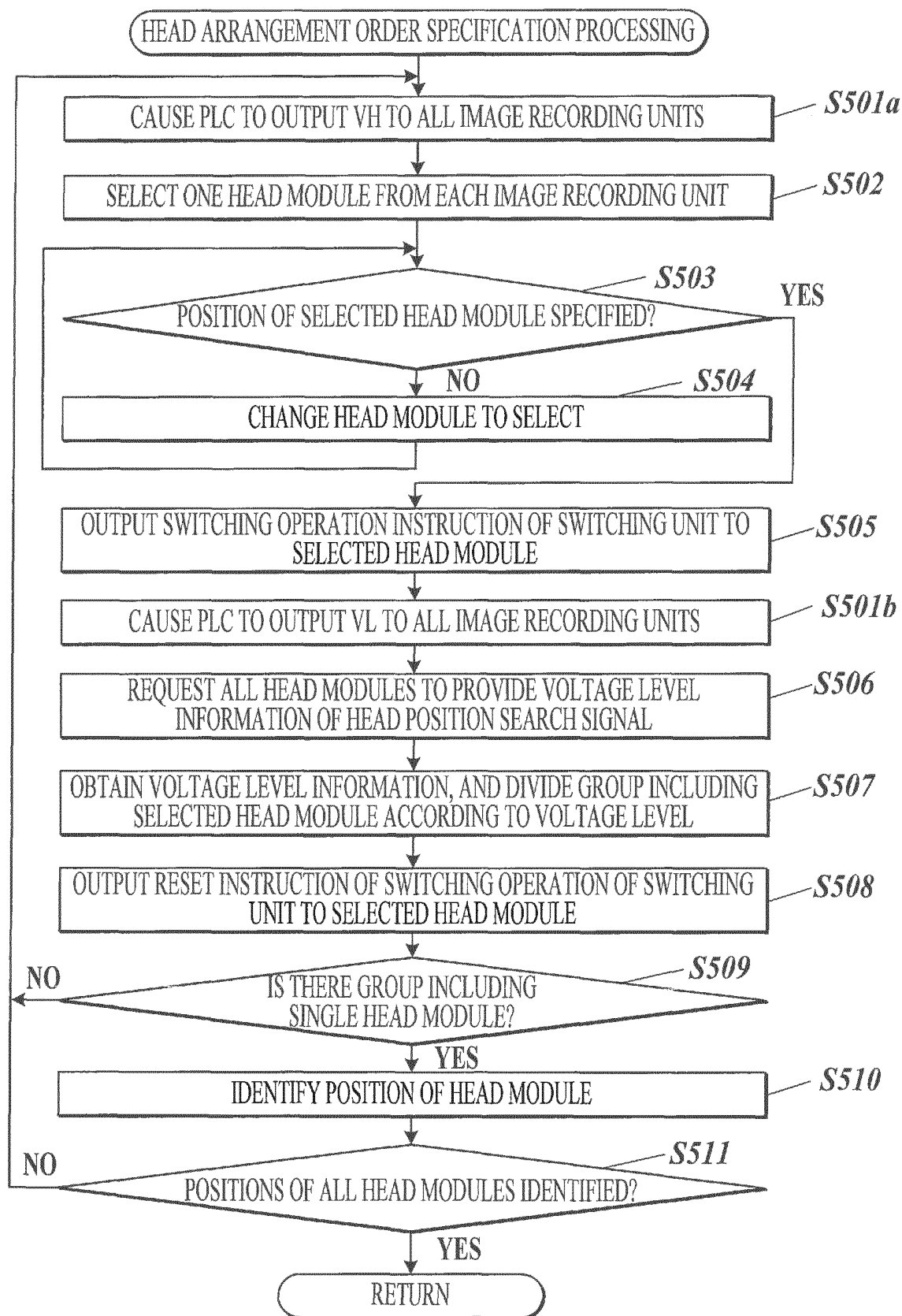
FIG.12

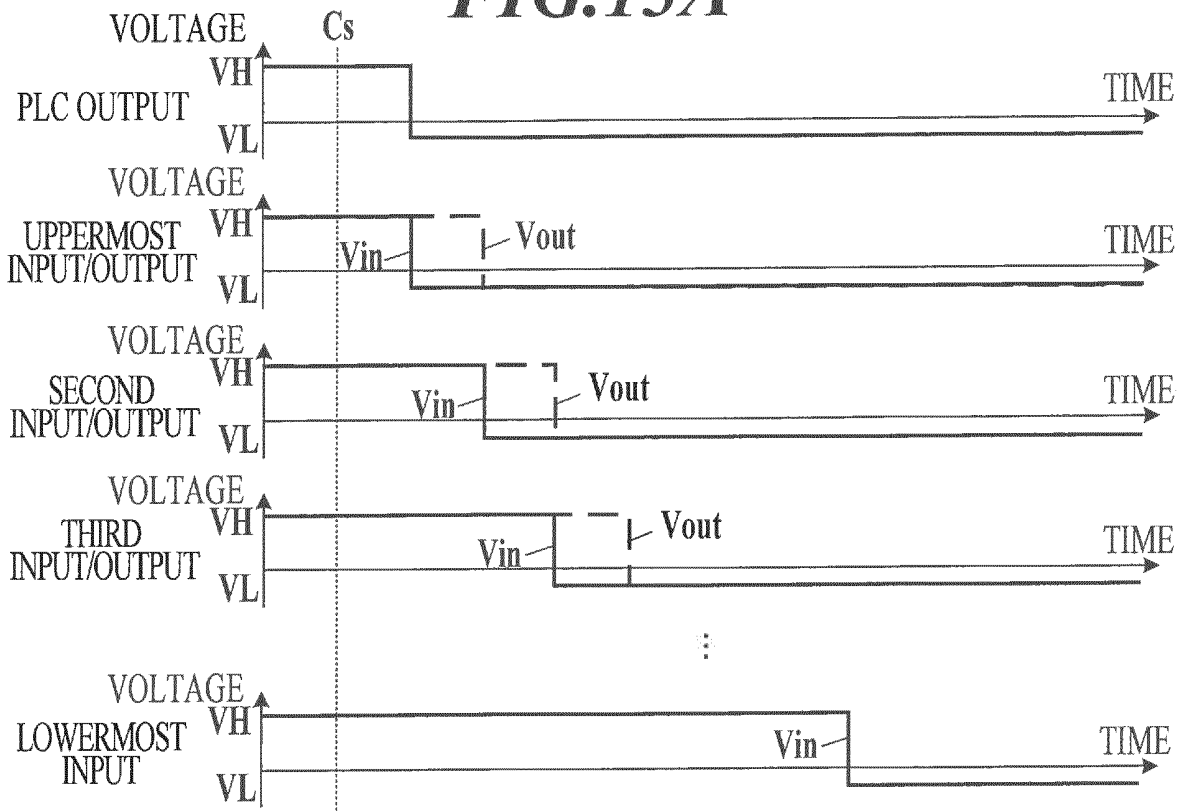
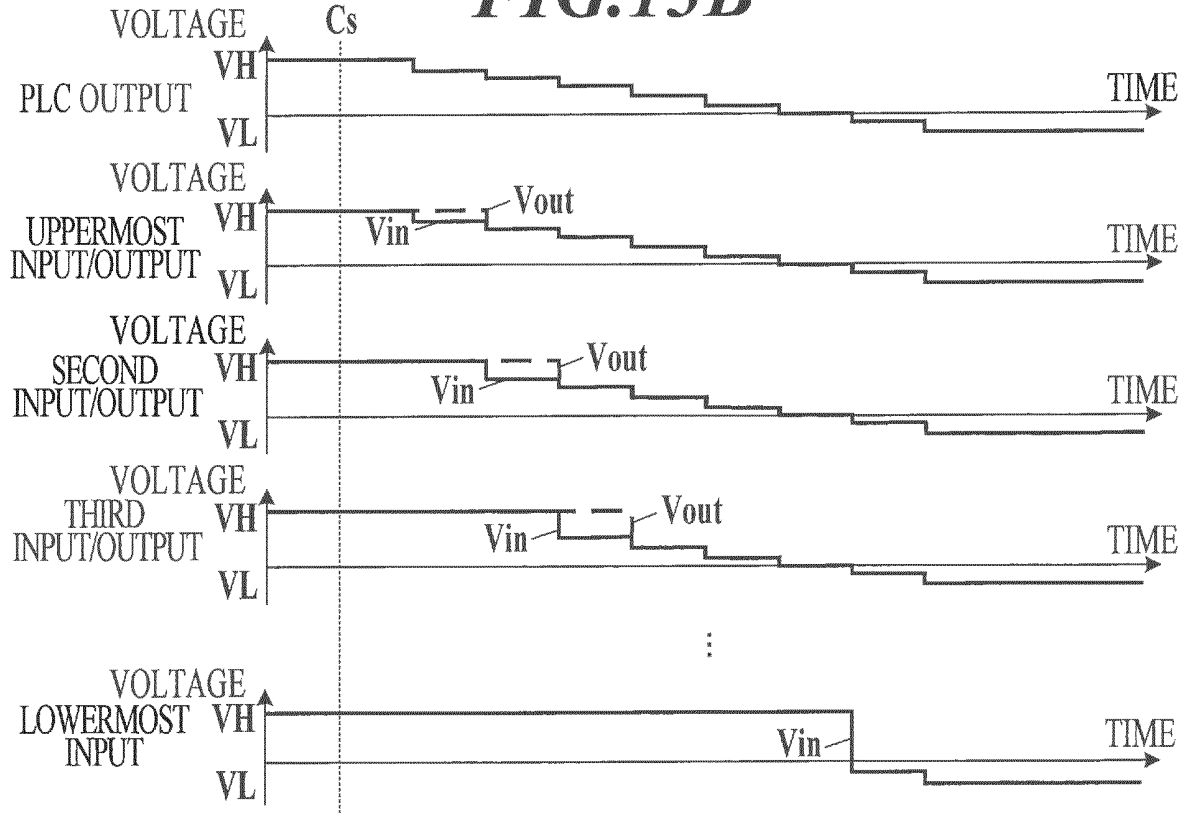
FIG.13A**FIG.13B**

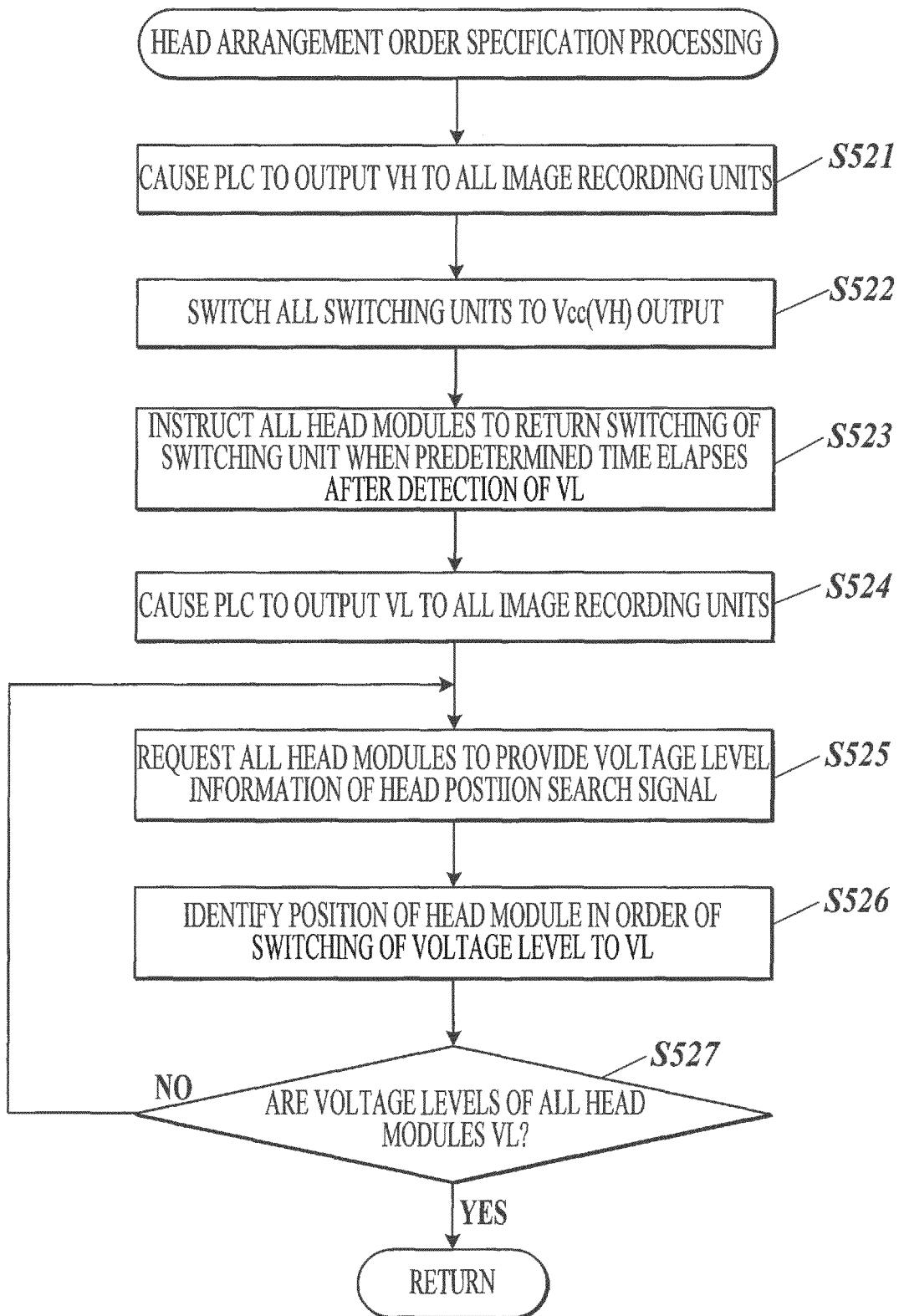
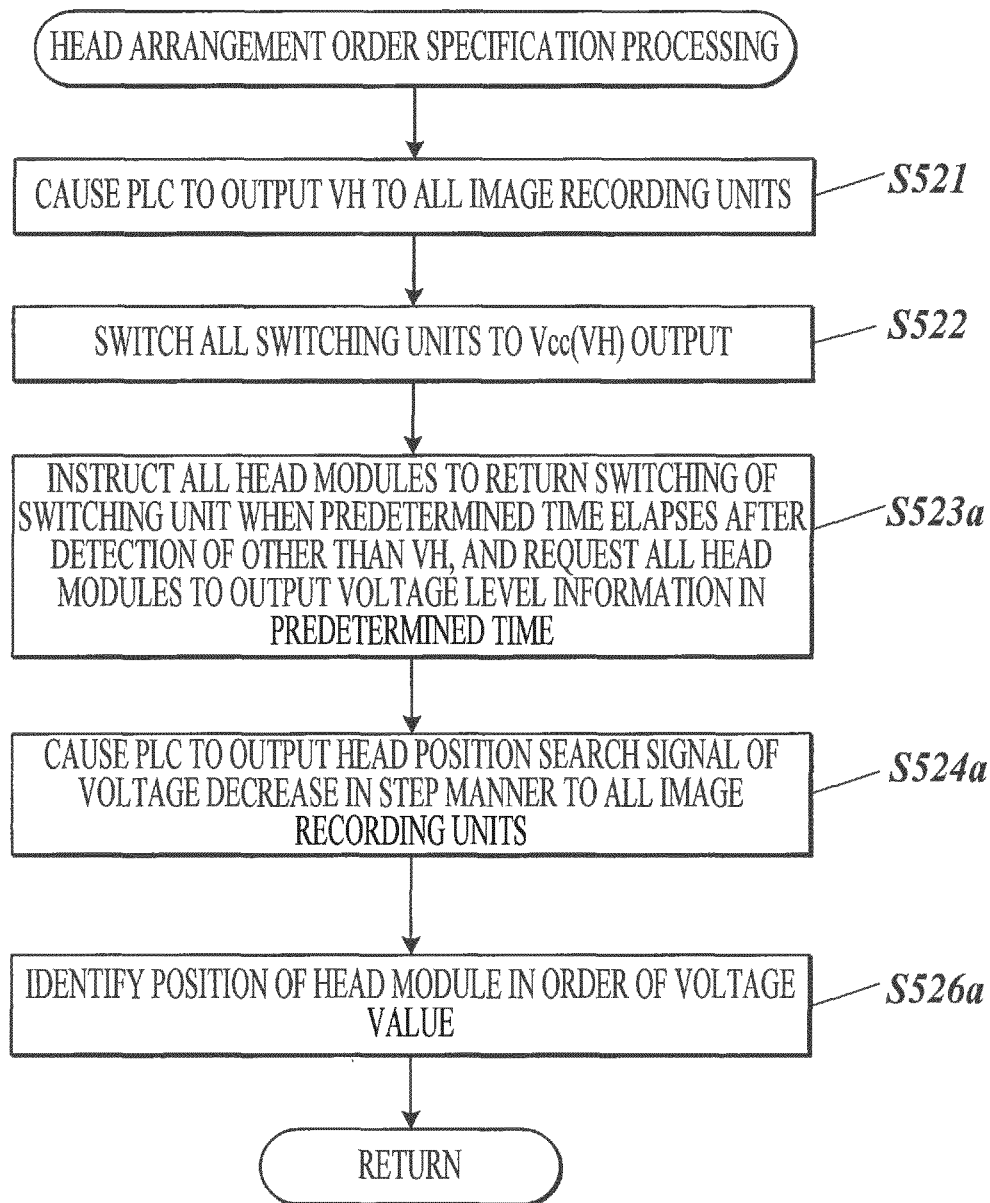
FIG.14

FIG.15

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/040025

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. B41J2/14 (2006.01) i, B41J2/155 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. B41J2/14, B41J2/155

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2017

Registered utility model specifications of Japan 1996-2017

Published registered utility model applications of Japan 1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2010-76191 A (FUJIFILM CORPORATION) 08 April 2010, paragraphs [0018]-[0055], fig. 1-3 (Family: none)	1-20
A	JP 2007-1208 A (CANON INC.) 11 January 2007, paragraphs [0025]-[0029], fig. 3, 4 (Family: none)	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

12 December 2017

Date of mailing of the international search report

26 December 2017

Name and mailing address of the ISA/

Japan Patent Office

3-4-3, Kasumigaseki, Chiyoda-ku,

Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/040025

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2009-181387 A (SEIKO EPSON CORPORATION) 13 August 2009, paragraphs [0009]-[0029], [0079]-[0101], fig. 1-3, 11 & US 2009/0195570 A1, paragraphs [0025]-[0050], [0098]-[0121], fig. 1-3, 11 & CN 101497277 A	1-20
A	WO 2005/110764 A1 (LEXMARK INTERNATIONAL, INC.) 24 November 2005, column 13, lines 10-22, fig. 23, 24 (Family: none)	1-20

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008012909 A [0005]