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(54) **IMAGE FORMING DEVICE, DOCUMENT FEEDER, AND METHOD OF DETERMINING SHEET SIZE**

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(57) **ABSTRACT**

An image forming device includes a tray on which a sheet is to be placed and including a plurality of first electrodes arranged along a first direction, a sheet guide including a conductor and movable along the first direction to different positions relative to the first electrodes, a detection circuit electrically connected to each of the first electrodes and configured to detect an amount of electric charge in each of the first electrodes, a printer configured to form an image on the sheet supplied from the tray, and a processor configured to determine a size of the sheet placed on the tray based on amounts of electric charge detected by the detection circuit, and control the printer to form an image on the sheet using the determined size.

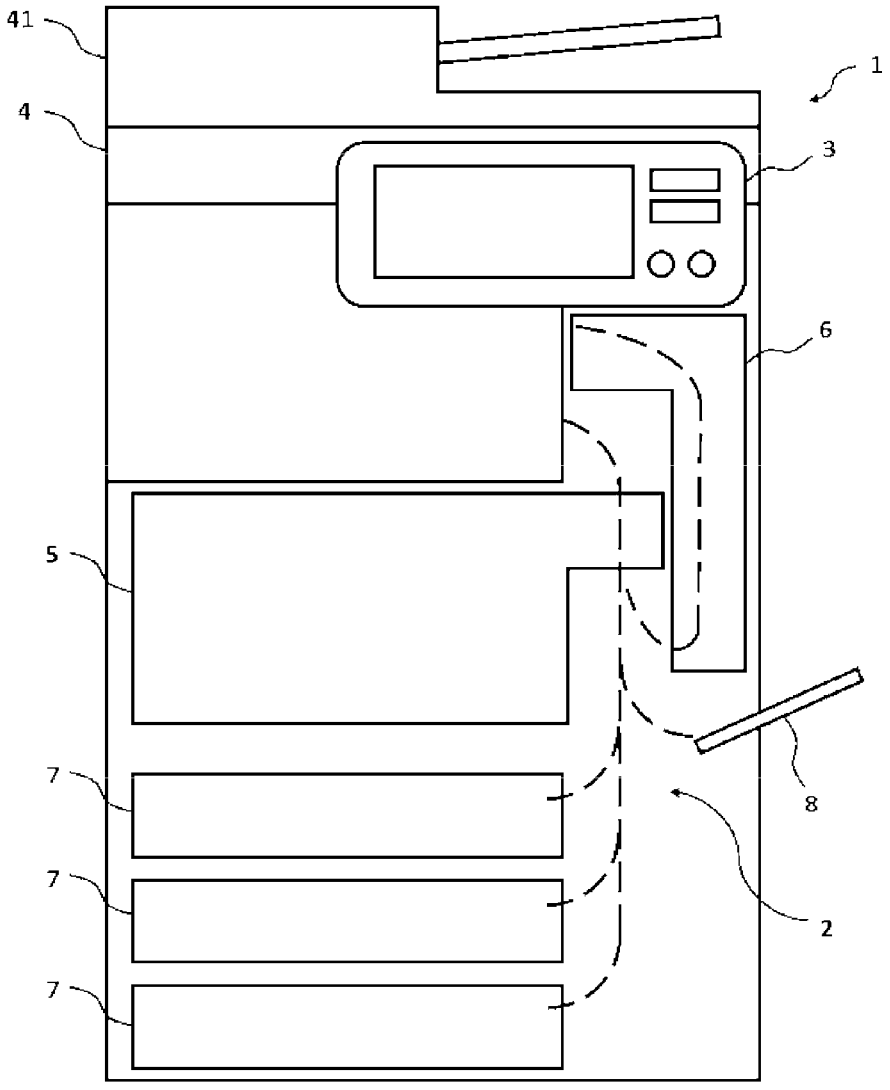

FIG. 1

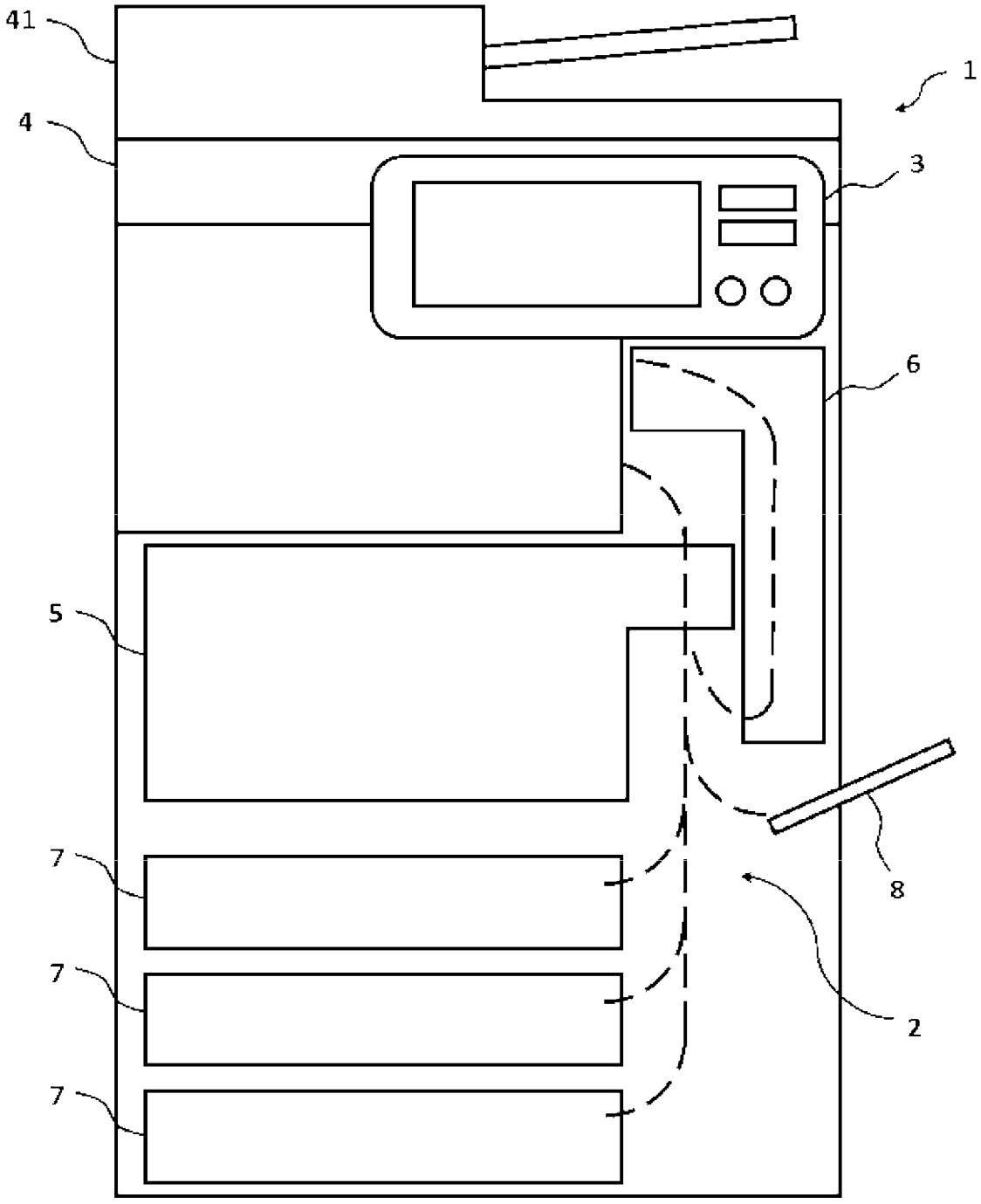

FIG. 2

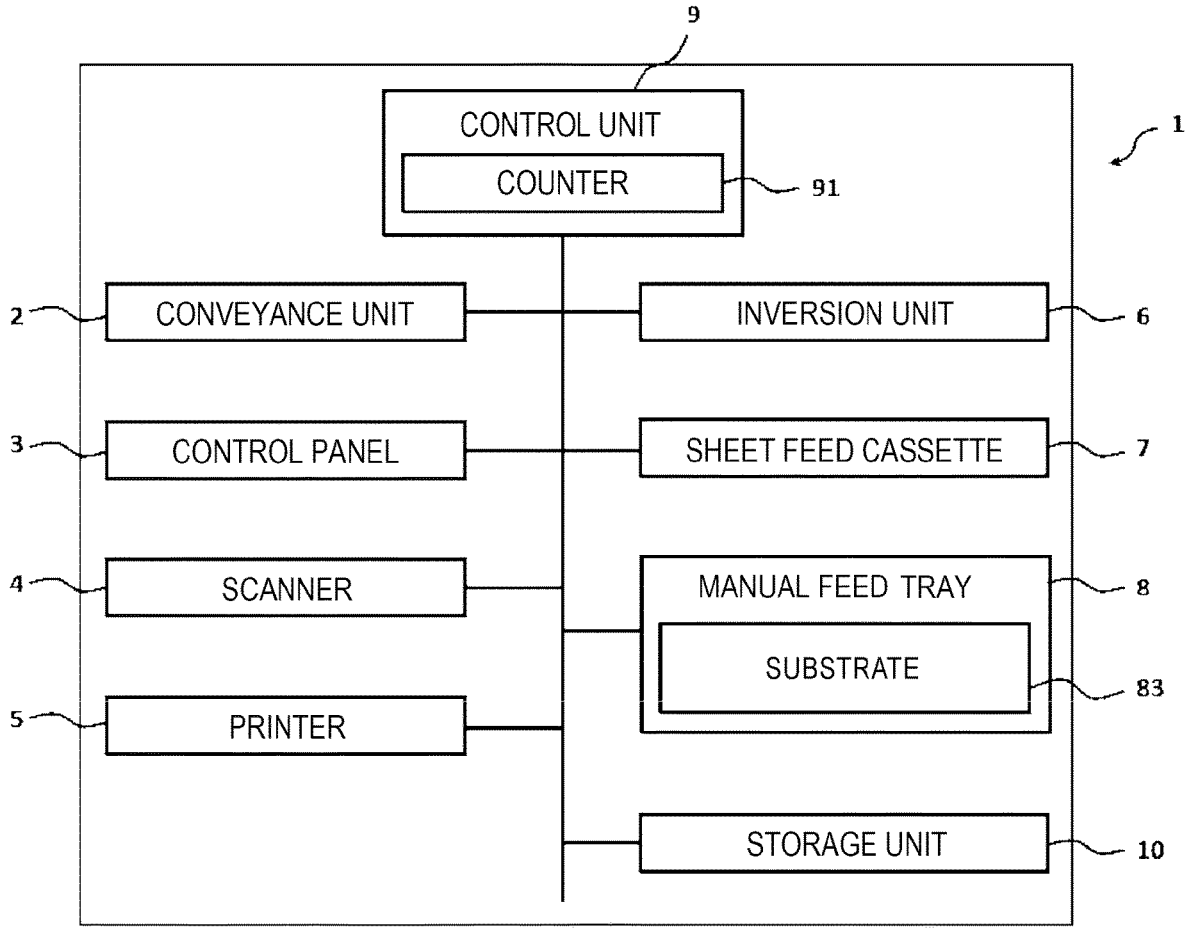
9
CONTROL UNIT
COUNTER
91
1
2
CONVEYANCE UNIT
INVERSION UNIT
6
3
CONTROL PANEL
SHEET FEED CASSETTE
7
4
SCANNER
MANUAL FEED TRAY
8
SUBSTRATE
83
5
PRINTER
STORAGE UNIT
10

FIG. 3

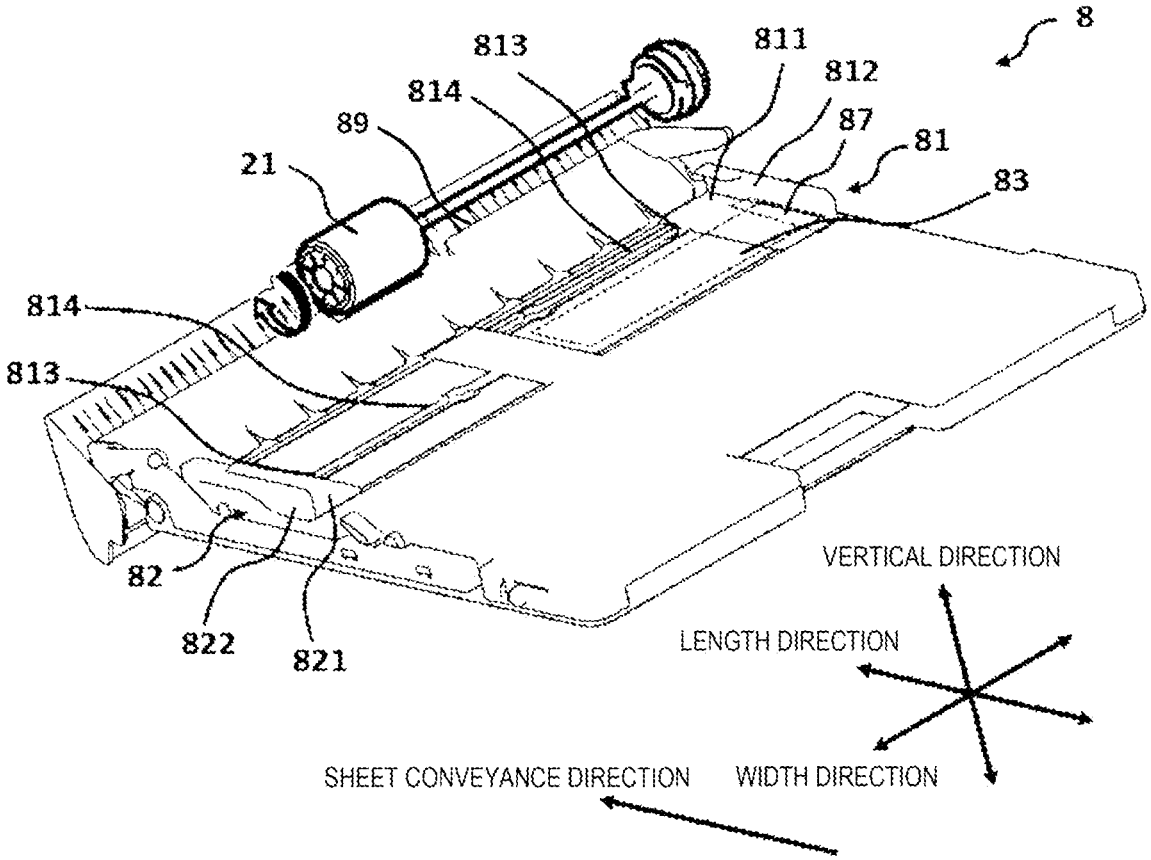
8
813
811
812
814
89
87
81
21
83
814
813
82
822
821
VERTICAL DIRECTION
LENGTH DIRECTION
SHEET CONVEYANCE DIRECTION
WIDTH DIRECTION

FIG. 4

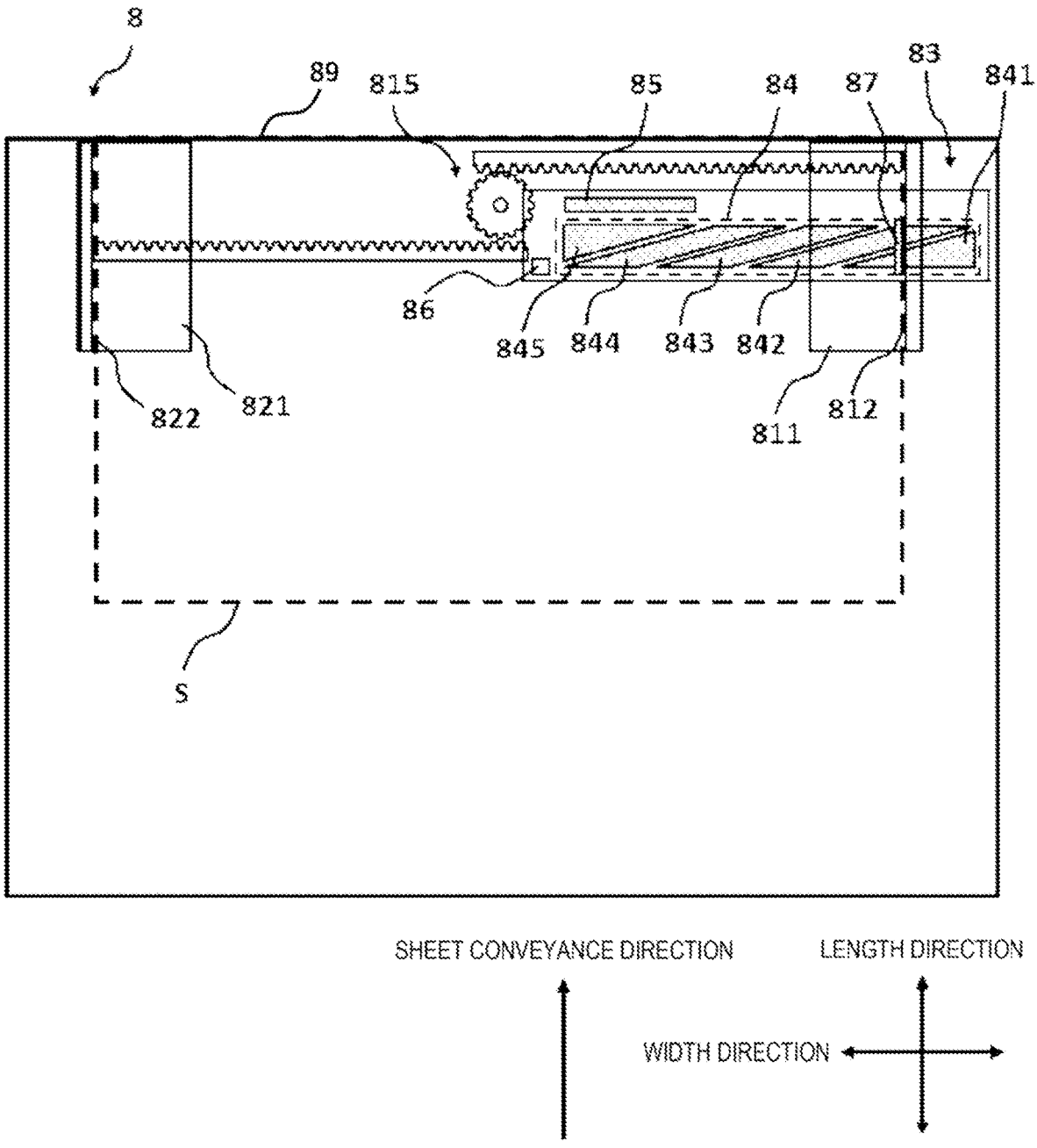
8
89
815
85
84
87
83
841
86
845
844
843
842
822
821
811
812
S
SHEET CONVEYANCE DIRECTION
LENGTH DIRECTION
WIDTH DIRECTION

FIG. 5

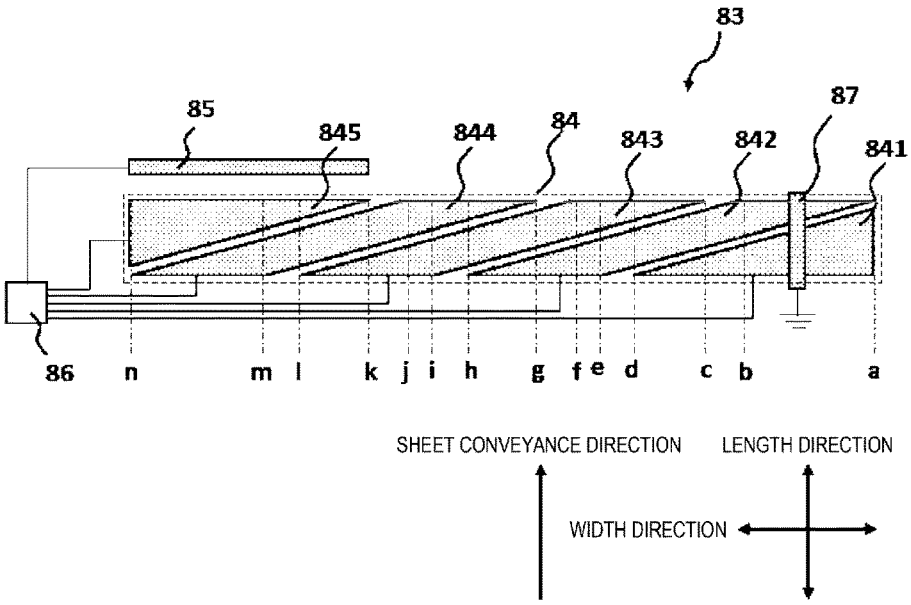
83
85
845
844
84
843
842
87
841
86
n
m
l
k
j
i
h
g
f
e
d
c
b
a
SHEET CONVEYANCE DIRECTION
LENGTH DIRECTION
WIDTH DIRECTION

FIG. 6

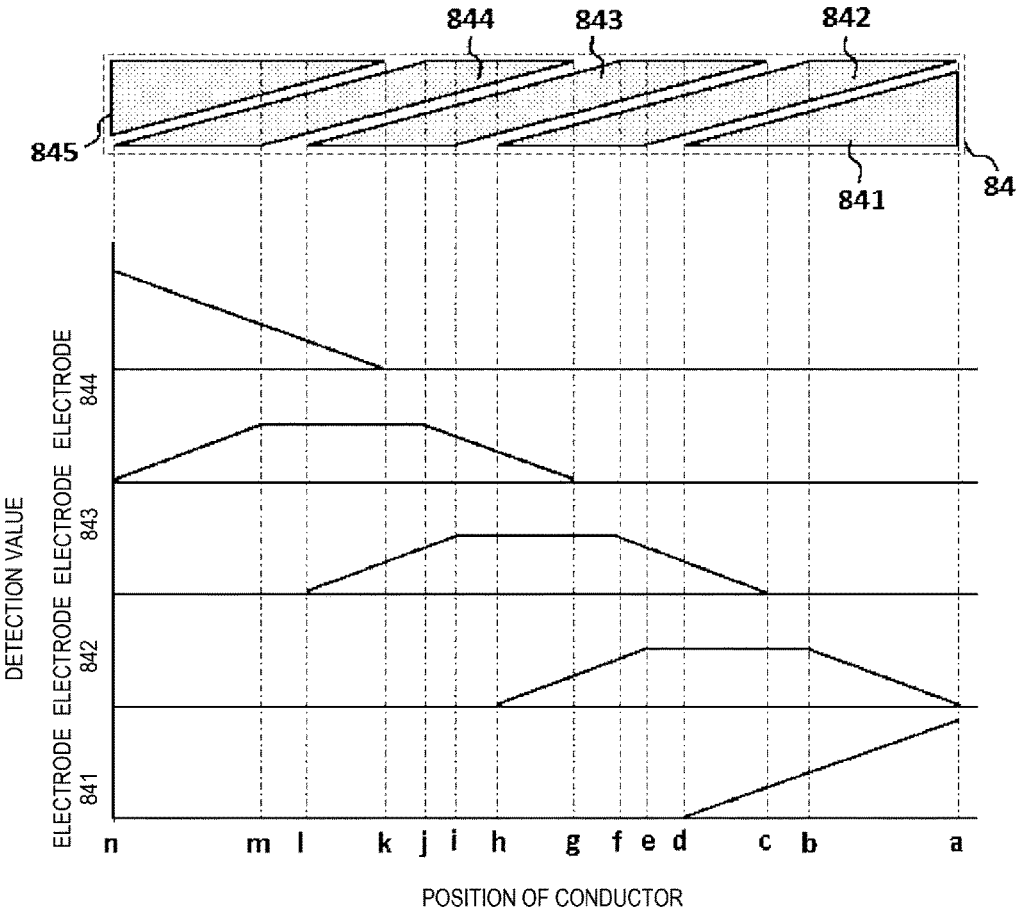
844
843
842
845
841
84
DETECTION VALUE
ELECTRODE 844
ELECTRODE 843
ELECTRODE 842
ELECTRODE 841
n
m
l
k
j
i
h
g
f
e
d
c
b
a
POSITION OF CONDUCTOR

FIG. 7

	BUSINESS CARD	A6	A5	B5	A4	B4	A3
ELECTRODE 845	1	1	0	0	0	0	0
ELECTRODE 844	0	1	1	0	0	0	0
ELECTRODE 843	0	0	1	1	1	0	0
ELECTRODE 842	0	0	0	0	1	1	0
ELECTRODE 841	0	0	0	0	0	1	1

FIG. 8

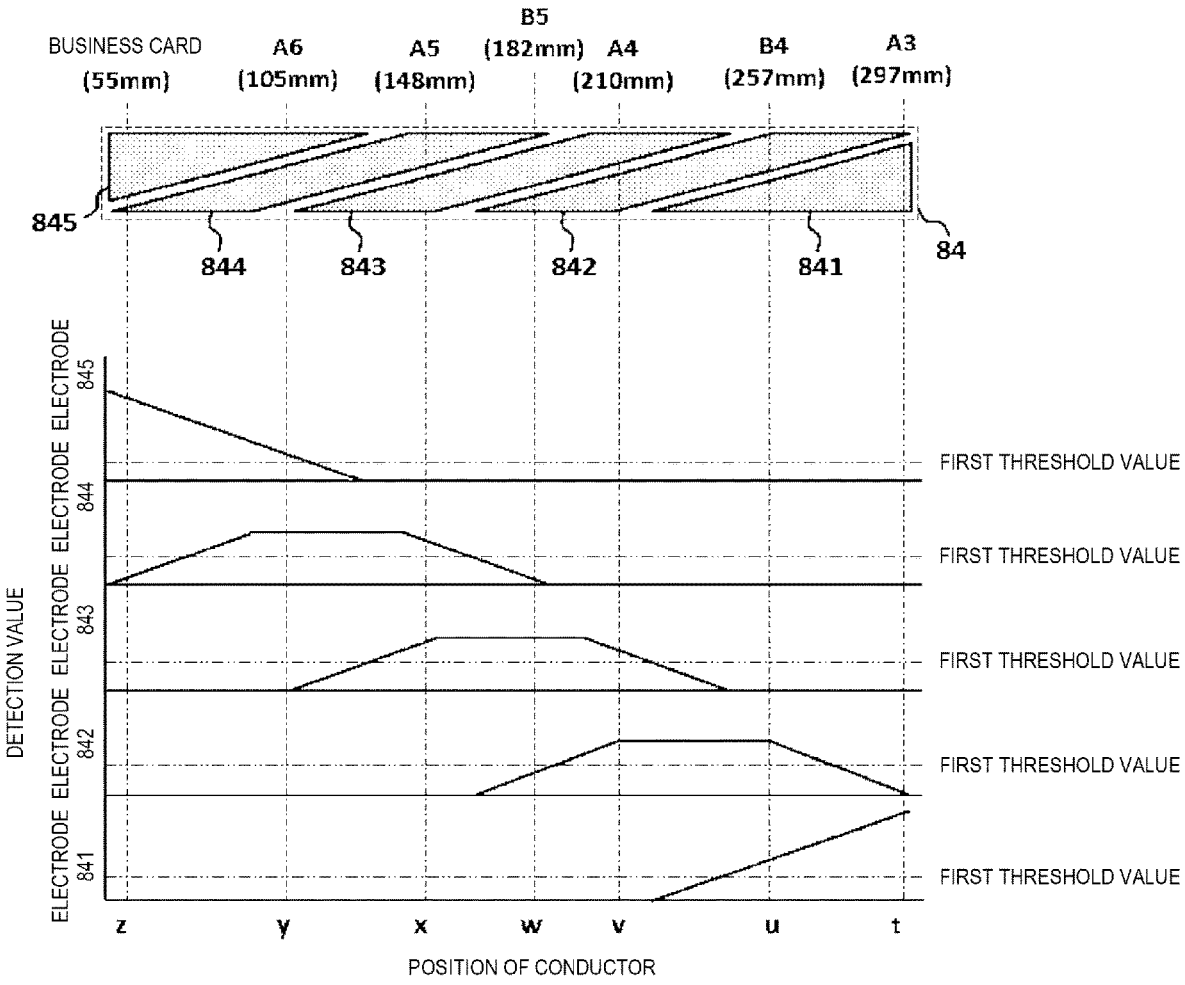

FIG. 9

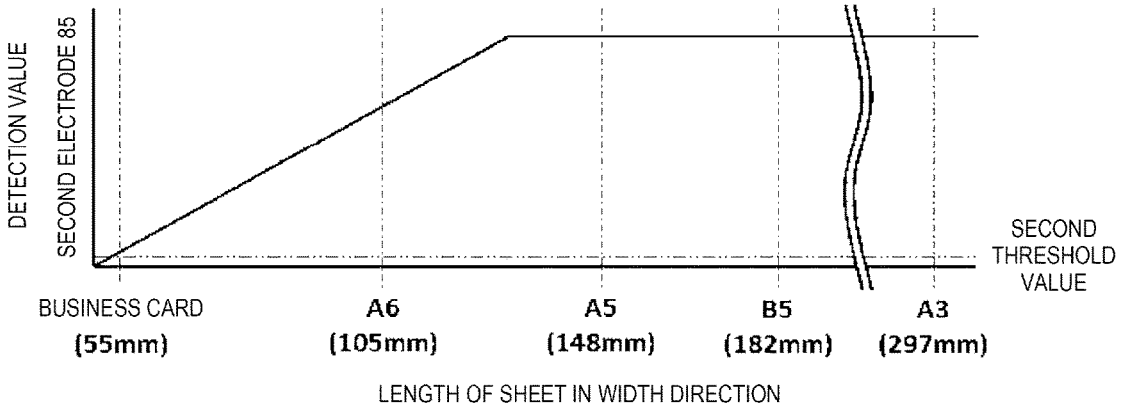
DETECTION VALUE
SECOND ELECTRODE 85
SECOND THRESHOLD VALUE
BUSINESS CARD (55mm)
A6 (105mm)
A5 (148mm)
B5 (182mm)
A3 (297mm)
LENGTH OF SHEET IN WIDTH DIRECTION

FIG. 10

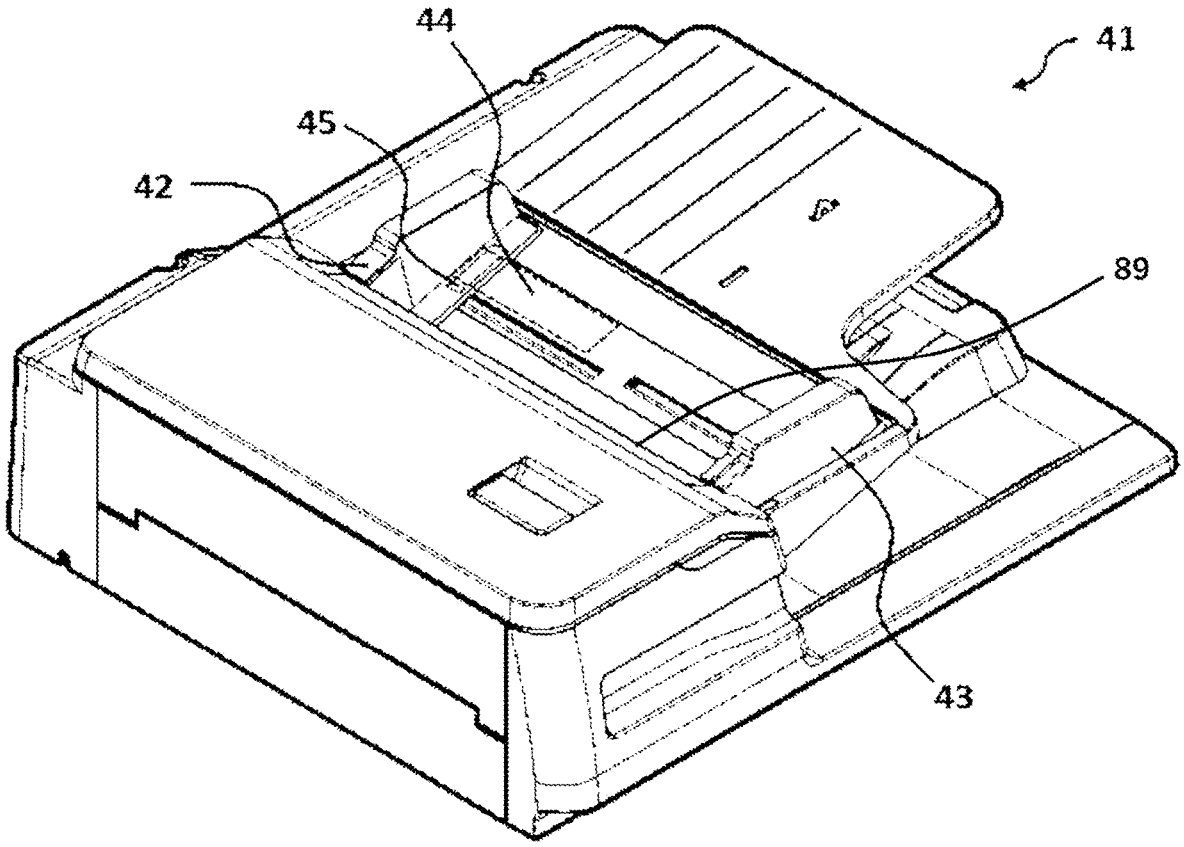
44
41
45
42
89
43

FIG. 11

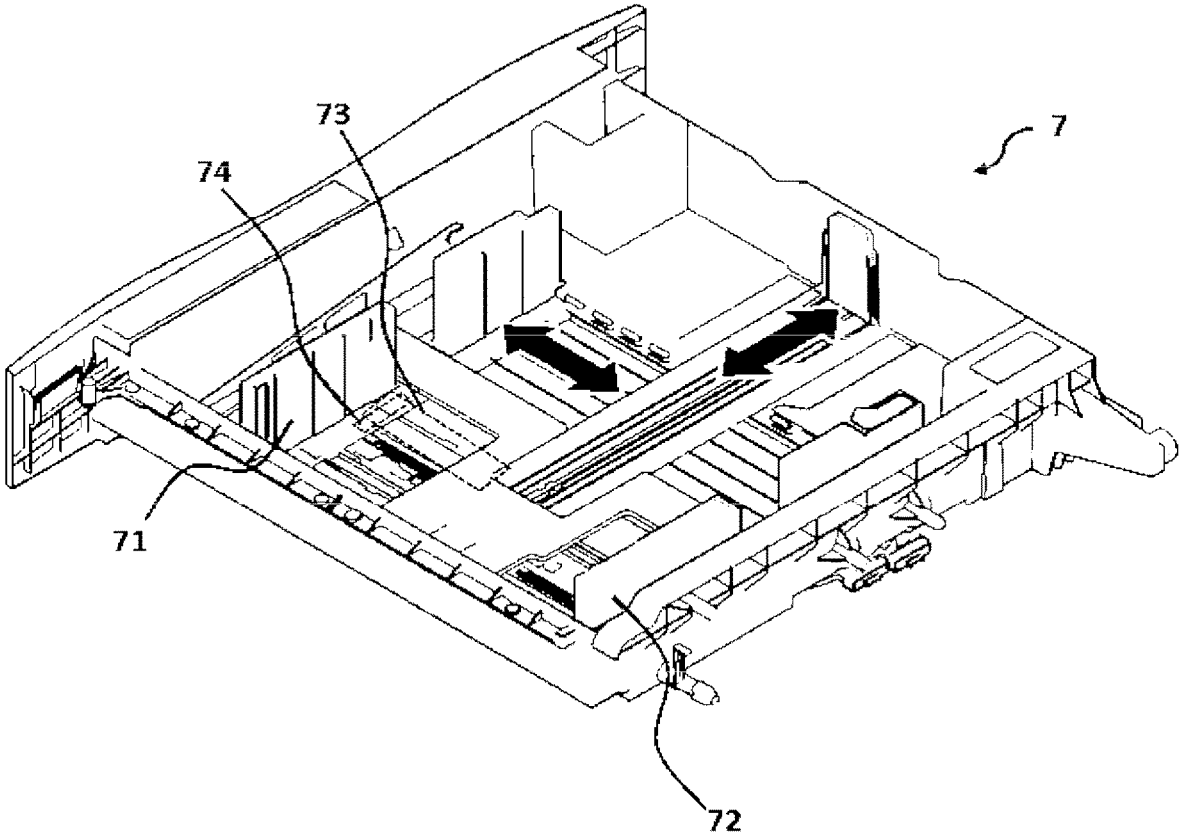

FIG. 12

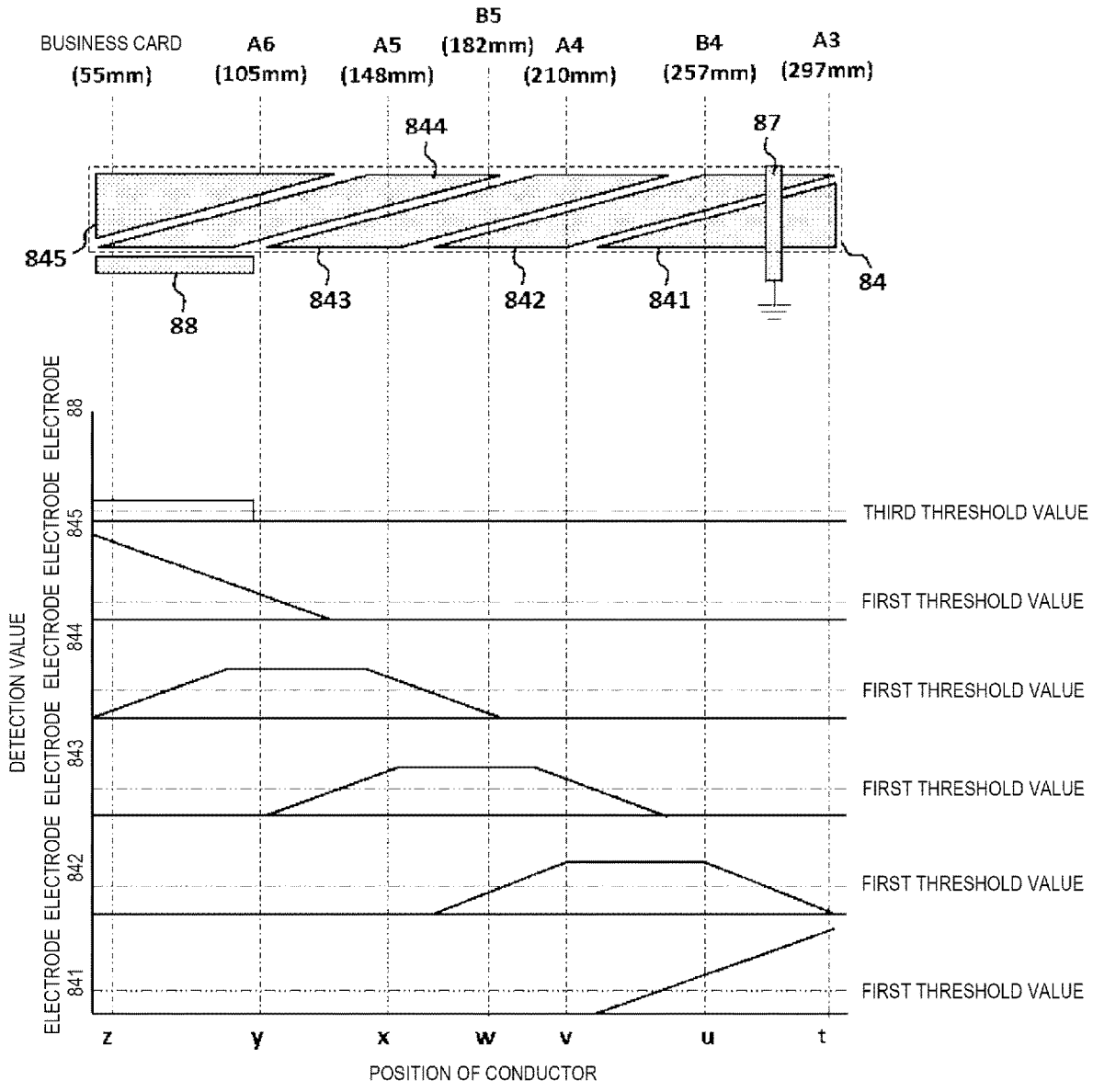
BUSINESS CARD
(55mm)
A6
(105mm)
A5
(148mm)
B5
(182mm)
A4
(210mm)
B4
(257mm)
A3
(297mm)
844
87
845
88
843
842
841
84
DETECTION VALUE
ELECTRODE 88
ELECTRODE 845
ELECTRODE 844
ELECTRODE 843
ELECTRODE 842
ELECTRODE 841
THIRD THRESHOLD VALUE
FIRST THRESHOLD VALUE
FIRST THRESHOLD VALUE
FIRST THRESHOLD VALUE
FIRST THRESHOLD VALUE
FIRST THRESHOLD VALUE
z
y
x
w
v
u
t
POSITION OF CONDUCTOR

IMAGE FORMING DEVICE, DOCUMENT FEEDER, AND METHOD OF DETERMINING SHEET SIZE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2021-148013, filed Sep. 10, 2021, the entire contents of which are incorporated herein by reference.

FIELD

[0002] Embodiments described herein relate generally to an image forming device, a document feeder, and a method of determining a sheet size.

BACKGROUND

[0003] A conventional image forming device having a manual feed tray can determine a size of a sheet placed thereon by detecting a position of a movable sheet guide via electrodes formed on the manual feed tray. However, in such a method, only a limited number of sheet sizes can be detected depending on the number of electrodes formed on the manual feed tray.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. **1** is a schematic diagram illustrating a multi-function peripheral (MFP) according to an embodiment.

[0005] FIG. **2** is a hardware block diagram of an MFP.

[0006] FIG. **3** is a perspective view illustrating a manual feed tray.

[0007] FIG. **4** is a plan view illustrating a manual feed tray.

[0008] FIG. **5** is a schematic diagram illustrating a substrate.

[0009] FIG. **6** is a graph of detection values detected at a first set of electrodes.

[0010] FIG. **7** is a table for determining sheet sizes based on detection values.

[0011] FIG. **8** is a graph of detection values detected at a first set of electrodes corresponding to predetermined sheet sizes.

[0012] FIG. **9** is a graph illustrating a change in detection values detected by a detection circuit at a second electrode.

[0013] FIG. **10** is a perspective view illustrating an auto document feeder (ADF).

[0014] FIG. **11** is a perspective view illustrating a sheet feed cassette.

[0015] FIG. **12** is a graph of detection values detected at a first set of electrodes and a third electrode.

DETAILED DESCRIPTION

[0016] In general, according to one embodiment, an image forming device capable of detecting various sheet sizes is provided.

[0017] An image forming device in one embodiment includes a tray on which a sheet is to be placed and including a plurality of first electrodes arranged along a first direction, a sheet guide including a conductor and movable along the first direction to different positions relative to the first electrodes, a detection circuit electrically connected to each of the first electrodes and configured to detect an amount of electric charge in each of the first electrodes, a printer configured to form an image on the sheet supplied from the tray, and a processor. The processor is configured to determine a size of the sheet placed on the tray based on amounts of electric charge detected by the detection circuit, and control the printer to form an image on the sheet using the determined size.

[0018] Hereinafter, certain example embodiments of an image forming device will be described with reference to the drawings. In this disclosure, an MFP **1** is described as an example of such an image forming device.

[0019] FIG. **1** is a schematic diagram illustrating the MFP **1**. As illustrated in FIG. **1**, the MFP **1** includes a conveyance unit **2**, a control panel **3**, a scanner **4**, a printer **5**, an inversion unit **6**, one or more sheet feed cassettes **7**, and a manual feed tray **8**.

[0020] FIG. **2** is a hardware block diagram of the MFP **1**. As illustrated in FIG. **2**, the MFP **1** further includes a control unit **9**, a storage unit **10**, and a substrate **83**.

[0021] The control unit **9** includes a processor such as a central processing unit (CPU) or a micro-processing unit (MPU), and a memory. The memory is, for example, a semiconductor memory, and includes a read only memory (ROM) that stores various control programs and a random access memory (RAM) that is used as a temporary work area by the processor. The control unit **9** controls each component of the MFP **1** based on the various programs and the like stored in the ROM.

[0022] The storage unit **10** is, for example, a hard disk drive (HDD) or a solid state drive (SSD). The storage unit **10** stores, for example, image data or the like acquired or generated by each component of the MFP **1**.

[0023] The conveyance unit **2** includes a conveyance path connecting the sheet feed cassettes **7**, the manual feed tray **8**, the printer **5**, a sheet discharge port, and the inversion unit **6**. The conveyance unit **2** conveys a sheet from the sheet feed cassette **7** or the manual feed tray **8** along the conveyance path. The conveyance unit **2** includes a plurality of conveyance rollers arranged along the conveyance path. In a conveyance direction of the sheet, the sheet feed cassette **7** or the manual feed tray **8** is referred to as the upstream side, and the sheet discharge port is referred to as the downstream side.

[0024] The control panel **3** includes a plurality of buttons for receiving an operation of a user. The control panel **3** outputs a signal corresponding to the operation performed by the user to the control unit **9** of the MFP **1**. The control panel **3** includes a touch panel integrated with a display. The display displays information related to the MFP **1**. The display is an image display device such as a liquid crystal display or an organic electro luminescence (EL) display.

[0025] The scanner **4** reads an image printed on a document. The scanner **4** includes, for example, an ADF **41** or a dual scan document feeder (DSDF). For example, the ADF **41** continuously conveys a plurality of sheets set in the ADF **41** in a manner of sliding the sheets on a glass surface of the scanner **4**, and the scanner **4** reads images on the conveyed sheets. Information on the read images may be transmitted to an external device such as a personal computer (PC) via a network. The information on the read images may be stored in the storage unit **10**, and may be printed on sheets as images by the printer **5**.

[0026] The printer **5** forms an image on a sheet conveyed from the sheet feed cassette **7** or the manual feed tray **8** based on image information transmitted from the scanner **4** or an

external device such as a PC. The image information indicates a size of the sheet on which the image is formed. The sheet on which the image is formed is conveyed to the sheet discharge port and discharged. The printer **5** uses toner as developer, for example.

[0027] The inversion unit **6** conveys a sheet, which is conveyed from the printer **5**, to the upstream side of the printer **5** so as to invert front and back sides of the sheet. The inversion unit **6** is arranged downstream of the printer **5** in the conveyance path. The inversion unit **6** operates, for example, when performing double-sided printing to form images on both sides of the sheet.

[0028] Each of the sheet feed cassettes **7** accommodates sheets on which images are to be formed.

[0029] FIG. **3** is a perspective view illustrating the manual feed tray **8** according to an embodiment. FIG. **4** is a plan view illustrating the manual feed tray **8** according to an embodiment. On the surface of the manual feed tray **8** on which sheets are stacked, a direction parallel to the conveyance direction of the sheet is defined as a length direction. On the surface of the manual feed tray **8** on which the sheets are stacked, a direction orthogonal to the conveyance direction of the sheet is defined as a width direction. A direction orthogonal to both the length direction and the width direction of the manual feed tray **8** is defined as a vertical direction. FIG. **4** illustrates sheets S stacked on the manual feed tray **8** when viewed from the vertical direction.

[0030] The manual feed tray **8** stacks sheets on which images are to be formed. The manual feed tray **8** draws the stacked sheets into the MFP **1** by a sheet feed roller **21**. The manual feed tray **8** includes a first guide **81**, a second guide **82**, the substrate **83**, and a conductor **87**.

[0031] The first guide **81** and the second guide **82** are a pair of guide members provided on the surface of the manual feed tray **8**. The first guide **81** includes a bottom surface **811** that is a flat surface facing the surface of the manual feed tray **8** and extending along the length direction, and a guide surface **812** that is a flat surface extending vertically upward from the bottom surface **811**. The second guide **82** includes a bottom surface **821** that is a flat surface facing the surface of the manual feed tray **8** and extending along the length direction, and a guide surface **822** that is a flat surface extending vertically upward from the bottom surface **821**. The first guide **81** and the second guide **82** are provided on the surface of the manual feed tray **8** with an interval therebetween in the width direction such that the guide surfaces **812** and **822** face each other. The guide surface **812** of the first guide **81** and the guide surface **822** of the second guide **82** guide the sheet stacked on and drawn from the manual feed tray **8** along the length direction by coming into contact with side edges of the sheet. A guide width, which is a distance between the guide surfaces **812** and **822** in the width direction, is variable. The first guide **81** and the second guide **82** have, for example, protrusions **813** extending vertically downward from the bottom surface **811** and the bottom surface **821** respectively, and each of the protrusions **813** engages with a corresponding groove **814** provided along the width direction on the surface of the manual feed tray **8**. The first guide **81** and the second guide **82** move in the width direction along the groove **814** of the manual feed tray **8**. The first guide **81** and the second guide **82** simultaneously move by a rack and pinion structure **815** in opposite directions with respect to a center line along the length direction on the surface of the manual feed tray **8**.

[0032] The conductor **87** faces the substrate **83**. In an embodiment, the conductor **87** is provided on the bottom surface **811** of the first guide **81** so as to face the manual feed tray **8**. The conductor **87** has, for example, a rectangular plate shape. The conductor **87** is, for example, a metal plate. As the first guide **81** moves, the conductor **87** moves in the width direction while facing the substrate **83**. That is, the position of the conductor **87** in the width direction above the substrate **83** corresponds to the position of the first guide **81** in the width direction above the substrate **83**. The installation position of the conductor **87** is not limited to the bottom surface **811** of the first guide **81** as long as the conductor **87** faces the substrate **83**.

[0033] FIG. **5** is a schematic diagram of the substrate **83** according to an embodiment. The substrate **83** includes a first set of electrodes **84** including electrodes **841**-**845**, a second electrode **85**, and a detection circuit **86**. The substrate **83** is provided on the surface of the manual feed tray **8** so as to face the conductor **87**. The substrate **83** extends in the width direction that is a moving direction of the conductor **87**. The substrate **83** is provided such that the leftmost electrode **845** and the second electrode **85** face each other along the surface of the manual feed tray **8**.

[0034] The first set of electrodes **84** is used to detect the position of the conductor **87** above the substrate **83**. The electrode **841**, the electrode **842**, the electrode **843**, the electrode **844**, and the electrode **845** are arranged along the width direction. That is, the electrodes **841**-**845** are arranged in order along the moving direction of the conductor **87**. Each of the electrodes **841**-**845** of the first electrode **84** is disposed to face the conductor **87** in the vertical direction at some positions of the electrode in the width direction. The number of the first set of electrodes **84** is not limited to five and may be any number greater than two.

[0035] The conductor **87** faces, in the vertical direction, both the electrode **842** and the electrode **843**, and the electrode **841** at some positions of the electrode **841** in the width direction. The conductor **87** faces, in the vertical direction, one or more of the electrode **841**, the electrode **843**, and the electrode **844**, and the electrode **842** at some positions of the electrode **842** in the width direction. The conductor **87** faces, in the vertical direction, one or more of the electrode **841**, the electrode **842**, the electrode **844**, and the electrode **845**, and the electrode **843** at some positions of the electrode **843** in the width direction. The conductor **87** faces, in the vertical direction, one or more of the electrode **842**, the electrode **843**, and the electrode **845**, and the electrode **844** at some positions of the electrode **844** in the width direction. The conductor **87** faces, in the vertical direction, one or both of the electrode **843** and the electrode **844**, and the electrode **845** at some positions of the electrode **845** in the width direction.

[0036] An arrangement of the first set of electrodes **84** will be described in detail. For convenience of the following description, positions of the first set of electrodes **84** in the width direction are marked from "a" to "n" and defined as a point "a" to a point "n". The length of the electrode **841** in the width direction corresponds to the distance from the point "a" to the point "d". The length of the electrode **842** in the width direction corresponds to the distance from the point "a" to the point "h". The length of the electrode **843** in the width direction corresponds to the distance from the point "c" to the point "l". The length of the electrode **844** in the width direction corresponds to the distance from the

point "g" to the point "n". The length of the electrode **845** in the width direction corresponds to the distance from the point "k" to the point "n".

[0037] For convenience of the description, a length of the electrode **841** facing the conductor **87** in the length direction is referred to as a first length. A length of the electrode **842** facing the conductor **87** in the length direction is referred to as a second length. A length of the electrode **843** facing the conductor **87** in the length direction is referred to as a third length. A length of the electrode **844** facing the conductor **87** in the length direction is referred to as a fourth length. A length of the electrode **845** facing the conductor **87** in the length direction is referred to as a fifth length.

[0038] For example, in FIG. **5**, when the conductor **87** is located in a section extending from the point "a" to the point "b" facing the electrode **841** and the electrode **842**, the conductor **87** faces the electrode **841** having the first length on the upstream side in the sheet conveyance direction and faces the electrode **842** having the second length on a downstream side in the sheet conveyance direction. As the conductor **87** is moved from the point "a" to the point "b", the first length becomes shorter, and the second length becomes longer. When the conductor **87** is located in a section extending from the point "b" to the point "c" facing the electrode **841** and the electrode **842**, the conductor **87** faces the electrode **841** having the first length on the upstream side in the sheet conveyance direction and faces the electrode **842** having the second length on the downstream side in the sheet conveyance direction. As the conductor **87** is moved from the point "b" to the point "c", the first length becomes shorter, and the second length is constant.

[0039] When the conductor **87** is located in a section extending from the point "c" to the point "d" facing the electrode **841**, the electrode **842**, and the electrode **843**, the conductor **87** faces the electrode **841** having the first length on the upstream side in the sheet conveyance direction, faces the electrode **842** having the second length on the downstream side in the sheet conveyance direction, and faces the electrode **843** having the third length on the downstream side of the electrode **842** in the sheet conveyance direction. As the conductor **87** is moved from the point "c" to the point "d", the first length becomes shorter, the second length is constant, and the third length becomes longer. When the conductor **87** is located in a section extending from the point "d" to the point "e" facing the electrode **842** and the electrode **843**, the conductor **87** faces the electrode **842** having the second length on the upstream side in the sheet conveyance direction and faces the electrode **843** having the third length on the downstream side in the sheet conveyance direction. As the conductor **87** is moved from the point "d" to the point "e", the second length is constant, and the third length becomes longer. When the conductor **87** is located in a section extending from the point "e" to the point "f" facing the electrode **842** and the electrode **843**, the conductor **87** faces the electrode **842** having the second length on the upstream side in the sheet conveyance direction and faces the electrode **843** having the third length on the downstream side in the sheet conveyance direction. As the conductor **87** is moved from the point "e" to the point "f", the second length becomes shorter, and the third length becomes longer. When the conductor **87** is located in a section extending from the point "f" to the point "g" facing the electrode **842** and the electrode **843**, the conductor **87** faces the electrode **842** having the second length on the upstream side in the sheet conveyance direction and faces the electrode **843** having the third length on the downstream side in the sheet conveyance direction. As the conductor **87** is moved from the point "f" to the point "g", the second length becomes shorter, and the third length is constant.

[0040] When the conductor **87** is located in a section extending from the point "g" to the point "h" facing the electrode **842**, the electrode **843**, and the electrode **844**, the conductor **87** faces the electrode **842** having the second length on the upstream side in the sheet conveyance direction, faces the electrode **843** having the third length on the downstream side in the sheet conveyance direction, and faces the electrode **844** having the fourth length on the downstream side of the electrode **843** in the sheet conveyance direction. As the conductor **87** is moved from the point "g" to the point "h", the second length becomes shorter, the third length is constant, and the fourth length becomes longer. When the conductor **87** is located in a section extending from the point "h" to the point "i" facing the electrode **843** and the electrode **844**, the conductor **87** faces the electrode **843** having the third length on the upstream side in the sheet conveyance direction and faces the electrode **844** having the fourth length on the downstream side in the sheet conveyance direction. As the conductor **87** is moved from the point "h" to the point "i", the third length is constant, and the fourth length becomes longer. When the conductor **87** is located in a section extending from the point "i" to the point "j" facing the electrode **843** and the electrode **844**, the conductor **87** faces the electrode **843** having the third length on the upstream side in the sheet conveyance direction and faces the electrode **844** having the fourth length on the downstream side in the sheet conveyance direction. As the conductor **87** is moved from the point "i" to the point "j", the third length becomes shorter, and the fourth length becomes longer. When the conductor **87** is located in a section extending from the point "j" to the point "k" facing the electrode **843** and the electrode **844**, the conductor **87** faces the electrode **843** having the third length on the upstream side in the sheet conveyance direction and faces the electrode **844** having the fourth length on the downstream side in the sheet conveyance direction. As the conductor **87** is moved from the point "j" to the point "k", the third length becomes shorter, and the fourth length is constant.

[0041] When the conductor **87** is located in a section extending from the point "k" to the point "l" facing the electrode **843**, the electrode **844**, and the electrode **845**, the conductor **87** faces the electrode **843** having the third length on the upstream side in the sheet conveyance direction, faces the electrode **844** having the fourth length on the downstream side in the sheet conveyance direction, and faces the electrode **845** having the fifth length on the downstream side of the electrode **844** in the sheet conveyance direction. As the conductor **87** is moved from the point "k" to the point "l", the third length becomes shorter, the fourth length is constant, and the fifth length becomes longer. When the conductor **87** is located in a section extending from the point "l" to the point "m" facing the electrode **844** and the electrode **845**, the conductor **87** faces the electrode **844** having the fourth length on the upstream side in the sheet conveyance direction and faces the electrode **845** having the fifth length on the downstream side in the sheet conveyance direction. As the conductor **87** is moved from the point "l"

to the point "m", the fourth length is constant, and the fifth length becomes longer. When the conductor **87** is located in a section extending from the point "m" to the point "n" facing the electrode **844** and the electrode **845**, the conductor **87** faces the electrode **844** having the fourth length on the upstream side in the sheet conveyance direction and faces the electrode **845** having the fifth length on the downstream side in the sheet conveyance direction. As the conductor **87** is moved from the point "m" to the point "n", the fourth length becomes shorter, and the fifth length becomes longer.

[0042] Among the areas of the electrodes **841-845** facing the conductor **87**, the area of at least one electrode facing the conductor **87** increases or decreases as the conductor **87** moves. For example, although the area of the electrode **842** facing the conductor **87** is constant between the point "b" and the point "e", the area of at least one of the electrode **841** and the electrode **843** facing the conductor **87** changes as the conductor **87** moves.

[0043] The second electrode **85** detects whether a sheet is placed on the manual feed tray **8**. The second electrode **85** is provided so as to cover a position in the width direction where a sheet having a smallest size among sheets placed on the manual feed tray **8** is placed. In an embodiment, the second electrode **85** is provided in the vicinity of the electrode **845** along the width direction. The second electrode **85** is provided at a position not facing the conductor **87**.

[0044] The detection circuit **86** is electrically connected to the first set of electrodes **84** and the second electrode **85**. The detection circuit **86** detects a detection value at each of the first set of electrodes **84** and the second electrode **85**. In one embodiment, the detection value is a capacitance of a capacitor formed between each of the first set of electrodes **84** and the second electrode **85** and the conductor **87**. Alternatively, the detection value may be the amount of electric charge or voltage at each of the first set of electrodes **84** and the second electrode **85**. The detection circuit **86** may calculate a capacitance from the detected voltage. A capacitor is formed by each electrode **841-845** of the first set of electrodes **84** when the electrode and the conductor **87** face each other, and the capacitance varies depending on the area of the electrode facing the conductor **87**. In one embodiment, the detection circuit **86** detects, as a detection value, a difference between a capacitance at each electrode **841-845** in a state of not facing the conductor **87** and a capacitance at each electrode **841-845** increased due to facing the conductor **87**. Hereinafter, the detection circuit **86** is described to detect a capacitance of a capacitor formed by each of the first set of electrodes **84** and the second electrode **85** and the conductor **87**.

[0045] FIG. **6** illustrates a graph of the detection values detected by the detection circuit **86** at the first set of electrodes **84**. FIG. **6** indicates the point "a" to the point "l" of the first set of electrodes **84** shown in FIG. **5**. The vertical axis of the graph of FIG. **6** indicates the detection value at each electrode **841-845**. The horizontal axis of the graph of FIG. **6** indicates a position of the conductor **87** above the first set of electrodes **84**. That is, the horizontal axis of the graph of FIG. **6** indicates the position of the first guide **81** in the width direction above the substrate **83**.

[0046] The detection value of the electrode **841** is maximum when the conductor **87** is at the point "a", and is minimum when the conductor **87** is in a section extending from the point "d" to the point "n". The detection value of the electrode **842** is maximum when the conductor **87** is in a section extending from the point "b" to the point "e", and is minimum when the conductor **87** is in a section extending from the point "h" to the point "n". The detection value of the electrode **843** is maximum when the conductor **87** is in a section extending from the point "f" to the point "i", and is minimum when the conductor **87** is in a section extending from the point "a" to the point "c", or in a section extending from the point "l" to the point "n". The detection value of the electrode **844** is maximum when the conductor **87** is in a section extending from the point "j" to the point "m", and is minimum when the conductor **87** is in a section extending from the point "a" to the point "g". The detection value of the electrode **845** is maximum when the conductor **87** is at the point "n", and is minimum when the conductor **87** is in a section extending from the point "a" to the point "k".

[0047] The control unit **9** detects the position of the conductor **87** in the width direction above the first electrode **84** based on the detection values of the electrodes **841-845**. For example, the control unit **9** compares the detection values of the electrodes **841** to **845** to detect the position of the conductor **87**. When comparing the detection values of the electrodes **841-845**, the control unit **9** may compare the detection values of all the electrodes **841-845** or may compare the detection values of at least two or more of the electrodes **841-845**.

[0048] For example, when a ratio of the detection values of the electrode **841** and the electrode **842** is 20:1, the control unit **9** determines that the conductor **87** is at a position where the length in the width direction between the guide surface **812** and the guide surface **822** is 297 mm. For example, when a ratio of the detection values of the electrode **842**, the electrode **843**, and the electrode **844** is 4:10:1, the control unit determines that the conductor **87** is at a position where the length in the width direction between the guide surface **812** and the guide surface **822** is 182 mm. The ratio of the detection values of the first set of electrodes **84** for detecting the position of the conductor **87** is an example, and is not limited to these numerical values.

[0049] The capacitance detected at each electrodes **841-845** of the first set of electrodes **84** may vary depending on a temperature of the outside air. Therefore, the control unit **9** may adjust the detected values based on a measured temperature to detect the position of the conductor **87**.

[0050] Accordingly, the control unit **9** can detect the position of the first guide **81** above the manual feed tray **8**, that is, the width of the sheet to be used.

[0051] The control unit **9** can detect a size of a predetermined sheet. The predetermined sheet is, for example, a sheet having a size of a standard defined as an international standard of ISO or the like. For example, JIS standard sizes are used, e.g., A3 size (297×420), B4 size (257×364), A4 size (210×297), B5 size (182×257), A5 size (148×210), A6 size (105×148), and a business card size (55×91). These sheet sizes are represented by (width×length).

[0052] FIG. **7** illustrates a table for determining predetermined sheet sizes based on detection values. FIG. **8** illustrates a graph of the detection values detected at the first set of electrodes **84** corresponding to the predetermined sizes. The control unit **9** detects the position of the conductor **87** in the width direction above the first electrode **84** based on whether the detection value of each of the electrodes **841-845** is equal to or higher than a first threshold value. Regarding the numerical values illustrated in FIG. **7**, "1"

indicates that the detection value of the electrode is equal to or greater than the first threshold value, and "0" indicates that the detection value of the electrode is less than the first threshold value. The first threshold value may be a different value depending on each electrode **841-845**. In FIG. **8**, for convenience of description, positions of the first electrode **84** in the width direction are marked from "t" to "z" and defined as points "t" to "z".

[0053] In FIG. **8**, for example, when the conductor **87** is at the point "t", only the detection value of the electrode **841** is equal to or greater than the first threshold value, and the size of the sheet is detected as A3 size. When the conductor **87** is at the point "u", the detection values of the electrode **841** and the electrode **842** are equal to or greater than the first threshold value, and the size of the sheet is detected as B4 size. When the conductor **87** is at the point "v", the detection values of the electrode **842** and the electrode **843** are equal to or greater than the first threshold value, and the size of the sheet is detected as A4 size. When the conductor **87** is at the point "w", only the detection value of the electrode **843** is equal to or greater than the first threshold value, and the size of the sheet is detected as B5 size. When the conductor **87** is at the point "x", the detection values of the electrode **843** and the electrode **844** are equal to or greater than the first threshold value, and the size of the sheet is detected as A5 size. When the conductor **87** is at the point "y", the detection values of the electrode **844** and the electrode **845** are equal to or greater than the first threshold value, and the size of the sheet is detected as A6 size. When the conductor **87** is at the point "z", only the detection value of the electrode **845** is equal to or greater than the first threshold value, and the size of the sheet is detected as the business card size.

[0054] Accordingly, the control unit **9** can detect a position of the first guide **81** above the manual feed tray **8**, that is, the width of a predetermined sheet to be used.

[0055] As described above, by detecting the position of the first guide **81** above the manual feed tray **8**, an image can be formed, on a sheet supplied from the manual feed tray **8**, based on the position of the first guide **81**.

[0056] The size of the sheet in the width direction is detected in the above-described embodiments. Alternatively, the size of the sheet in the length direction can be detected by arranging the substrate **83** and the conductor **87** along the length direction such that the conductor **87** is movable along the length direction.

[0057] FIG. **9** illustrates a change in capacitance detected by the detection circuit **86** at the second electrode **85**. The vertical axis of the graph of FIG. **9** indicates detection values detected at the second electrode **85**. The horizontal axis of the graph of FIG. **9** indicates a size, in the width direction, of a sheet placed on the second electrode **85**. The graph of FIG. **9** illustrates detection values detected at the second electrode **85** (i.e., capacitances between the second electrode **85** and the sheet placed above and facing the second electrode **85**). The sheet is placed such that a center line of the sheet is aligned with the center line of the manual feed tray **8**. The graph of FIG. **9** is a graph in a case where a length of the sheet placed above the second electrode **85** is at least longer than a length of the second electrode **85** in the length direction. The detection value of the second electrode **85** exceeds a second threshold value when at least a sheet having a smallest size among sheets to be placed on the manual feed tray **8** is placed thereon. In the example of FIG. **9**, the detection value of the second electrode **85** exceeds the second threshold value when at least a sheet having a business card size is placed on the manual feed tray **8**.

[0058] The control unit **9** detects that a sheet is placed on the manual feed tray **8**, by detecting, by the detection circuit **86**, that the detection value of the second electrode **85** is equal to or greater than the second threshold value. Further, the control unit **9** may detect that a sheet is placed on the manual feed tray **8**, by the detection circuit **86** detecting that the detection values of the first set of electrodes **84** and the second electrode **85** are equal to or greater than the second threshold value. The second threshold value related to the detection values of the first set of electrodes **84** is smaller than the first threshold value. The detection values of the first set of electrodes **84** exceed the second threshold value when at least a sheet having a smallest size among sheets to be placed on the manual feed tray **8** is placed thereon.

[0059] Alternatively, a sheet placed on the manual feed tray **8** may be detected by the first set of electrodes **84**. For example, the control unit **9** detects that a sheet is placed on the manual feed tray **8**, by the detection circuit **86** detecting that a detection value of the electrode **845** is equal to or greater than the second threshold value. Preferably, an electrode of the first set of electrodes **84** that detects a sheet does not face the conductor **87** in the vertical direction. This is because there is a high possibility that the detection value at that electrode and the conductor **87** is equal to or greater than the second threshold value, and it will be detected that a sheet is placed even when no sheet is placed. Specifically, when the detection value of the electrode **845** in FIG. **5** is used for detection of a placed sheet, the first set of electrodes **84** can detect sheets having sizes covering from the point "a" to the point "k" which do not face the electrode **845**.

[0060] Accordingly, the MFP **1** according to the above-described embodiments can detect that a sheet is placed on the manual feed tray **8**.

[0061] The control unit **9** can detect a length of the sheet based on a change in the capacitance of the second electrode **85** detected by the detection circuit **86**. The control unit **9** includes a counter circuit **91** for counting time. For example, when a sheet is drawn into the MFP **1** for printing or the like, the control unit **9** counts time elapsed from the start of sheet conveyance until the detection value at the second electrode **85** falls below the second threshold, i.e., the second electrode **85** does not face the sheet. The control unit **9** can detect the length of the sheet placed on the manual feed tray **8** based on: a gap between the second electrode **85** and a carry-in entrance **89** of the housing of the MFP **1** into which the sheet is drawn, a conveyance speed of the sheet, and time counted by the counter **91**. The gap between the second electrode **85** and the carry-in entrance **89** of the MFP **1** and the conveyance speed of the sheet are stored in the storage unit **10** in advance. Specifically, the gap between the second electrode **85** and the carry-in entrance **89** is a distance from the end of the second electrode **85** in the sheet conveyance direction to a position where the end of the sheet placed on the tray in the sheet conveyance direction is engaged with the housing. The conveyance speed of the sheet is calculated from, for example, the rotation speed of the sheet feed roller **21**.

[0062] Accordingly, the MFP **1** according to the above-described embodiments can detect a size of a drawn-in sheet in the length direction.

[0063] FIG. **10** is a perspective view illustrating the ADF **41**. In an embodiment, the ADF **41** provided in the scanner

4 includes a first guide 42, a second guide 43, a substrate 44, and a conductor 45. The first guide 42, the second guide 43, the substrate 44, and the conductor 45 are similar to the first guide 81, the second guide 82, the substrate 83, and the conductor 87 of the manual feed tray 8 described above, and thus descriptions thereof will be omitted. As a control unit that detects a position of the conductor 45 and placement of a sheet, one provided in the ADF 41 may be used. Alternatively, the control unit 9 of the MFP 1 to which the ADF 41 is connected may detect the position of the conductor 45. The control unit provided in the ADF 41 and the control unit 9 of the MFP1 can communicate with each other. The position of the conductor 45 detected by the control unit of the ADF 41 and the information on which the sheet is placed are transmitted to the control unit 9 of the MFP 1.

[0064] Although the manual feed tray 8 and the ADF 41 have been described as examples, the present disclosure is applicable to the sheet feed cassette 7 as illustrated in FIG. 11.

[0065] FIG. 11 is a perspective view illustrating the sheet feed cassette 7. In an embodiment, the sheet feed cassette 7 includes a first guide 71, a second guide 72, a substrate 73, and a conductor 74. The first guide 71, the second guide 72, the substrate 73, and the conductor 74 are similar to the first guide 81, the second guide 82, the substrate 83, and the conductor 87 of the manual feed tray 8 described above, and thus descriptions thereof will be omitted. The control unit 9 of the MFP 1 detects a position of the conductor 74 and placement of a sheet, for example.

[0066] FIG. 12 is a graph of detection values detected at the first set of electrodes 84 and a third electrode 88 according to a modification. In the modification, the control unit 9 can detect that a position of the first guide 81 above the manual feed tray 8, that is, a size, in the width direction, of a sheet to be used does not reach a minimum size supported by the MFP 1. The MFP 1 according to the modification does not support a sheet having a size smaller than A6 size (105×148). The first set of electrodes 84 in FIG. 12 is the same as the one described above. The third electrode 88 is additionally provided on the substrate 83. The third electrode 88 is electrically connected to the detection circuit 86. The conductor 87 faces the third electrode 88 at some positions in the width direction. The third electrode 88 is arranged on a center line side of the manual feed tray 8 with respect to a position corresponding to a size, in the width direction, of the sheet having the minimum size that is supported by the MFP 1 among positions above the manual feed tray 8 detected based on detection values of the first set of electrodes 84, and is arranged in a region where the conductor 87 is movable. In the example of FIG. 12, the third electrode 88 is arranged on the center line side of the manual feed tray 8 with respect to the position (i.e., the point y) where A6 size, which is a size of the sheet supported by the MFP 1, is detected, and is arranged in a region where the conductor 87 is movable. The detection value of the third electrode 88 exceeds a third threshold value when the third electrode 88 and the conductor 87 face each other.

[0067] The control unit 9 detects that the first guide 81 does not reach the position corresponding to the size, in the width direction, of the sheet having the minimum size supported by the MFP 1, by detecting, by the detection circuit 86, that the detection value at the third electrode 88 is equal to or greater than the third threshold value.

[0068] When a detection value at the third electrode 88 is equal to or greater than the third threshold value, the control unit 9 may not accept an input for executing printing for which a sheet is to be fed from the manual feed tray 8. When the detection value at the third electrode 88 of the substrate 44 provided in the ADF 41 is equal to or greater than the third threshold value, an input for executing scanning or copying that requires conveyance of the sheet by the ADF 41 may not be accepted. When the detection value at the third electrode 88 of the substrate 73 provided in the sheet feed cassette 7 is equal to or greater than the third threshold value, an input for executing printing, for which a sheet is to be fed from the paper feed cassette 7 in which the detection value equal to or greater than the third threshold value is detected, may not be accepted.

[0069] Although certain embodiments have been described, these embodiments have been presented by way of examples only, and are not intended to limit the scope of the disclosure. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions, and changes in the form of the embodiments described herein may be made without departing from the spirit of the disclosure. These embodiments and modifications thereof are included in the scope and the spirit of the disclosure and are also included in the disclosure described in the claims and an equivalent scope thereof.

What is claimed is:

1. An image forming device, comprising:
- a tray on which a sheet is to be placed and including a plurality of first electrodes arranged along a first direction;
- a sheet guide including a conductor and movable along the first direction to different positions relative to the first electrodes;
- a detection circuit electrically connected to each of the first electrodes and configured to detect an amount of electric charge in each of the first electrodes;
- a printer configured to form an image on the sheet supplied from the tray; and
- a processor configured to:
  - determine a size of the sheet placed on the tray based on amounts of electric charge detected by the detection circuit, and
  - control the printer to form an image on the sheet using the determined size.

2. The image forming device according to claim 1, wherein two of the first electrodes that are adjacent to each other are separated by a gap extending along a second direction that is oblique with respect to the first direction.

3. The image forming device according to claim 2, wherein the first direction is perpendicular to a sheet conveyance direction in which the sheet is conveyed on the tray.

4. The image forming device according to claim 1, wherein the processor is further configured to:
- determine whether the amount of electric charge in each of the first electrodes is equal to or greater than a first threshold value, and
- determine the size of the sheet based on the amount of electric charge of which electrode is equal to or greater than the first threshold value.

5. The image forming device according to claim 4, wherein

at the different positions, the sheet guide faces one or more of the first electrodes other than one electrode located at an end of the first electrodes, and

the processor is further configured to determine that a sheet is placed on the tray when the amount of electric charge in said one electrode is equal to or greater than a second threshold value.

6. The image forming device according to claim **5**, wherein the second threshold value is smaller than the first threshold value.

7. The image forming device according to claim **1**, wherein

the tray further includes a second electrode within an area to which the sheet guide is not movable,

the detection circuit is electrically connected to the second electrode and is further configured to an amount of electric charge in the second electrode, and

the processor is further configured to determine that a sheet is placed on the tray when the amount of electric charge in the second electrode is equal to or greater than a second threshold value.

8. The image forming device according to claim **7**, wherein

one of the first electrodes is in the area, and the processor is further configured to determine that a sheet is placed on the tray when the amount of electric charge stored in at least one of the second electrode and said one of the first electrodes is equal to or greater than the second threshold value.

9. The image forming device according to claim **7**, wherein the area is at least partly covered by a sheet having a minimum size supported by the image forming device, when the sheet is placed on the tray.

10. The image forming device according to claim **1**, wherein the amount of electric charge in each of at least two of the first electrodes changes as the sheet guide is moved.

11. A document feeder connectable to an image forming device, comprising:

a tray on which a sheet is to be placed and including a plurality of first electrodes arranged along a first direction;

a sheet guide including a conductor and movable along the first direction to different positions relative to the first electrodes;

a detection circuit electrically connected to each of the first electrodes and configured to detect an amount of electric charge in each of the first electrodes; and

a processor configured to:

determine a size of the sheet placed on the tray based on amounts of electric charge detected by the detection circuit, and

output the determined size to the image forming device.

12. The document feeder according to claim **11**, wherein two of the first electrodes that are adjacent to each other are separated by a gap extending along a second direction that is oblique with respect to the first direction.

13. The document feeder according to claim **12**, wherein the first direction is perpendicular to a sheet conveyance direction in which the sheet is conveyed on the tray.

14. The document feeder according to claim **11**, wherein the processor is further configured to:

determine whether the amount of electric charge in each of the first electrodes is equal to or greater than a first threshold value, and

determine the size of the sheet based on the amount of electric charge of which electrode is equal to or greater than the first threshold value.

15. The document feeder according to claim **14**, wherein

at the different positions, the sheet guide faces one or more of the first electrodes other than one electrode located at an end of the first electrodes, and

the processor is further configured to determine that a sheet is placed on the tray when the amount of electric charge in said one electrode is equal to or greater than a second threshold value.

16. The document feeder according to claim **15**, wherein the second threshold value is smaller than the first threshold value.

17. The document feeder according to claim **11**, wherein

the tray further includes a second electrode within an area to which the sheet guide is not movable,

the detection circuit is electrically connected to the second electrode and is further configured to an amount of electric charge in the second electrode, and

the processor is further configured to determine that a sheet is placed on the tray when the amount of electric charge in the second electrode is equal to or greater than a second threshold value.

18. A method of determining a size of a sheet placed on a tray for printing or scanning, the tray including a plurality of first electrodes arranged along a first direction and facing a sheet guide including a conductor and movable along the first direction to different positions relative to the first electrodes, the method comprising:

detecting an amount of electric charge in each of the first electrodes; and

determining a size of the sheet placed on the tray based on amounts of electric charge detected in each of the first electrodes.

19. The method according to claim **18**, further comprising:

determining whether the amount of electric charge in each of the first electrodes is equal to or greater than a first threshold value, wherein

the size of the sheet is determined based on the amount of electric charge of which electrode is equal to or greater than the first threshold value.

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

at the different positions, the sheet guide faces one or more of the first electrodes other than one electrode located at an end of the first electrodes, and

the method further comprises determining that the sheet is placed on the tray when the amount of electric charge in said one electrode is equal to or greater than a second threshold value.

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