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(54) **IMAGE FORMING APPARATUS AND NON-TRANSITORY COMPUTER READABLE MEDIUM STORING IMAGE FORMING PROGRAM**

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(57) **ABSTRACT**

An image forming apparatus includes a plural image forming units each having a plural image forming sections, and an intermediate transfer body on which toner images formed by the plural image forming sections are primarily transferred, a plural secondary transfer units that are provided corresponding to the plural image forming units, and secondarily transfer the toner images of the intermediate transfer body to a recording medium, and a processor, in which each image forming unit has the image forming section of the same color, and the processor is configured to: in response to an instruction to output a color chart of the same color, execute a mode in which the color chart of the toner image having a density of intermediate gradation, formed by the image forming section of the same color for each image forming unit, is secondarily transferred to the recording medium and output.

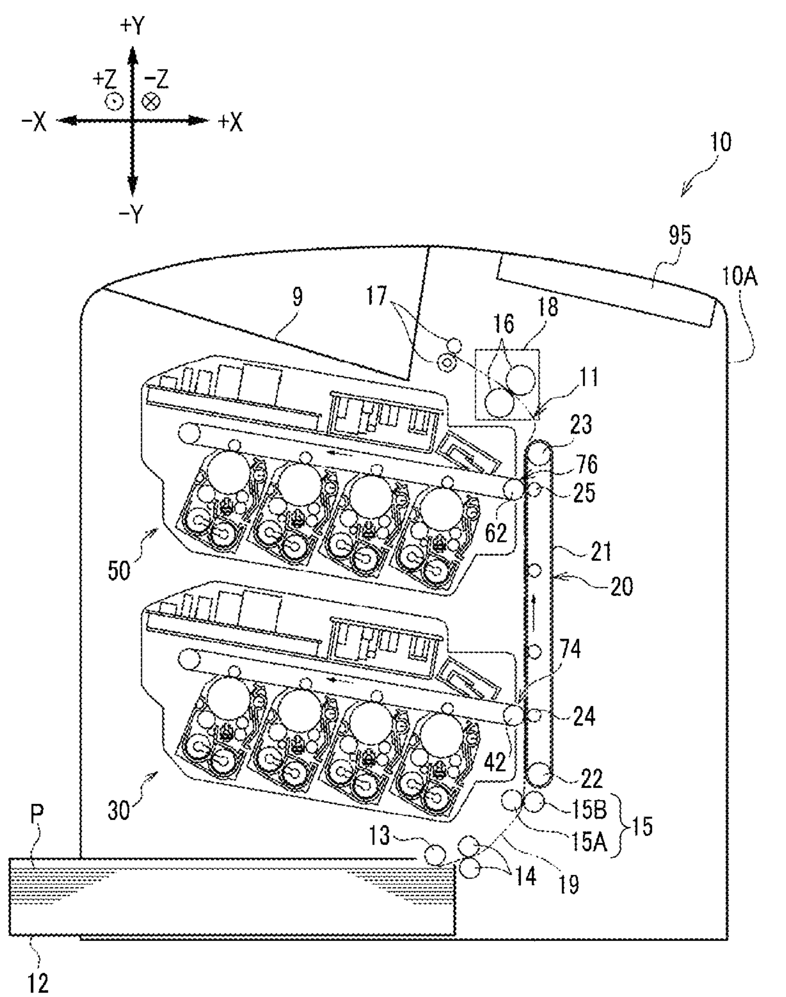


FIG. 1

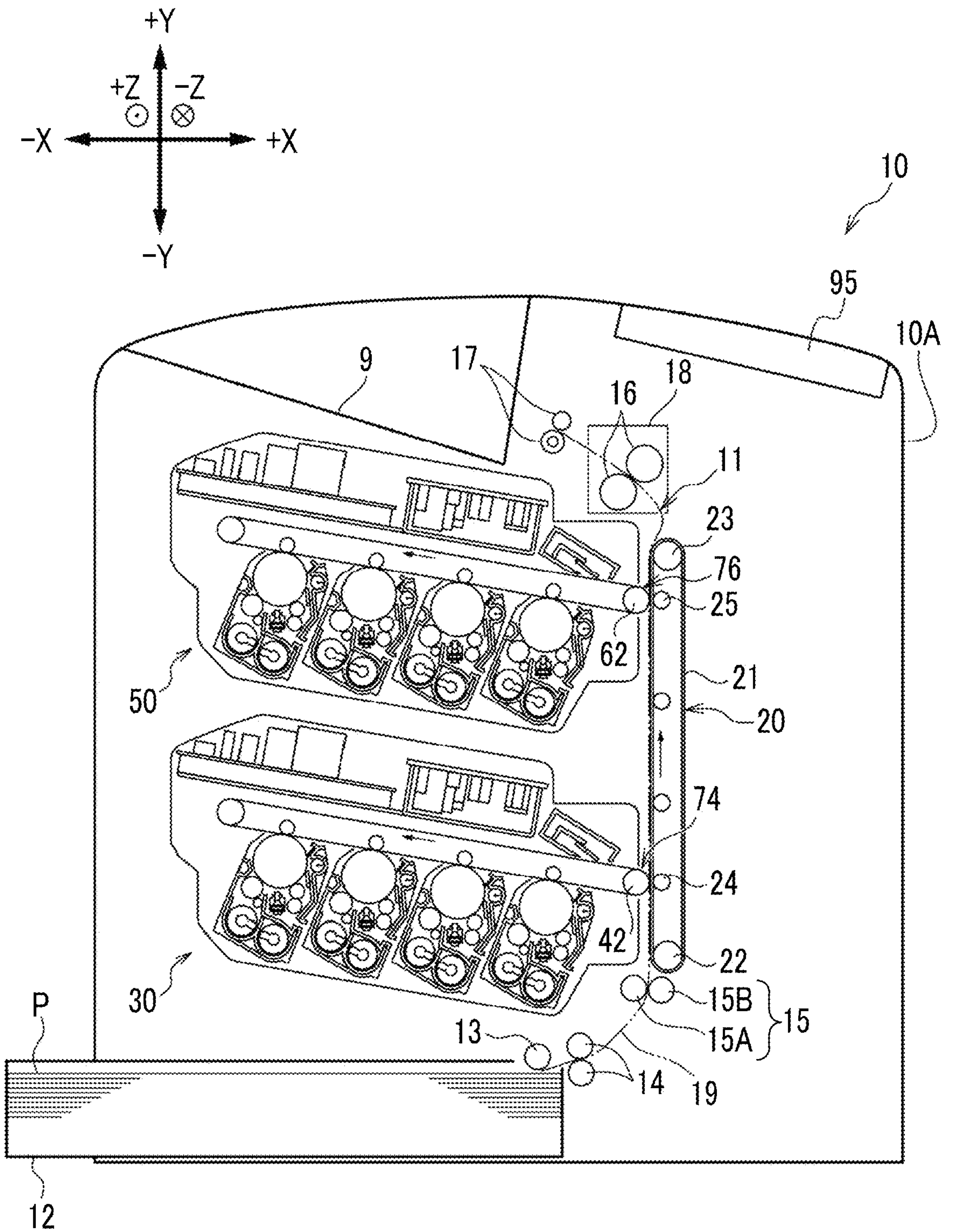

+Y
+Z
−Z
−X
+X
−Y
10
95
10A
9
17
16
18
11
23
76
25
62
21
20
50
74
24
42
22
15B
15
15A
30
P
13
14
19
12

FIG. 2

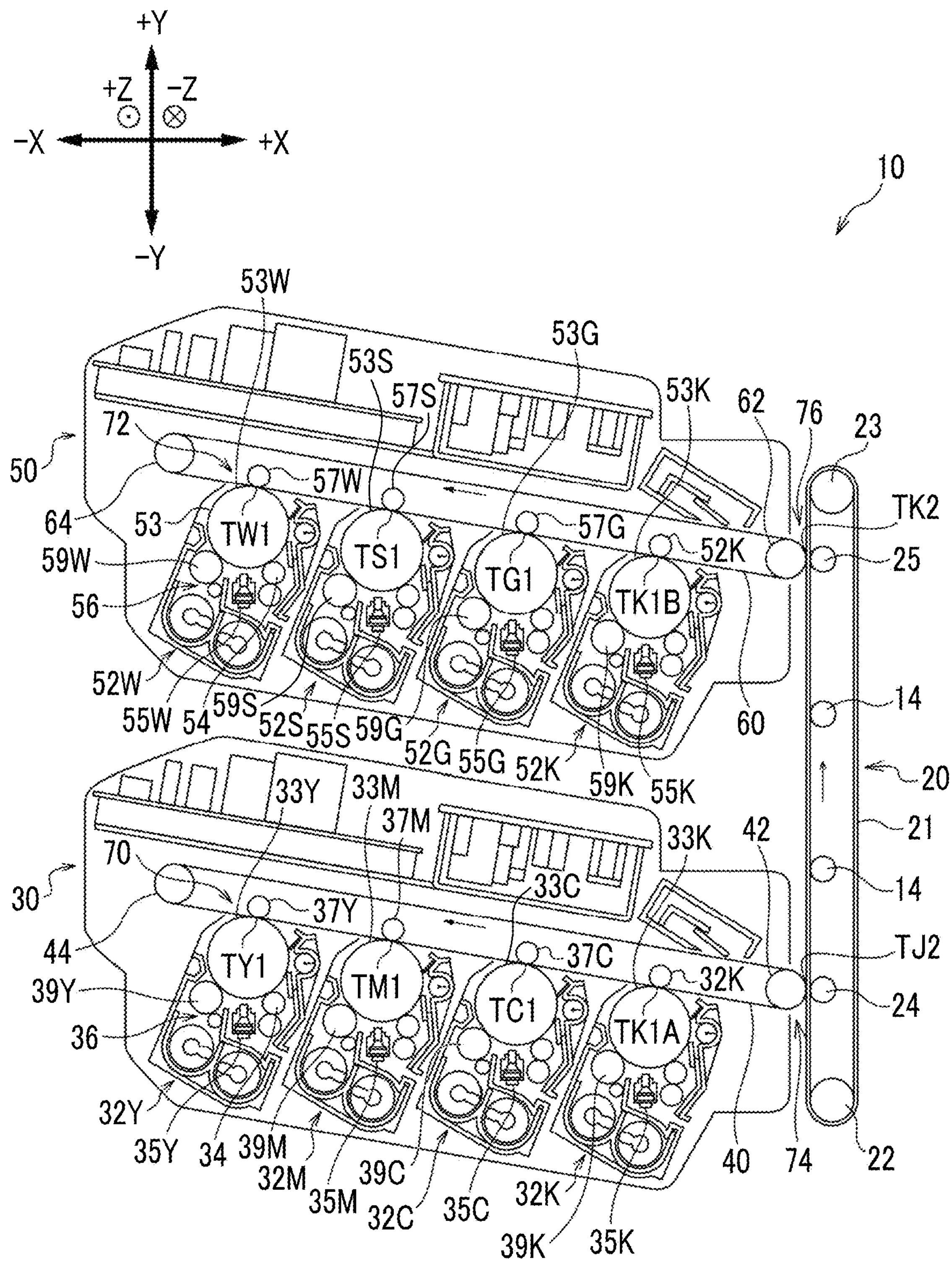

+Y
+Z
-Z
-X
+X
-Y
10
53W
53S
57S
53G
53K
62
76
23
72
50
57W
64
53
TW1
TS1
57G
TG1
52K
TK2
25
59W
TK1B
56
52W
55W
54
59S
52S
55S
59G
52G
55G
52K
59K
55K
60
14
20
21
33Y
33M
37M
33K
42
70
30
37Y
33C
14
44
TY1
TM1
37C
TC1
32K
TJ2
39Y
TK1A
24
36
32Y
35Y
34
39M
32M
35M
39C
32C
35C
32K
39K
35K
40
74
22

FIG. 3

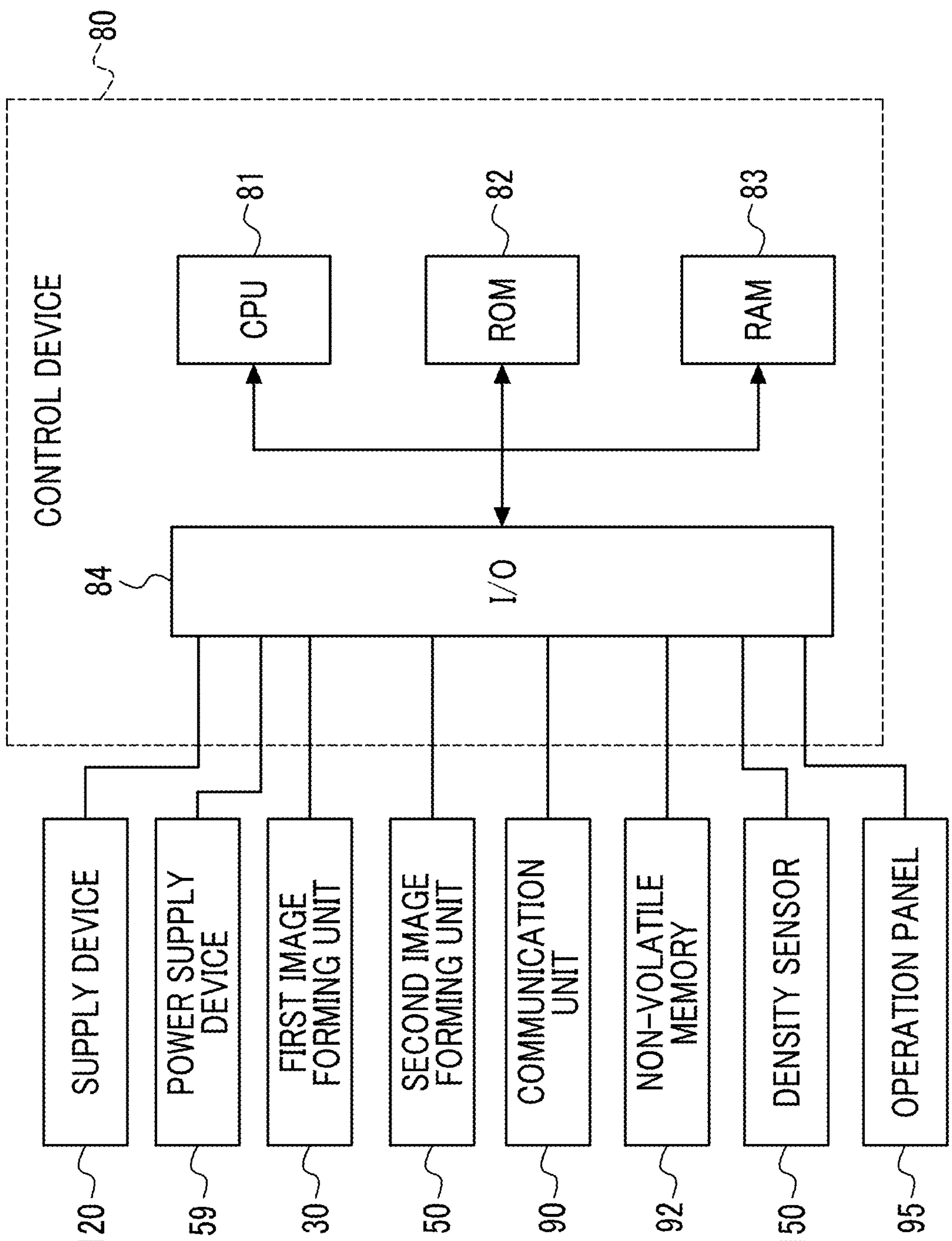

80
CONTROL DEVICE
CPU
81
ROM
82
RAM
83
I/O
84
SUPPLY DEVICE
120
POWER SUPPLY DEVICE
159
FIRST IMAGE FORMING UNIT
30
SECOND IMAGE FORMING UNIT
50
COMMUNICATION UNIT
90
NON-VOLATILE MEMORY
92
DENSITY SENSOR
150
OPERATION PANEL
95

FIG. 4

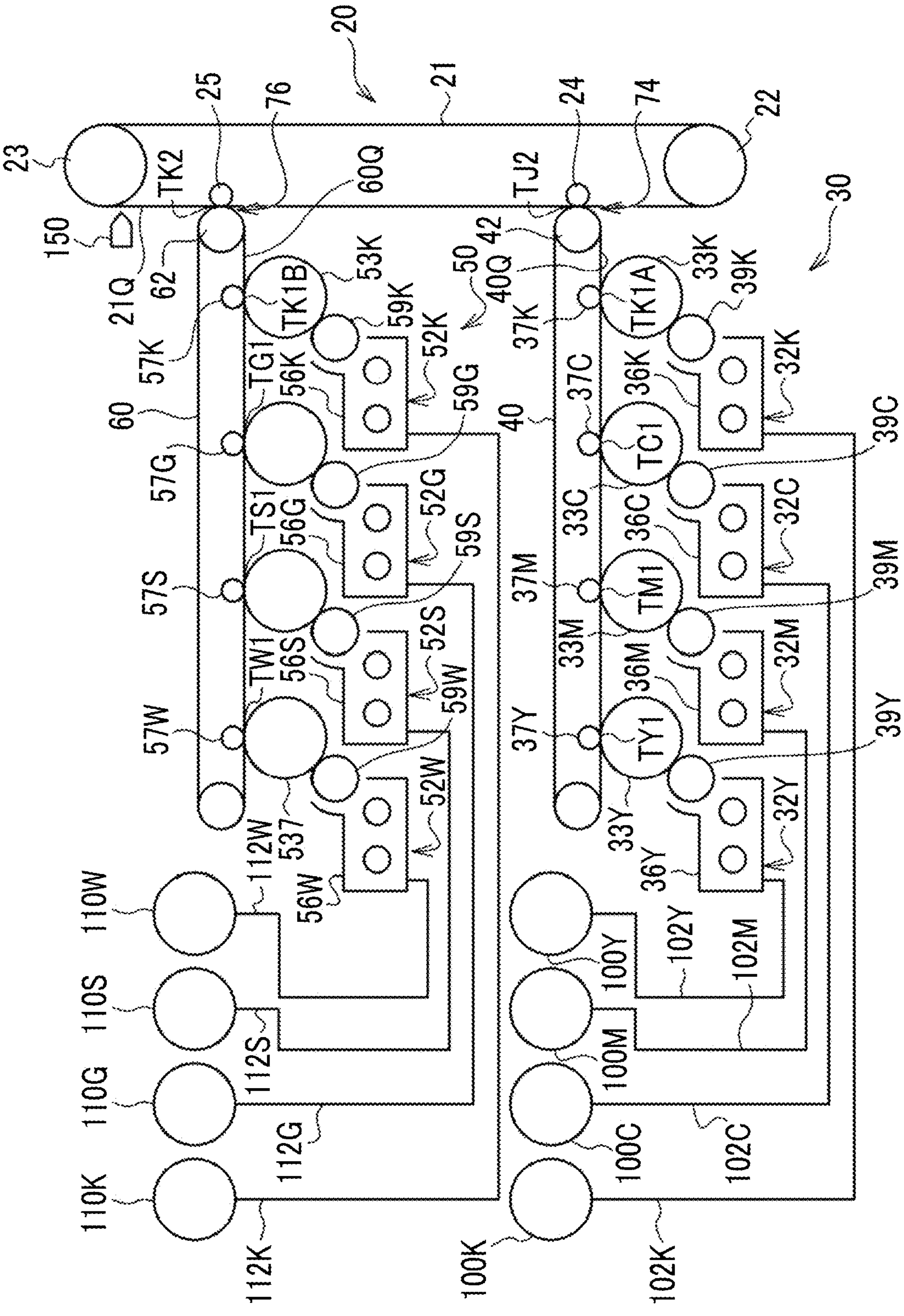

20
21
22
23
24
25
74
76
TK2
TJ2
60Q
30
150
21Q
62
42
40Q
50
53K
33K
TK1B
TK1A
59K
39K
57K
37K
52K
32K
TG1
56K
36K
37C
59G
39C
60
40
57G
TC1
TS1
56G
33C
36C
52G
32C
59S
39M
57S
37M
TM1
TW1
56S
33M
36M
52S
32M
59W
39Y
57W
37Y
TY1
52W
32Y
112W
537
33Y
36Y
56W
110W
110S
110G
110K
100Y
100M
100C
100K
102Y
102M
102C
102K
112S
112G
112K

FIG. 5

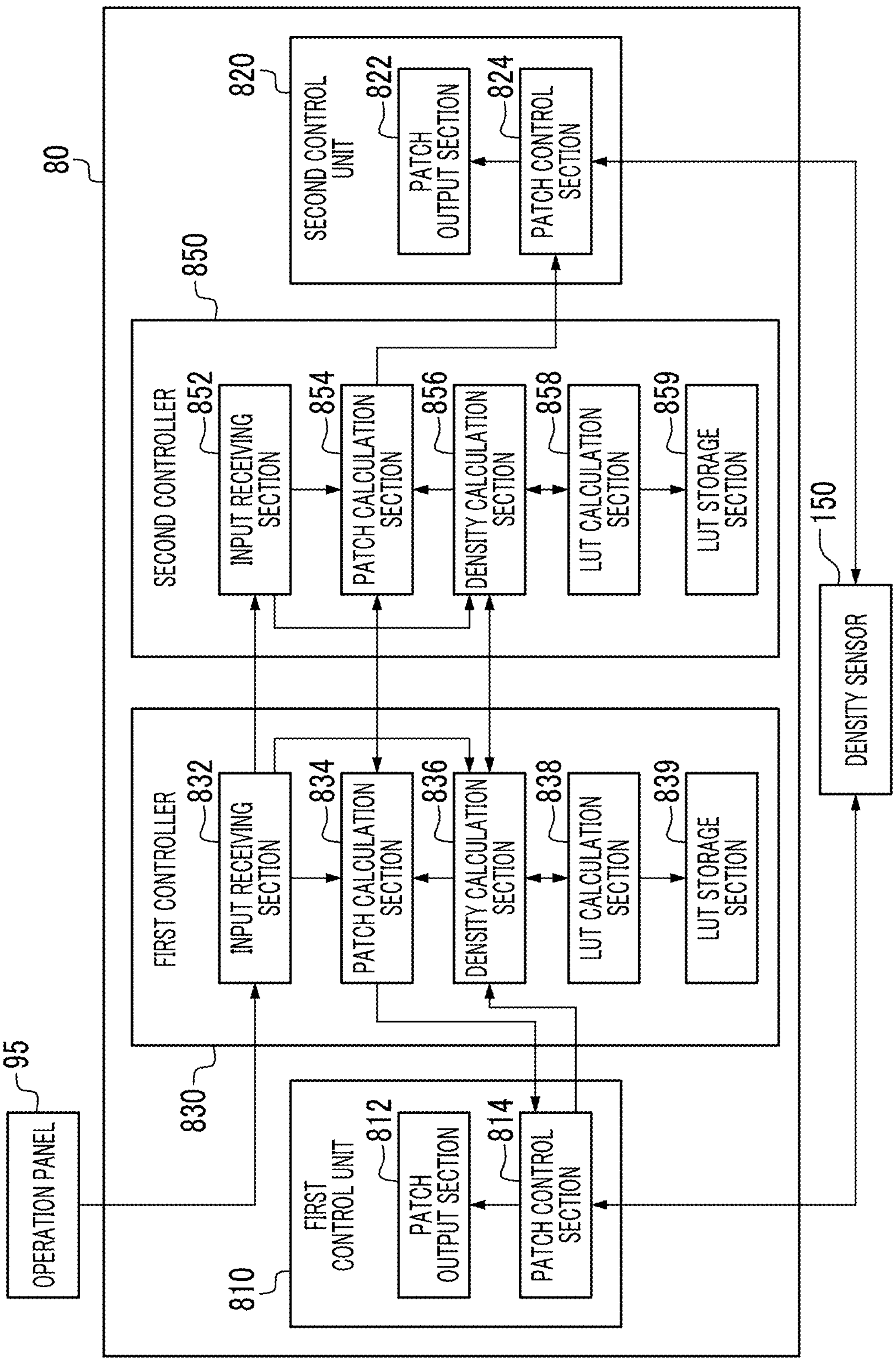

80
820
SECOND CONTROL UNIT
822
PATCH OUTPUT SECTION
824
PATCH CONTROL SECTION
850
SECOND CONTROLLER
852
INPUT RECEIVING SECTION
854
PATCH CALCULATION SECTION
856
DENSITY CALCULATION SECTION
858
LUT CALCULATION SECTION
859
LUT STORAGE SECTION
150
DENSITY SENSOR
830
FIRST CONTROLLER
832
INPUT RECEIVING SECTION
834
PATCH CALCULATION SECTION
836
DENSITY CALCULATION SECTION
838
LUT CALCULATION SECTION
839
LUT STORAGE SECTION
95
OPERATION PANEL
810
FIRST CONTROL UNIT
812
PATCH OUTPUT SECTION
814
PATCH CONTROL SECTION

FIG. 6

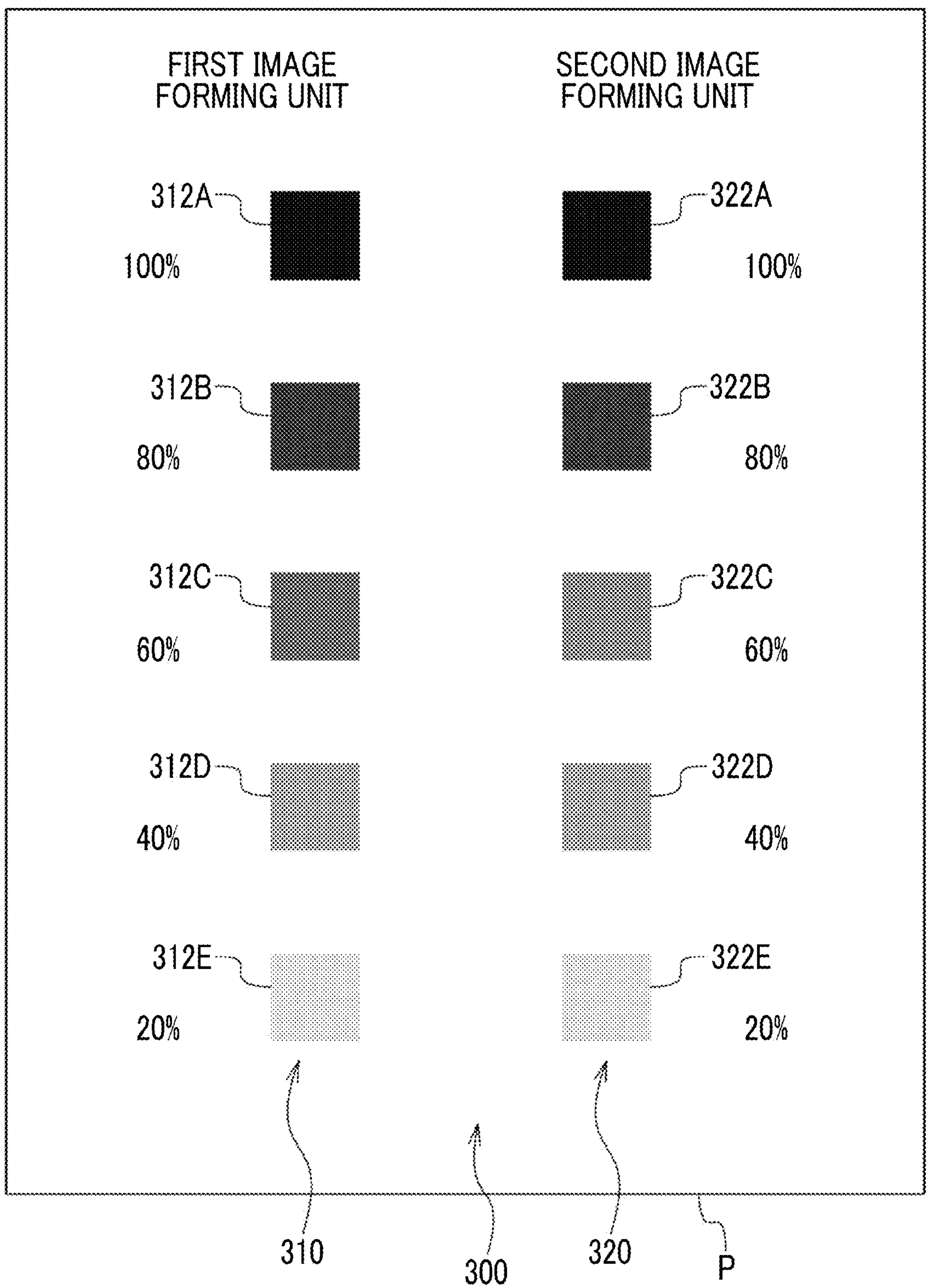

FIRST IMAGE FORMING UNIT
SECOND IMAGE FORMING UNIT
312A
100%
322A
100%
312B
80%
322B
80%
312C
60%
322C
60%
312D
40%
322D
40%
312E
20%
322E
20%
310
300
320
P

FIG. 7

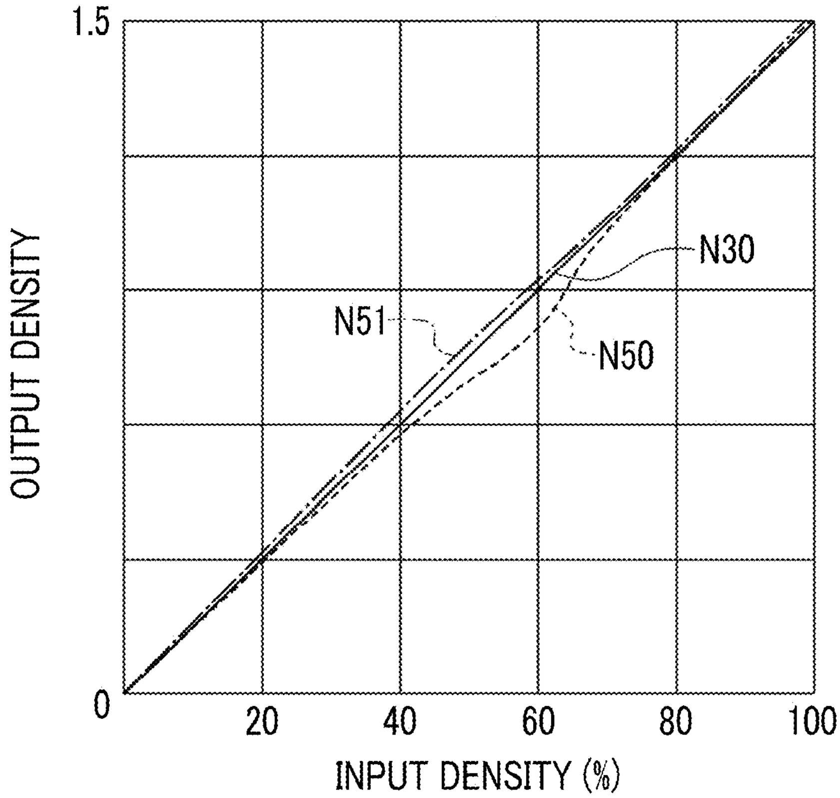

1.5
0
20
40
60
80
100
OUTPUT DENSITY
INPUT DENSITY (%)
N30
N51
N50

FIG. 8

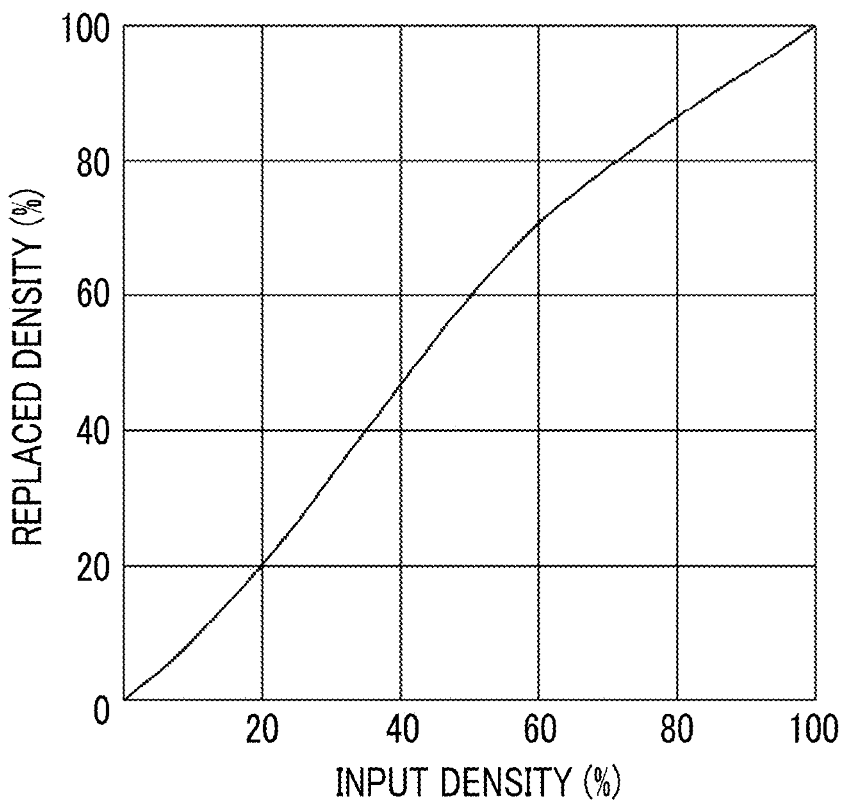
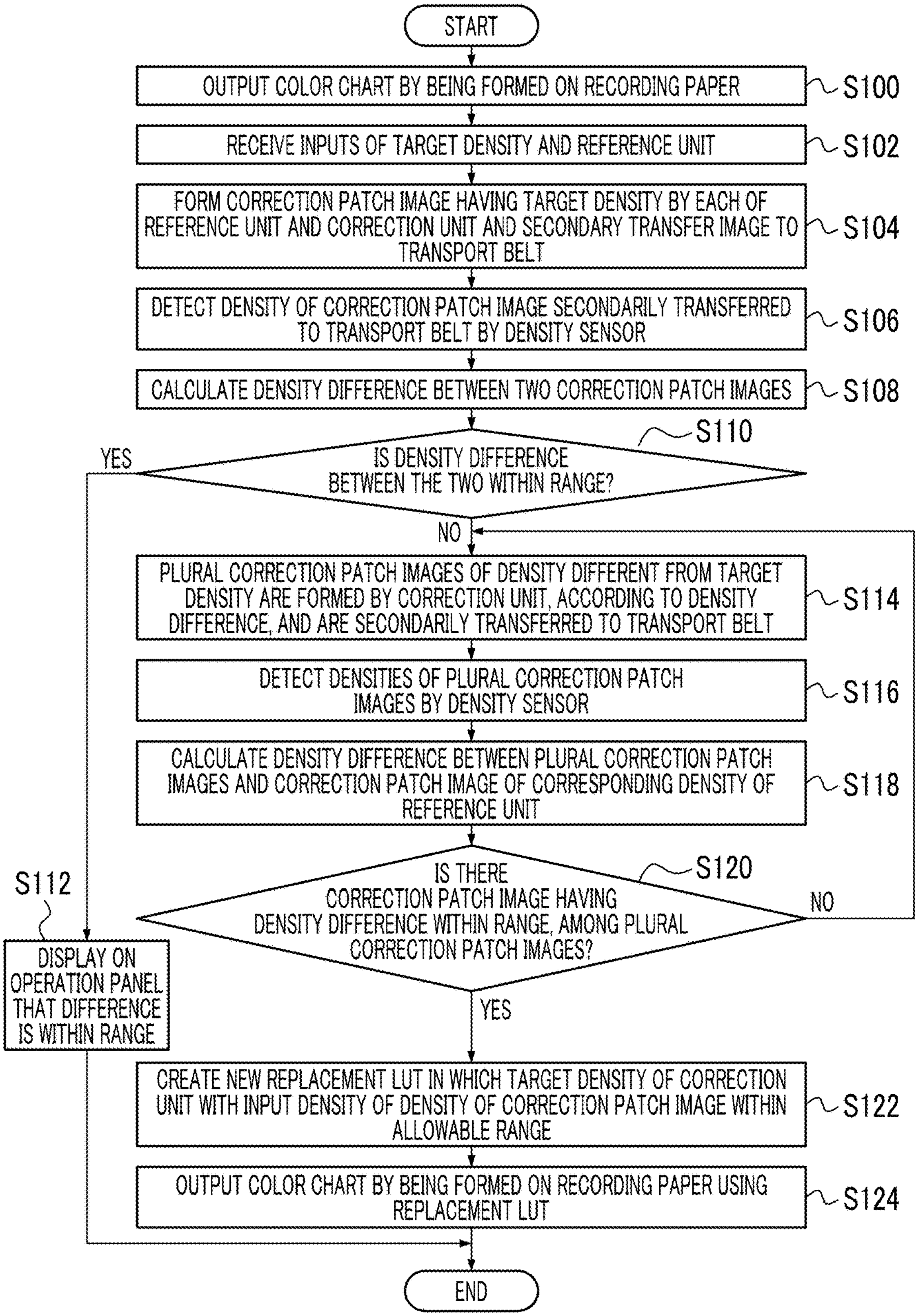

100
80
60
40
20
0
20
40
60
80
100
REPLACED DENSITY (%)
INPUT DENSITY (%)

FIG. 9



START
OUTPUT COLOR CHART BY BEING FORMED ON RECORDING PAPER
S100
RECEIVE INPUTS OF TARGET DENSITY AND REFERENCE UNIT
S102
FORM CORRECTION PATCH IMAGE HAVING TARGET DENSITY BY EACH OF REFERENCE UNIT AND CORRECTION UNIT AND SECONDARY TRANSFER IMAGE TO TRANSPORT BELT
S104
DETECT DENSITY OF CORRECTION PATCH IMAGE SECONDARILY TRANSFERRED TO TRANSPORT BELT BY DENSITY SENSOR
S106
CALCULATE DENSITY DIFFERENCE BETWEEN TWO CORRECTION PATCH IMAGES
S108
S110
IS DENSITY DIFFERENCE BETWEEN THE TWO WITHIN RANGE?
YES
NO
PLURAL CORRECTION PATCH IMAGES OF DENSITY DIFFERENT FROM TARGET DENSITY ARE FORMED BY CORRECTION UNIT, ACCORDING TO DENSITY DIFFERENCE, AND ARE SECONDARILY TRANSFERRED TO TRANSPORT BELT
S114
DETECT DENSITIES OF PLURAL CORRECTION PATCH IMAGES BY DENSITY SENSOR
S116
CALCULATE DENSITY DIFFERENCE BETWEEN PLURAL CORRECTION PATCH IMAGES AND CORRECTION PATCH IMAGE OF CORRESPONDING DENSITY OF REFERENCE UNIT
S118
S120
IS THERE CORRECTION PATCH IMAGE HAVING DENSITY DIFFERENCE WITHIN RANGE, AMONG PLURAL CORRECTION PATCH IMAGES?
NO
YES
S112
DISPLAY ON OPERATION PANEL THAT DIFFERENCE IS WITHIN RANGE
CREATE NEW REPLACEMENT LUT IN WHICH TARGET DENSITY OF CORRECTION UNIT WITH INPUT DENSITY OF DENSITY OF CORRECTION PATCH IMAGE WITHIN ALLOWABLE RANGE
S122
OUTPUT COLOR CHART BY BEING FORMED ON RECORDING PAPER USING REPLACEMENT LUT
S124
END

FIG. 10

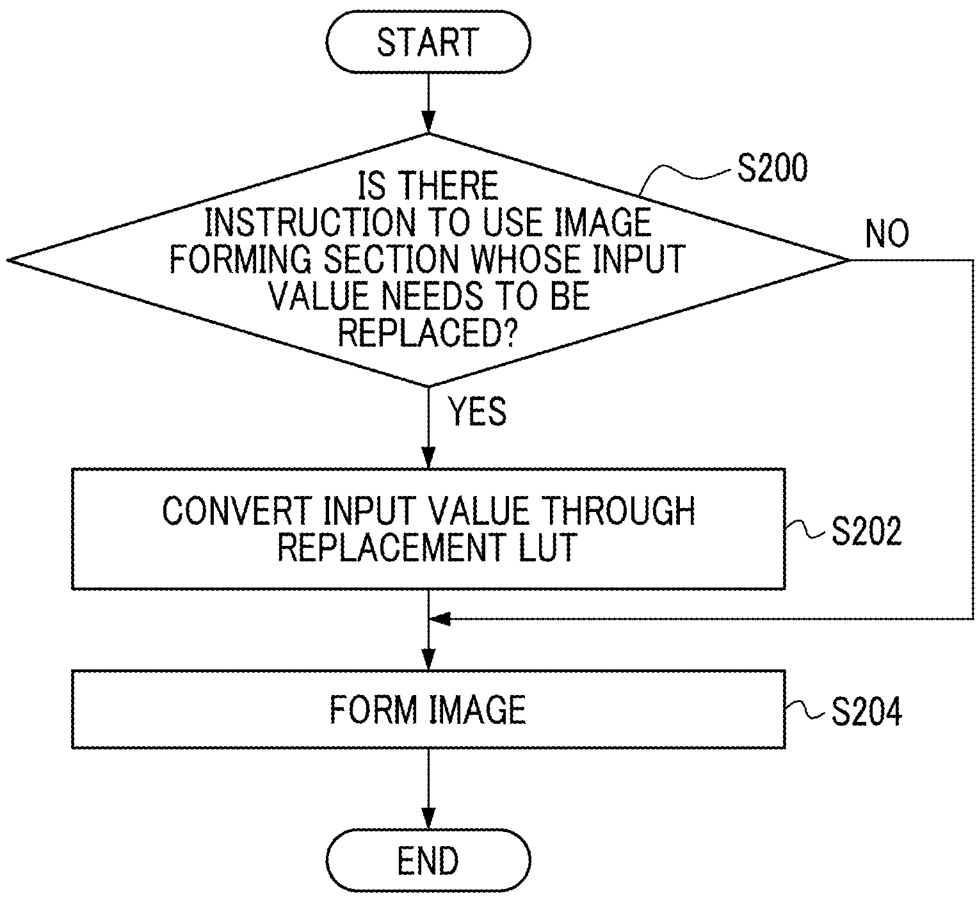

START
IS THERE INSTRUCTION TO USE IMAGE FORMING SECTION WHOSE INPUT VALUE NEEDS TO BE REPLACED?
S200
NO
YES
CONVERT INPUT VALUE THROUGH REPLACEMENT LUT
S202
FORM IMAGE
S204
END

IMAGE FORMING APPARATUS AND NON-TRANSITORY COMPUTER READABLE MEDIUM STORING IMAGE FORMING PROGRAM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2022-138590 filed Aug. 31, 2022.

BACKGROUND

(i) Technical Field

[0002] The present invention relates to an image forming apparatus and a non-transitory computer readable medium storing an image forming program.

(ii) Related Art

[0003] JP2001-066837A discloses a technique related to an image forming apparatus used in an electrophotographic copying machine, a printer, or the like. In this related art, in controlling toner replenishment to a developer by comparing the result of density measurement of a reference patch by an optical sensor with a reference patch target value for toner replenishment control, and in controlling the image forming conditions that affect the formed image by comparing the result of density measurement of the reference patch by the optical sensor with the reference patch target value for gradation control, only the reference patch target value for toner replenishment control is changed according to the measurement result by a counter that counts the number of prints using developer.

[0004] JP3020987B discloses a technique related to a color image forming apparatus. In this related art, the color balance of the first color image forming apparatus is adjusted in order to match the color balance of the first color image forming apparatus with the color balance of the second color image forming apparatus.

[0005] JP5665782B discloses a technique related to an image forming unit that can form an image on paper, an image reading unit that can read an image output from the image forming unit, and an image forming apparatus that can calculate information of the image reading unit and execute gradation correction of the image forming unit. In the related art, there is a control unit that changes the degree of influence of the reflectance of a paper depending on the gradation and corrects the degree of influence to a predetermined gradation characteristic.

SUMMARY

[0006] In an image forming apparatus including a plurality of image forming units each having an intermediate transfer body to which a toner image formed by a plurality of image forming sections is primarily transferred, and secondarily transferring a toner image of the intermediate transfer body of the plurality of image forming units to a recording medium, in a case where the different image forming units have the image forming sections of the same color, even in a case where there is a difference between the densities of intermediate gradation of the toner images of the same color, the toner images cannot be compared.

[0007] Aspects of non-limiting embodiments of the present disclosure relate to an image forming apparatus and a non-transitory computer readable medium storing an image forming program that include a plurality of image forming units each having an intermediate transfer body to which a toner image formed by a plurality of image forming sections is primarily transferred, and secondarily transferring a toner image of the intermediate transfer body of the plurality of image forming units to a recording medium, in which the densities of intermediate gradation of toner images of the same color, formed by different image forming sections can be compared.

[0008] Aspects of certain non-limiting embodiments of the present disclosure overcome the above disadvantages and/or other disadvantages not described above. However, aspects of the non-limiting embodiments are not required to overcome the disadvantages described above, and aspects of the non-limiting embodiments of the present disclosure may not overcome any of the disadvantages described above.

[0009] According to an aspect of the present disclosure, there is provided an image forming apparatus including: a plurality of image forming units each having a plurality of image forming sections, and an intermediate transfer body on which toner images formed by the plurality of image forming sections are primarily transferred; a plurality of secondary transfer units that are provided corresponding to the plurality of image forming units, and secondarily transfer the toner images of the intermediate transfer body to a recording medium; and a processor, in which each image forming unit has the image forming section of the same color, and the processor is configured to: in response to an instruction to output a color chart of the same color, execute a mode in which the color chart of the toner image having a density of intermediate gradation, formed by the image forming section of the same color for each image forming unit is secondarily transferred to the recording medium and output.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Exemplary embodiment(s) of the present invention will be described in detail based on the following figures, wherein:

[0011] FIG. **1** is a configuration diagram of an image forming apparatus according to a first exemplary embodiment of the present invention;

[0012] FIG. **2** is a partially enlarged view of FIG. **1**;

[0013] FIG. **3** is a block diagram showing an example of a hardware configuration of the image forming apparatus;

[0014] FIG. **4** is a schematic diagram schematically showing a configuration of a major part of the image forming apparatus according to the first exemplary embodiment;

[0015] FIG. **5** is a block diagram showing an example of a functional configuration of a control device;

[0016] FIG. **6** is a diagram showing an example of a color chart;

[0017] FIG. **7** is a graph illustrating an example of a relationship between an input density and an output density;

[0018] FIG. **8** is a graph illustrating an example of an LUT in which an input value is replaced;

[0019] FIG. **9** is a flowchart showing a flow of a density correction mode; and

[0020] FIG. **10** is a flowchart showing a flow of image formation.

DETAILED DESCRIPTION

[0021] Exemplary Embodiment

[0022] An image forming apparatus according to an exemplary embodiment of the present invention will be described.

[0023] In addition, the width direction of the image forming apparatus **10** shown in FIG. **1** is an X direction, the height direction is a Y direction, and the depth direction is a Z direction, which are indicated by arrows X, Y, and Z, respectively. In a case where it is necessary to distinguish one side and the other side of the X direction, the Y direction, and the Z direction, with respect to the image forming apparatus **10** shown in FIG. **1**, the right side is described as the +X side, the left side is described as the −X side, and the upper side is described as the +Y side, the lower side is described as −Y side, the front side is described as +Z side, and the rear side is described as −Z side. Further, in the present exemplary embodiment, the recording paper P is adopted as an example of the recording medium, the upstream side in the conveyance direction in which the recording paper P is conveyed is defined as the "upstream side in the conveyance direction", and the downstream side in the conveyance direction is "downstream side in the conveyance direction". In addition, the image forming apparatus **10** in the present exemplary embodiment is a so-called single-pass type, and printing is performed by the recording paper P passing through the front of a first image forming unit **30** and a second image forming unit **50**, which will be described later.

[0024] Overall Configuration

[0025] First, the overall configuration of the image forming apparatus will be described.

[0026] As shown in FIG. **1**, the image forming apparatus **10** includes an operation panel **95**, an accommodating unit **12** that accommodates recording paper P as an example of a recording medium, a conveyance unit **11** that conveys the recording paper P along a conveyance path **19**, and the first image forming unit **30** and the second image forming unit **50** that form a toner image to be transferred to the recording paper P. In addition, the toner image is an image using a toner as an example of a color material such as a developer.

[0027] The accommodating unit **12** can be pulled out from the image forming apparatus main body **10**A, which is the apparatus main body of the image forming apparatus **10**, and accommodates the recording paper P.

[0028] The conveyance unit **11** includes a feed roll **13**, a conveyance roll **14**, a resist roll pair **15**, a conveyor belt device **20**, a fixing device **18**, a discharge roll **17**, and the like, in order from the upstream side in the conveyance direction.

[0029] The feed roll **13** sends out the recording paper P accommodated in the accommodating unit **12** to the conveyance path **19** configuring the conveyance unit **11**. The conveyance roll **14** conveys the recording paper P along the conveyance path **19**.

[0030] The resist roll pair **15** conveys the recording paper P conveyed by the conveyance roll **14** to a secondary transfer position TJ**2** on the upstream side, which will be described later. In the resist roll pair **15**, the pinch roll **15**B rotates in a manner driven by the resist roll **15**A. Then, the resist roll pair **15** sandwiches the recording paper P between the resist roll **15**A and the pinch roll **15**B, and conveys the recording paper P to the downstream side in the conveyance direction.

[0031] The conveyor belt device **20** conveys the recording paper P to the downstream side in the conveyance direction along the conveyance path **19** while secondarily transferring the toner image formed by the first image forming unit **30** and the second image forming unit **50** to the recording paper P. In addition, the details of the conveyor belt device **20** will be described later.

[0032] The fixing device **18** has a fixing roll pair **16**, passes through the fixing roll pair **16**, and heats and pressurizes the recording paper P, on which the toner image is transferred, to fix the toner image on the recording paper P.

[0033] The discharge roll **17** discharges the recording paper P on which the toner image is fixed by the fixing device **18**, to the discharge unit **9**.

[0034] The first image forming unit **30** and the second image forming unit **50** are disposed side by side in the vertical direction. In addition, in the present exemplary embodiment, the second image forming unit **50** is disposed above the first image forming unit **30**. From another point of view, the second image forming unit **50** is disposed on the downstream side in the conveyance direction of the first image forming unit **30**.

[0035] As shown in FIG. **2**, the first image forming unit **30** includes four image forming sections **32**, and an endless intermediate transfer belt **40** as an example of an intermediate transfer body. The toner images formed by the four image forming sections **32** are transferred to the intermediate transfer belt **40**, and the intermediate transfer belt **40** is mounted to be rotatable counterclockwise with a front view of FIG. **2**.

[0036] The image forming section **32** includes an image forming section **32**K that forms a black toner image of black color, an image forming section **32**M that forms a magenta toner image of magenta color, an image forming section **32**C that forms a cyan toner image of cyan color, and an image forming section **32**Y that forms a yellow toner image of yellow color. The four image forming sections **32** are disposed in the order of the image forming section **32**Y, the image forming section **32**M, the image forming section **32**C, and the image forming section **32**K in order from the upstream side in the rotation direction (the side closer to the support roll **44** to be described later) in which the intermediate transfer belt **40** rotates. In addition, in the following, the upstream side in the rotation direction of the intermediate transfer belt **40** is referred to as "the rotation direction upstream side", and the downstream side in the rotation direction is referred to as "the rotation direction downstream side". That is, in the image forming section **32**, the image forming section **32**Y is disposed on the most rotation direction downstream side.

[0037] In addition, in a case where it is not necessary to distinguish between Y, M, C, and K, Y, M, C, and K are omitted.

[0038] The image forming section **32** includes a photoconductor **33**, a charging member **34** that charges the surface of the photoconductor **33**, an exposure device **35** that irradiates the charged photoconductor **33** with exposure light, and a developing device **36** that develops an electrostatic latent image formed by the irradiation of the exposure light to be visualized as a toner image.

[0039] Developing rolls **39**Y, **39**M, **39**C, and **39**K are provided in the developing device **36**, respectively, and are applied with a developing bias by the power supply device **159** (see FIG. **3**), respectively.

[0040] Further, primary transfer rolls **37**Y, **37**M, **37**C, and **37**K for transferring the toner image formed by the image forming section **32** to the intermediate transfer belt **40** are disposed at positions facing each photoconductor **33** with the intermediate transfer belt **40** interposed therebetween. The intermediate transfer belt **40** is wound around a support roll **44** that supports the intermediate transfer belt **40** and a backup roll **42** that is disposed on the secondary transfer unit **74** on the upstream side, which will be described later. In addition, the primary transfer unit **70** includes a photoconductor **33**, a primary transfer roll **37**, and an intermediate transfer belt **40**. Further, the primary transfer positions TY**1**, TM**1**, TC**1**, and TK**1**A are set between the photoconductors **33**Y, **33**M, **33**C, and **33**K and the intermediate transfer belt **40**, respectively.

[0041] The second image forming unit **50** has the same configuration as the above-described first image forming unit **30** except that colors for forming an image are different. The second image forming unit **50** includes four image forming sections **52** and an endless intermediate transfer belt **60** as an example of an intermediate transfer body. The toner images formed by the four image forming sections **52** are transferred to the intermediate transfer belt **60**, and the intermediate transfer belt **60** is mounted to be rotatable counterclockwise with a front view of FIG. **2**.

[0042] In addition, the image forming section **52** has the same configuration as the image forming section **32** of the first image forming unit **30**. Further, the intermediate transfer belt **60** and the primary transfer roll **57** described later have the same configuration as the intermediate transfer belt **40** and the primary transfer roll **37** of the first image forming unit **30**. Further, the other constituent members configuring the second image forming unit **50** are the same as in the first image forming unit **30**.

[0043] The image forming section **52** includes an image forming section **52**K that forms a black toner image of black color, an image forming section **52**G that forms a gold toner image of gold color, an image forming section **52**S that forms a silver toner image of silver color, and an image forming section **52**W that forms a white toner image of white color. The four image forming sections **52** are disposed in the order of the image forming section **52**W, the image forming section **52**S, the image forming section **52**G, and the image forming section **52**K, from the rotation direction upstream side (in the present example, the side closer to the support roll **64** described later). That is, in the image forming section **52**, the image forming section **52**K is disposed on the most rotation direction downstream side, the image forming section **52**G and the image forming section **52**S are disposed on the rotation direction upstream side with respect to the image forming section **52**K, and the image forming section **52**W is disposed on the most rotation direction upstream side.

[0044] In addition, in a case where it is not necessary to distinguish between W, S, G, and K, W, S, G, and K are omitted.

[0045] The image forming section **52** includes a photoconductor **53**, a charging member **54**, an exposure device **55**, and a developing device **56**.

[0046] Developing rolls **59**W, **59**S, **59**G, and **59**K are provided in the developing device **56**, respectively, and are applied with a developing bias by the power supply device **159** (see FIG. **3**), respectively.

[0047] Further, the primary transfer rolls **57**W, **57**S, **57**G, and **57**K are disposed at positions facing respective photoconductors **53** with the intermediate transfer belt **60** interposed therebetween. The intermediate transfer belt **60** is wound around a support roll **64** and a backup roll **62** disposed on a secondary transfer unit **76** on the downstream side, which will be described later. In addition, the primary transfer unit **72** includes the photoconductor **53**, the primary transfer roll **57**, and the intermediate transfer belt **60**. Further, the primary transfer positions TW**1**, TS**1**, TG**1**, and TK**1**B are set between the photoconductors **53**Y, **53**M, **53**C, and **53**W and the intermediate transfer belt **60**, respectively.

[0048] As shown in FIG. **4**, the developing device **36** of the image forming section **32** of each color of the first image forming unit **30** and the developing device **56** of the image forming section **52** of each color of the second image forming unit **50** are connected to a plurality of toner cartridges **100** and **110** containing toner corresponding to each color via supply paths **102** and **112**. The toner accommodating the respective toner cartridges **100** and **110** is appropriately supplied to the developing devices **36** and **56** of respective colors via the supply paths **102** and **112** by operating a supply device **120** (see FIG. **3**) provided in the supply paths **102** and **112**. In addition, the supply device **120** (see FIG. **3**) is provided with individual developing devices **36**Y, **36**M, **36**C, **36**K, **56**C, **56**W, **56**G, and **56**K from the toner cartridges **100**Y, **100**M, **100**C, **100**K, **110**W, **110**S, **110**G, and **110**K, respectively. The configuration is such that toner can be supplied to the device.

[0049] Details of Conveyor Belt Device

[0050] Next, the details of the conveyor belt device **20** will be described.

[0051] As shown in FIG. **2**, the conveyor belt device **20** includes an endless conveyor belt **21**, support rolls **22** and **23** that support the conveyor belt **21**, the conveyance rolls **14**, and backup rolls that sandwich the intermediate transfer belts **40** and **60**. Secondary transfer rolls **24** and **25** disposed at positions facing the **42** and **62** are included.

[0052] The secondary transfer roll **24** sandwiches the recording paper P and the conveyor belt **21** between the backup roll **42** and the secondary transfer roll **24**, and transfers the toner image formed on the intermediate transfer belt **40** of the first image forming unit **30** to the recording paper P. Similarly, the secondary transfer roll **25** sandwiches the recording paper P and the conveyor belt **21** between the backup roll **62** and the secondary transfer roll **25**, and transfers the toner image formed on the intermediate transfer belt **60** of the second image forming unit **50** to the recording paper P.

[0053] In addition, the secondary transfer unit **74** includes the backup roll **42**, the secondary transfer roll **24**, and the intermediate transfer belt **40**. Further, the secondary transfer unit **76** includes the backup roll **62**, the secondary transfer roll **25**, and the intermediate transfer belt **60**.

[0054] A transfer bias is applied to the secondary transfer rolls **24** and **25** by the power supply device **159** (see FIG. **3**), respectively.

[0055] The secondary transfer position TJ**2** is defined between the intermediate transfer belt **40** of the first image forming unit **30** and the conveyor belt **21**, and the secondary transfer position TK**2** is defined between the intermediate transfer belt **60** of the second image forming unit **50** and the conveyor belt **21**. In addition, the secondary transfer position TK**2** is the most downstream secondary transfer position.

[0056] Further, the conveyor belt device **20** includes a belt cleaning device (not shown) that cleans the conveyor belt **21**. The belt cleaning device (not shown) performs cleaning on the rotation direction upstream side of the most downstream secondary transfer position TK**2** and on the rotation direction downstream side of the most upstream secondary transfer position TJ**2**. In addition, in the conveyor belt **21**, a position to be cleaned by a belt cleaning device (not shown) is defined as a cleaning position CL.

[0057] Here, each image forming section **32** of the first image forming unit **30** and each image forming section **52** of the second image forming unit **50** form a color chart **300** (see FIG. **6**) composed of an automatic adjustment patch image for automatically adjusting the density with each color toner, and correction patch images **312**A, **312**B, **312**C, **312**D, **312**E, **322**A, **322**B, **322**C, **322**D, and **322**E. Hereinafter, the correction patch images **312**A, **312**B, **312**C, **312**D, **312**E, **322**A, **322**B, **322**C, **322**D, and **322**E may be referred to as correction patch images **312**, **322**.

[0058] As shown in FIG. **4**, a density sensor **150** as an example of a detection device that detects the densities of the automatic adjustment patch image and the correction patch images **312** and **322** that are secondarily transferred to the conveyor belt **21** is provided near the upper end of the conveyor belt **21**. The density sensor **150** detects the densities of the automatic adjustment patch image and the correction patch images **312** and **322** in a flat portion **21**Q between the secondary transfer position TK**2** and the upper support roll **23** on which the conveyor belt **21** is wound, on the downstream side of the most downstream secondary transfer position TK**2**.

[0059] The density sensor **150** may be disposed at a position at which the densities of the automatic adjustment patch image and the correction patch images **312**A, **312**B, **312**C, **312**D, **312**E, **322**A, **322**B, **322**C, **322**D, and **322**E on the upstream side in the rotation direction of the most downstream secondary transfer position TK**2** and on the upstream side in the rotation direction of the cleaning position CL.

[0060] The operation panel **95** of the present exemplary embodiment shown in FIG. **1** is a display on which a touch panel is superimposed, but the present invention is not limited thereto. An icon image or the like is displayed on the operation panel **95** as an example of an image representing an item that is an operation target in order to execute a function desired by the user. There is no restriction on the type of the icon image as long as the icon image is an operation target of the user, and the icon image includes, for example, a button, a scroll bar, a check box, and a radio button. In a case where a user operation is performed on the icon image, a process associated with the operation content in advance is executed by the control device **80** (see FIG. **3**) described later, and a response to the operation is displayed on the operation panel **95**.

[0061] Control Device

[0062] Next, the control device **80** that controls the operation of the image forming apparatus **10** will be described.

[0063] FIG. **3** is a block diagram showing a hardware configuration of the image forming apparatus **10**. As shown in FIG. **3**, the control device **80** includes a first image forming unit **30**, a second image forming unit **50**, a communication unit **90**, a non-volatile memory **92**, a supply device **120**, a power supply device **159**, a density sensor **150**, and an operation panel **95**, and the like are electrically connected.

[0064] The control device **80** is connected to a Central Processing Unit (CPU) **81**, a Read Only Memory (ROM) **82**, a Random Access Memory (RAM) **83**, and an input/output interface (I/O) **84** via a bus. In addition, the CPU **81** is an example of a processor.

[0065] Here, the ROM **82** stores an image formation control program (not shown) to be executed by the CPU **81**. Then, the CPU **81** reads the image formation control program (not shown) from the ROM **82** and expands the image formation control program into the RAM **83** to execute a printing process or the like by the image formation control program (not shown).

[0066] Further, the first image forming unit **30**, the second image forming unit **50**, the communication unit **90**, and the non-volatile memory **92** are connected to the I/O **84**. The communication unit **90** is an interface for mutual data communication between a terminal device such as a personal computer (not shown) and an image forming apparatus **10**. The non-volatile memory **92** stores information necessary for the image forming apparatus **10** to execute the image forming operation.

[0067] The control device **80** performs various controls for forming a toner image on the intermediate transfer belt **40** (see FIG. **2** and the like) by the image forming section **32** (see FIG. **2** and the like) of each color of the first image forming unit **30**. The control device **80** performs various controls for forming a toner image on the intermediate transfer belt **60** (see FIG. **2** and the like) by the image forming section **52** (see FIG. **2** and the like) of each color of the second image forming unit **50**.

[0068] Further, the control device **80** controls the developing bias to be applied by the power supply device **159** to the developing rolls **39**Y, **39**M, **39**C, **39**W, **59**T, **59**S, **59**G, and **59**K (see FIG. **2** or the like) of the developing devices **36** and **56**. Further, the control device **80** controls the transfer bias to be applied by the power supply device **159** to the secondary transfer rolls **24** and **25** (see FIG. **2** or the like).

[0069] In addition, the control device **80** uses the supply device **120** to control the supply timing, supply amount, and the like of each color toner of the toner cartridges **100**Y, **100**M, **100**C, **100**K, **110**W, **110**S, **110**G, and **110**K (see FIG. **3**) to be supplied to the developing devices **36**Y, **36**M, **36**C, **36**K, **56**W, **56**S, **56**G, and **56**K (see FIG. **2** and the like).

[0070] In addition, the control device **80** executes a mode of automatically adjusting the density of the toner image, which will be described later, and a mode in which the user corrects the density.

[0071] FIG. **5** is a block diagram showing an example of a functional configuration of the control device **80**.

[0072] The control device **80** includes a first control unit **810** and a first controller **830** for the first image forming unit **30**, and a second control unit **820** and a second controller **850** for the second image forming unit **50**, as a functional configuration.

[0073] The first control unit **810** and the second control unit **820** have patch output sections **812** and **822** and patch control sections **814** and **824** to output, respectively. The first controller **830** and the second controller **850** include input receiving sections **832** and **852**, patch calculation sections **834** and **854**, density calculation sections **836** and **856**, LUT calculation sections **838** and **858**, and LUT storage sections

839 and 859, respectively. Note that "LUT" is an abbreviation for a lookup table and is a mathematical formula that defines the density adjustment of an image.

[0074] The input receiving sections **832** and **852** have a function of sharing the information input from the operation panel **95** between the first controller **830** and the second controller **850**. Further, the input receiving sections **832** and **852** have a function of passing information input from the operation panel **95** to the patch calculation sections **834** and **854**.

[0075] The patch calculation sections **834** and **854** specify the density to be corrected in the correction patch images **312** and **322** in the color chart **300** (see FIG. **6**) described later, and have a function of requesting output and calculation of the correction patch image having the specified density to the patch control sections **814** and **824**.

[0076] The density calculation sections **836** and **856** have a function of calculating the density of the correction patch image and requesting the LUT calculation sections **838** and **858** to create a replacement LUT in which the input value to be described later is replaced. In addition, the density information is shared between the density calculation section **836** and the density calculation section **856**.

[0077] The LUT calculation sections **838** and **858** have a function of creating a replacement LUT. The LUT storage sections **839** and **859** have a function of storing the replacement LUT created by the LUT calculation sections **838** and **858**.

[0078] The patch control sections **814** and **824** have a function of transmitting density information of the correction patch image received from the patch calculation sections **834** and **854** to the patch output sections **812** and **824**. Further, the patch control sections **814** and **824** receive the density information of the density patch image detected from the density sensor **150** (see FIG. **2**), and pass the density information of the correction patch image to the density calculation sections **836** and **856**. The patch output sections **812** and **822** have a function of forming and outputting a correction patch image based on the density information transmitted from the patch control sections **814** and **824**.

[0079] Image Forming Process

[0080] Next, the outline of the image forming process in the image forming apparatus **10** will be described.

[0081] First, the CPU **81** of the control device **80** controls each image forming section **32** such that a toner image is formed on the intermediate transfer belt **40** of the first image forming unit **30**. Similarly, each image forming section **52** is controlled such that a toner image is formed on the intermediate transfer belt **60** of the second image forming unit **50**.

[0082] Specifically, the CPU **81** applies a voltage to the charging members **34** and **54**, and charges the surfaces of the photoconductors **33** and **53** so as to have a predetermined potential, by using the charging members **34** and **54** to which the voltage is applied. Subsequently, the control device **80** irradiates the surfaces of the photoconductors **33** and **53** charged by the charging members **34** and **54** with exposure light by the exposure devices **35** and **55** to form an electrostatic latent image, based on the image data acquired via the communication unit **90**. Thus, an electrostatic latent image corresponding to the image data is formed on the surfaces of the photoconductors **33** and **53**.

[0083] Next, the CPU **81** develops the electrostatic latent image formed by the exposure devices **35** and **55** by the developing devices **36** and **56** and visualizes the electrostatic latent image as a toner image. Further, the control device **80** superimposes and transfers the toner image formed on the surfaces of the photoconductors **33** and **53** of each color on the intermediate transfer belts **40** and **60**, by the primary transfer rolls **37** and **57**.

[0084] In this way, in the first image forming unit **30**, for example, a toner image on which yellow (Y), magenta (M), cyan (C), and black (K) toners are superimposed is formed on the intermediate transfer belt **40**. Similarly, in the second image forming unit **50**, for example, a toner image in which black (K), gold color (G), silver color (S), and white (W) toners are superimposed is formed on the intermediate transfer belt **60**.

[0085] Here, the recording paper P sent out from the accommodating unit **12** to the conveyance path **19** by the feed roll **13** is sent out to the secondary transfer position TJ**2** on the upstream side in the conveyance direction, after the convey timing is adjusted by the resist roll pair **15** based on the control of the control device **80**. At the secondary transfer position TJ**2**, the recording paper P is conveyed between the backup roll **42** and the secondary transfer roll **24**, so that the toner image on the outer peripheral surface of the intermediate transfer belt **40** is transferred to the recording paper P. Then, the recording paper P on which the toner image is transferred is conveyed to the conveyance direction downstream side and reaches the secondary transfer position TK**2** on the conveyance direction downstream side.

[0086] At this time, the CPU **81** adjusts the timing to start image formation such that the toner image formed on the intermediate transfer belt **60** of the second image forming unit **50** is superimposed and transferred on the recording paper P that have been conveyed from the conveyance direction upstream side.

[0087] The recording paper P, on which the toner images of each color formed by the first image forming unit **30** and the second image forming unit **50** are superimposed and transferred, is fixed by the fixing roll pair **16** of the fixing device **18**, and then is discharged to the discharge unit **9** provided on the upper part of the image forming apparatus main body **10**A, by the discharge roll **17**.

[0088] Automatic Adjustment of Density

[0089] Next, the automatic adjustment of density will be described.

[0090] The CPU **81** of the control device **80** forms the patch image for automatic adjustment of each color, secondarily transfers the patch image for automatic adjustment to the conveyor belt **21**, and causes the density sensor **150** to detect the patch image for automatic adjustment that has been secondarily transferred. In the present exemplary embodiment, the densities of the patch image for automatic adjustment are 100% and 20%.

[0091] The CPU **81** adjusts the developing bias, the exposure light amount, and the like of the development rolls **59**Y, **59**M, **59**C, **59**W, **59**T, **59**S, **59**G, and **59**K based on the detection value of the density sensor **150**. Specifically, the CPU **81** adjusts the developing bias, the amount of exposure light, and the like so that the output density, which is a detection value obtained by detecting an automatic adjustment patch image having an input density of 100%, corresponds to a value corresponding to the input density of 100%. The developing bias, the exposure light amount, and the like are adjusted so that the output density, which is a detection value obtained by detecting an automatic adjustment patch image having an input density of 20%, corresponds to a value corresponding to the input density of 100%.

[0092] The "input density" is an input gradation value, and the "output density" is a density of a toner image secondarily transferred to the recording paper P. The output density can be detected by detecting the toner image secondarily transferred to the conveyor belt **21** with the density sensor **150**. The "density" of the toner image formed on the recording paper P is calculated from the ratio of the amount of light to be illuminated and the amount of light to be reflected (or transmitted). The density is calculated by the common logarithm of the inverse of the reflectance.

[0093] Comparison of Densities of Intermediate Gradation of Toner Images of the Same Color Next, a point of making it possible to compare the densities of the intermediate gradation of the toner images of the same color formed by the image forming sections of different image forming units will be described. Specifically, a point of making it possible to compare the output density of the toner image of the intermediate gradation of the image forming section **32**K of the first image forming unit **30** and the output density of the toner image of the intermediate gradation of the image forming section **52**K of the second image forming unit **50** shown in FIGS. **2** and **4**, at a common intermediate gradation will be described. In addition, "same color" means that the color of the toner as an example of the developer is the same.

[0094] That is, in the present exemplary embodiment, as shown in FIGS. **2** and **4**, each of the first image forming unit **30** and the second image forming unit **50** has a function of forming a toner image with black toner. The image forming apparatus **10** secondarily transfers, to the recording paper P, the color chart **300** (see FIG. **6**) configured with the patch images **312** and **322** for correcting the density of the intermediate gradation formed by the black image forming section **32**K of the first image forming unit **30** and the black image forming section **52**K of the second image forming unit **50**, respectively, and output, and has a density correction mode in which a user visually observes the color chart **300** to correct the density. Therefore, this density correction mode will be described next.

[0095] Density Correction Mode

[0096] The user gives an instruction for performing the density correction mode from the operation panel **95**. Upon receiving this instruction, the control device **80** (see FIG. **3**) outputs the color chart **300** shown in FIG. **6**.

[0097] As shown in FIG. **6**, the color chart **300** is composed of a column **310** of the correction patch images **312**A, **312**B, **312**C, **312**D, and **312**E formed of the toner images, and a column **320** of the correction patch images **322**A, **322**B, **322**C, **322**D, and **322**E formed of the toner images.

[0098] Specifically, the column **310** is composed of a correction patch image **312**A having a density of an input density of 100%, a correction patch image **312**B having a density of 80%, a correction patch image **312**C having a density of 60%, a correction patch image **312**D having a density of 40%, and a correction patch image **312**E having a density of 20%, which are formed by the image forming section **32**K of the first image forming unit **30**.

[0099] The column **320** is composed of a correction patch image **322**A having a density of an input density of 100%, a correction patch image **322**B having a density of 80%, a correction patch image **322**C having a density of 60%, a correction patch image **322**D having a density of 40%, and a correction patch image **322**E having a density of 20%, which are formed by the image forming section **52**K of the second image forming unit **50**.

[0100] The column **310** and the column **320** are formed side by side on one recording paper P. As described above, in a case where these correction patch images are not distinguished, "correction patch image **312** and correction patch image **322**" are described. Further, the input density will be described later.

[0101] A numerical value indicating each density is printed next to the correction patch images **312** and **322** of each density. Further, the names of the corresponding image forming units are printed on the respective columns **310** and **320**. In the present exemplary embodiment, the first image forming unit **30** is printed as "first image forming unit", and the second image forming unit **50** is printed as "second image forming unit".

[0102] The user visually compares the correction patch images **312** and **322** of the color chart **300**, and confirms whether or not the densities are the same for both.

[0103] In this example, the correction patch image **312**C having a density of 60% and the correction patch image **322**C are slightly different from each other. In addition, in the present example, the correction patch image **322**C is lighter than the correction patch image **312**C.

[0104] The user visually compares the correction patch image **312**C of the color chart **300** with a density of 60% and the correction patch image **322**C, and visually compares the correction patch image **312**C of the first image forming unit **30** with a density of 60% and the second image forming unit. It is determined which of **50** is used as a reference with the correction patch image **322**C having a density of 60%. In other words, the density of the correction patch image **312**C having a density of 60% of the first image forming unit is corrected to match the density of the correction patch image **322**C having a density of 60% of the second image forming unit **50**, or the second image. It is determined whether the density of the correction patch image **322**C having a density of 60% of the second image forming unit **50** is corrected to match the density of the correction patch image **312**C having a density of 60% of the first image forming unit **30**. The user may make a determination by any method. In the present exemplary embodiment, the determination is made by the subjectivity of the user.

[0105] The density to be adjusted is referred to as a "target density", the image forming unit as a reference is referred to as a "reference unit", and the image forming unit for which the density is corrected is referred to as a "correction unit".

[0106] In this example, it is assumed that the user decides to use the correction patch image **312**C having a density of 60% of the first image forming unit as a reference. That is, it is determined that the "target density" is the density of 60%, the "reference unit" is the first image forming unit **30**, and the "correction unit" is the second image forming unit **50**.

[0107] After the determination, the user inputs from the operation panel **95** (see FIG. **1**) that the target density for density correction is set to a density of 60% and that the first image forming unit **30** is used as a reference unit.

[0108] In response to this instruction, after performing a density correction for adjusting the density of 60% of the second image forming unit **50** to the density of 60% of the first image forming unit **30**, the control device **80** outputs the color chart **300** after the density correction after reception by being formed on the recording paper P, and ends the density correction mode.

[0109] The user visually checks the color chart **300** again. After the checking, in a case where there is no problem, or in a case where there is a problem but within an allowable range, the process ends as it is. In a case where the user determines that further density correction is necessary, the user takes measures such as contacting a service man.

[0110] In addition, in a case where the density difference between the correction patch image **312**C of the first image forming unit **30** and the correction patch image **322**C of the second image forming unit **50** is within a range and it is not necessary to perform a correction for matching the two densities, that fact is displayed on the operation panel **95**. In a case where there is no problem or there is a problem but within an allowable range, the user ends the process as it is. In a case where the user determines that the density correction is necessary, the user takes measures such as contacting a service man.

[0111] Density Correction

[0112] Next, an example of a specific method for density correction in which the CPU **81** (see FIG. **3**) of the control device **80** adjusts the density of 60% of the second image forming unit **50** formed on the recording paper P to the density of 60% of the first image forming unit **30** will be described using the flowchart of FIG. **9**. In addition, in the present exemplary embodiment, the control device **80** stores a numerical value corresponding to the density. For example, in the present exemplary embodiment, the density of 50% is stored as a numerical value of 125.

[0113] In a case where an instruction to perform the density correction mode is received from the operation panel **95** (see FIG. **1**) operated by the user, the CPU **81** forms the color chart **300** on the recording paper P and outputs the color chart **300** (step S**100**). The CPU **81** receives the target density and the reference unit input by the user from the operation panel **95** (step S**102**). In this example, as described above, the target density is 60%, and the reference unit is the first image forming unit **30**.

[0114] The CPU **81** forms a correction patch image having an input density of a target density in each of the correction unit and the reference unit, and secondary transfers the image to the conveyor belt **21** (step S**104**). The correction patch image formed by the correction unit is an example of a target patch image, and the correction patch image formed by the reference unit is an example of a reference patch image.

[0115] In the present exemplary embodiment, the first image forming unit **30** forms the correction patch image **312**C having an input density of 60%, and the second image forming unit **50** forms the correction patch image **322**C having an input density of 60%. The correction patch images are secondarily transferred to the conveyor belt **21**. The correction patch image **312**C is an example of a reference patch image, and the correction patch image **322**C is an example of a target patch image. In addition, as described above, the description of the input density will be described later.

[0116] The CPU **81** detects the density of the correction patch image of the target density of the correction unit and the reference unit secondarily transferred to the conveyor belt **21** by the density sensor **150** (step S**106**). In this example, the density sensor **150** detects the densities of the correction patch images **312**C and **322**C secondarily transferred to the conveyor belt **21**.

[0117] The CPU **81** calculates the density difference between the correction patch images of the target densities of the correction unit and the reference unit secondarily transferred to the conveyor belt **21** (step S**108**). In this example, the difference in density between the correction patch image **312**C and the correction patch image **322**C having a density of 60% is calculated.

[0118] The CPU **81** determines whether or not the density difference is within a preset range (step S**110**). The range of the density difference in the present exemplary embodiment is less than 0.05.

[0119] In a case where the density difference is within the range (step S**110**: YES), the CPU **81** proceeds to the process of step S**112** and displays on the operation panel **95** that the density difference between the two is within the defined range and the correction is unnecessary (step S**112**).

[0120] In a case where the range is out of the range (step **5110**: NO), the CPU **81** proceeds to the process of step S**114**, and according to the density difference, a plurality of correction patch images as an example of the target patch image are generated by the correction unit at an input density different from the target density are formed and secondarily transferred to a conveyor belt (step: S**114**). Specifically, in a case where the density of the correction unit is darker than that of the reference unit, the correction unit forms a correction patch image with an input density lighter than the target density. Specifically, in a case where the density of the correction unit is lighter than that of the reference unit, the correction unit forms a correction patch image with an input density darker than the target density.

[0121] In addition, for example, a plurality of (in the present example, three) correction patch images formed with a lighter input density or a dark input density are formed in increments of 2% from the correction patch image **312**C.

[0122] In the present exemplary embodiment, the density of 60% of the second image forming unit **50** which is the correction unit is lighter than the density of 60% of the first image forming unit **30** which is the reference unit. Therefore, the second image forming unit **50** forms correction patch images having an input density darker than 60%, specifically, a density of 62%, a density of 64%, and a density of 66%.

[0123] The CPU **81** detects the density of a plurality of correction patch images secondarily transferred to the conveyor belt **21** by the density sensor **150** (step S**116**).

[0124] The CPU **81** calculates a density difference between the plurality of correction patch images and correction patch image (correction patch image **312**C (see FIG. **6**) in the present example) of target density of the reference unit (first image forming unit **30** in the present example) (step S**118**).

[0125] The CPU **81** determines whether or not there is a correction patch image, among the plurality of correction patch images, having a density difference within a range from the density of the correction patch image (correction patch image **312**C (see FIG. **6**) in the present example) of the target density of the reference unit (first image forming unit **30** in the present example) (step S**120**).

[0126] In a case where there is no correction patch image within the range (step S**120**: NO), the process returns to the process of step S**114**, and again, according to the density difference, the correction unit forms a plurality of correction patch images with a density different from the target density and secondarily transfers the correction patch images on the conveyor belt (step: S**114**). At this time, the correction patch image is formed with a density different from the previous density. For example, in a case where the density of the correction unit is darker than that of the reference unit, a correction patch image is formed with an input density lighter than the previous density. In a case where the density of the correction unit is lighter than that of the reference unit, a correction patch image is formed with an input density darker than the previous density. In the case of the present exemplary embodiment, for example, correction patch images having an input density of 68%, a density of 70%, and a density of 72% are formed.

[0127] In a case where there is a correction patch image within the range (step S**120**: YES), the process proceeds to step S**122**, and a replacement LUT is created in which the density of the correction patch image within the range is replaced with a density at which the input density is 60%. In a case where there are a plurality of correction patch images within the range, the density having the smallest density difference is adopted (step S**122**).

[0128] Specifically, for example, it is assumed that the difference between the correction patch image having an input density of 70% formed by the second image forming unit **50** and the correction patch image **312**C having a density of 60% of the first image forming unit **30** was within a range. In this case, in a case where the second image forming unit **50** forms a toner image having an input density of 60%, a replacement LUT is created in which the input density is replaced with a density of 70%. The replacement LUT will be described later.

[0129] The CPU **81** outputs the color chart **300** using the replacement LUT (step S**124**).

[0130] Replacement LUT

[0131] Next, the replacement LUT will be described. As described above, "LUT" is an abbreviation for a lookup table and is a mathematical formula that defines the density adjustment of an image. In this description, a graph is used to make the concept of replacement easy to understand, but the graph is not actually stored in the control device **80**.

[0132] FIG. **7** is a graph showing a relationship between an input density and an output density of the same color, that is, in the present exemplary embodiment, an input density and an output density of black. As described above, the input density is an input gradation value, and the output density is a density detected by the density sensor **150** of the secondary transferred toner image. Further, as described above, in the present exemplary embodiment, the input density and the output density are stored in the control device **80** as corresponding numerical values.

[0133] The line N**30** indicates the relationship between the input density and the output density of the image forming section **32**K of the first image forming unit **30**. Although the line N**30** is a straight line for easy understanding, in reality, the line N**30** is almost never a straight line.

[0134] The line N**50** indicates the relationship between the input density and the output density of the image forming section **52**K of the second image forming unit **50** in a case where the replacement LUT is not used. The line N**51** indicates the relationship between the input density and the output density of the image forming section **52**K of the second image forming unit **50** in a case where the input value is replaced by the replacement LUT. The input density of the line N**51** is the input density before the replacement.

[0135] As described above, in the line N**50**, the input density is 60%, but the output density is 55%, which is smaller than the density of 60%. Further, when the input density of the image forming section **52**K of the second image forming unit **50** is the density of 70%, the output density is assumed to be the density of 60%. That is, it is assumed that the input density of the correction patch image **312**C is 60%, the density of the correction patch image **322**C is 55%, and the density of the correction patch within the range in step S**120** is 70%.

[0136] Therefore, a replacement LUT is created in which with respect to the input density of the image forming section **52**K of the second image forming unit **50**, a density of 60% is replaced with a density of 70%.

[0137] As described above, in the automatic density adjustment, the density is automatically adjusted between the density of 100% and the density of 20%. Therefore, it is assumed that the input density and the output density are the same or substantially the same for the density of 100% and the density of 20%. Therefore, the replacement LUT is created by using the density of 100% and the density of 20% as fixed values, and by performing linear interpolation, with the change of replacing the input density of 60% with the input density of 70% as the maximum change point. Note that FIG. **7** is a graph conceptually illustrating a replacement LUT created through linear interpolation.

[0138] Here, a case where the density correction has already been performed once and there is a replacement LUT will be described.

[0139] In a case where the density is adjusted for the second time or later, in a case where the color chart **300** is formed on the recording paper P in step S**100** and is output, a replacement LUT is used. However, in a case where the correction patch image is secondarily transferred to the conveyor belt **21** in step S**104** or the like, the replacement LUT is not used.

[0140] Therefore, for example, in a case where there is already a replacement LUT that replaces the input density of 60% with the input density 65%, the replacement LUT is created by setting the input density of 70% as an output value for the input density of 60% instead of the input density 65%. That is, as described above, a replacement LUT that replaces the input density of 60% with the input density of 70% is created and overwritten.

[0141] Image Formation

[0142] Next, an image forming process in a case where the replacement LUT is used will be described using the flowchart of FIG. **10**.

[0143] Upon receiving the printing instruction, the CPU **81** (see FIG. **3**) of the control device **80** determines whether or not there is an instruction to use the image forming unit whose input value needs to be replaced (step S**200**). In the case of the present exemplary embodiment, it is determined whether or not there is an instruction to form an image by using the image forming section **52**K of the second image forming unit **50**.

[0144] In a case where there is no need (step S**200**: NO), the CPU **81** proceeds to the process of step S**204** and forms an image on the recording paper P (step S**204**).

[0145] In a case where there is a need (step S**200**: YES), the CPU **81** proceeds to the process of step S**202**, converts the input density through the replacement LUT, forms an image on the recording paper P, and outputs the image (step S**202**).

[0146] Action

[0147] Next, the action of the present exemplary embodiment will be described.

[0148] In the image forming apparatus **10** of the present exemplary embodiment, the color chart **300** on which the correction patch image **312** of the intermediate gradation of the image forming section **32**K of the first image forming unit **30** and the correction patch image **322** of the intermediate gradation of the image forming section **52**K of the second image forming unit **50** of the same color, black, in the present exemplary embodiment, are formed is secondarily transferred to the recording paper P and output. Therefore, the density of the intermediate gradation of the image forming section **32**K of the first image forming unit **30** and the density of the intermediate gradation of the image forming section **52**K of the second image forming unit **50** may be compared with a common intermediate gradation.

[0149] From another point of view, as compared with the case where the color chart **300** is not output, it may be possible to easily check whether or not there is a difference between the density of the intermediate gradation of the image forming section **32**K of the first image forming unit **30** and the density of the intermediate gradation of the image forming section **52**K of the second image forming unit **50**.

[0150] Further, the color chart **300** is secondarily transferred to one recording paper P and output. In the present exemplary embodiment, two columns of the column **310** of the correction patch images **312**A, **312**B, **312**C, **312**D, and **312**E, and the column **320** of the correction patch images **322**A, **322**B, **322**C, **322**D, and **322**E which are formed of the toner images are formed on one sheet of recording paper P and output.

[0151] Therefore, compared with a case where the color chart is divided and output on a plurality of sheets of recording paper P, the density of the intermediate gradation may be compared with the common intermediate gradation. From another viewpoint, it may be possible to accurately check whether or not there is a difference between the densities of the intermediate gradations.

[0152] Further, the column **310** of the correction patch image **312** and the column **320** of the correction patch image **320** are formed side by side and output. Therefore, in comparison with a case where the correction patch image **312** and the correction patch image **320** are formed and output as an example, it may be possible to make it possible to compare the densities of the common intermediate gradation. From another viewpoint, it is possible to accurately check whether or not there is a difference in the densities of intermediate gradation.

[0153] Further, after outputting the color chart **300**, the inputs of a target density of a target for which the density is to be adjusted in the density of the color chart **300** (density of 60% in the present exemplary embodiment) and a reference unit which is a reference (the first image forming unit **30** in the present exemplary embodiment) are received. Therefore, as compared with a case where only the target density is input, the densities of intermediate gradation in the toner image of the image forming section **32**K of the first image forming unit **30** and the toner image of the image forming section **52**K of the second image forming unit **50** may be aligned.

[0154] Further, since a correction is performed for adjusting the density of the toner image having the input density of 60% formed by the image forming section **52**K of the second image forming unit **50** to the density of the toner image having the input density of 60% formed by the image forming section **32**K of the first image forming unit **30** which is a reference, it may be possible to align the densities of intermediate gradation as compared with the case where the correction is not performed.

[0155] Further, in a case where the image forming section **52**K of the second image forming unit **50** forms an image, the input density is replaced through the replacement LUT. Therefore, as compared with a case where the input density is not replaced, the densities of intermediate gradation of the toner image formed by the image forming section **32**K of the first image forming unit **30** and the toner image formed by the image forming section **52**K of the second image forming unit **50** may be adjusted.

[0156] Further, until the density difference between the correction patch image formed by the second image forming unit **50**, which is the correction unit, and the correction patch image **322**C of the target density of the first image forming unit **30**, which is the reference unit, is within the range, the density of the correction patch image of the correction unit is changed to reform the correction patch image.

[0157] Therefore, as compared with a case where the density of the correction patch image formed by the second image forming unit **50** is not changed not to reform the correction patch image, the density of intermediate gradation of the toner images formed by the image forming section **32**K of the first image forming unit **30**, which is the reference unit, and the image forming section **52**K of the second image forming unit **50**, which is the correction unit, may be more accurately aligned.

[0158] Further, after the density is corrected, the color chart **300** in which the input value is converted through the replacement LUT is formed on the recording paper P and is output. Therefore, the user may easily check that the densities of intermediate gradation of the toner images formed by the image forming section **32**K of the first image forming unit **30**, which is the reference unit, and the image forming section **52**K of the second image forming unit **50**, which is the correction unit, are aligned.

[0159] Others

[0160] The present invention is not limited to the above exemplary embodiments.

[0161] For example, in the above exemplary embodiment, the input of the execution of the density correction mode, the input of the target density, and the input of the reference unit, performed by the user, are performed from the operation panel **95**, but the present invention is not limited thereto. For example, the user may input from a personal computer, a smartphone, a tablet terminal, or the like that is electrically connected to the image forming apparatus **10** by wire or wireless.

[0162] Further, for example, in the above exemplary embodiment, in the image forming apparatus **10**, the first image forming unit **30** and the second image forming unit **50** have the black toner images of the same color, but the present invention is not limited thereto. For example, all four colors may be the same colors. In a case where a plurality of colors are the same color, a target density and a reference unit are determined and input for each color, and the CPU creates a replacement LUT for correction for each color. For example, for cyan, the target density is 40% and the reference unit is the first image forming unit **30**, and for magenta, the target density is 60% and the reference unit is the second image forming unit **50**.

[0163] Further, for example, in the above exemplary embodiments, the image forming apparatus **10** includes two image forming units, that is, the first image forming unit **30** and the second image forming unit **50**, but the present invention is not limited thereto. The image forming apparatus may include three or more image forming units. Further, for example, in the above exemplary embodiments, the first image forming unit **30** and the second image forming unit **50** have four image forming sections **32** and **52**, respectively, but the present invention is not limited thereto. The image forming unit may have two or more image forming sections.

[0164] Here, the case of an image forming apparatus including three or more image forming units will be described. One image forming unit to be used as a reference is determined, and an image forming unit whose density is adjusted to the reference image forming unit is defined as a correction unit. The number of correction units may be one or plural. In addition, in this case, in addition to the reference unit, the user may input a correction unit for correcting the density.

[0165] The color chart **300** shown in FIG. **6** is an example and is not limited thereto. For example, although the density of the correction patch images **312** and **322** of the color chart **300** is in increments of 20%, the increment width of 20% or more and the increment width of less than 20% may be used. Further, the increment width of the density may be reduced as the density becomes lighter. For example, the densities are 3%, 5%, 10%, 15%, 20%, 30%, 40%, 60%, 80%, and 100%. Further, the density increment may be changed for each color.

[0166] Further, various types of control by the control device **80** may be read as a mode or a control form.

[0167] Further, in the above exemplary embodiments, the recording paper P is used as an example of the recording medium, but the present invention is not limited thereto. Other than the recording paper P, for example, an OHP sheet or the like may be used.

[0168] In the embodiments above, the term "processor" refers to hardware in a broad sense. Examples of the processor include general processors (e.g., CPU: Central Processing Unit) and dedicated processors (e.g., GPU: Graphics Processing Unit, ASIC: Application Specific Integrated Circuit, FPGA: Field Programmable Gate Array, and programmable logic device). In the embodiments above, the term "processor" is broad enough to encompass one processor or plural processors in collaboration which are located physically apart from each other but may work cooperatively. The order of operations of the processor is not limited to one described in the embodiments above, and may be changed. More specifically, the hardware structure of these various processors is an electric circuit in which circuit elements such as semiconductor elements are combined.

[0169] In the above exemplary embodiment, the mode in which the program is stored (installed) in the ROM or the storage in advance has been described, but the present invention is not limited to this. The program may be provided in a form recorded on a Compact Disk Read Only Memory (CD-ROM), a Digital Versatile Disk Read Only Memory (DVD-ROM), a Universal Serial Bus (USB) memory, or the like. Further, the program may be downloaded from an external apparatus via a network.

[0170] Further, the configuration of the image forming apparatus is not limited to the configuration of the above exemplary embodiments, and various configurations can be used. Further, the present invention can be implemented in various ways without departing from the concept of the present invention.

[0171] Supplementary Note

[0172] (((1)))

[0173] An image forming apparatus comprising:

[0174] a plurality of image forming units each having a plurality of image forming sections, and an intermediate transfer body on which toner images formed by the plurality of image forming sections are primarily transferred;

[0175] a plurality of secondary transfer units that are provided corresponding to the plurality of image forming units, and secondarily transfer the toner images of the intermediate transfer body to a recording medium; and

[0176] a processor,

[0177] wherein each image forming unit has the image forming section of the same color, and the processor is configured to:

[0178] in response to an instruction to output a color chart of the same color, execute a mode in which the color chart of the toner image having a density of intermediate gradation, formed by the image forming section of the same color for each image forming unit, is secondarily transferred to the recording medium and output.

[0179] (((2)))

[0180] The image forming apparatus according to (((1))),

[0181] wherein in the mode,

[0182] the color chart is formed on one recording medium and output.

[0183] (((3)))

[0184] The image forming apparatus according to (((1))),

[0185] wherein columns of toner images having the density of intermediate gradation, constituting the color chart, formed for respective image forming units, are arranged side by side on one recording medium.

[0186] (((4)))

[0187] The image forming apparatus according to any one of (((1))) to (((3))),

[0188] wherein in the mode,

[0189] after the color chart is output,

[0190] inputs of a target density of a target for which density is adjusted in the density of intermediate gradation of the color chart and the image forming unit as a reference are received.

[0191] (((5)))

[0192] The image forming apparatus according to (((4))),

[0193] wherein in the mode,

[0194] a correction is performed for adjusting a density of the toner image of the same color formed by another image forming unit to a density of the toner image of the same color having the target density, formed by the image forming unit as the reference.

[0195] (((6)))

[0196] The image forming apparatus according to (((4))) or (((5))), further comprising:

[0197] a detection device that detects a density of the toner image,

[0198] wherein in the mode,

[0199] a reference patch image of the target density of the image forming unit as the reference and a target patch image of the target density of the other image forming unit are formed, and the detection device is caused to perform detection,

[0200] a plurality of the target patch images having densities different from the target density are formed based on a density difference between the two patch images by the other image forming unit, and the detection device is caused to perform detection, and

[0201] an input density of the target density in a case where the image forming section of the same color of the other image forming unit forms the toner image is replaced with an input density of the target patch image having a density closest to the reference patch image.

[0202] (((7)))

[0203] The image forming apparatus according to any one of (((4))) to (((6))),

[0204] wherein in the mode,

[0205] a density of the target patch image is changed to reform the target patch image until a density difference between the density of the target patch image and the target patch image having the density closest to the reference patch image falls within a predetermined range.

[0206] (((8)))

[0207] The image forming apparatus according to any one of (((4))) to (((7))),

[0208] wherein in the mode,

[0209] after the inputs of the target density and the image forming unit as the reference are received,

[0210] the color chart is secondarily transferred to the recording medium and output again.

[0211] The foregoing description of the exemplary embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

What is claimed is:

1. An image forming apparatus comprising:

a plurality of image forming units each having a plurality of image forming sections, and an intermediate transfer body on which toner images formed by the plurality of image forming sections are primarily transferred;

a plurality of secondary transfer units that are provided corresponding to the plurality of image forming units, and secondarily transfer the toner images of the intermediate transfer body to a recording medium; and

a processor,

wherein each image forming unit has the image forming section of the same color, and the processor is configured to:

in response to an instruction to output a color chart of the same color, execute a mode in which the color chart of the toner image having a density of intermediate gradation, formed by the image forming section of the same color for each image forming unit, is secondarily transferred to the recording medium and output.

2. The image forming apparatus according to claim **1**, wherein in the mode,

the color chart is formed on one recording medium and output.

3. The image forming apparatus according to claim **2**, wherein columns of toner images having the density of intermediate gradation, constituting the color chart, formed for respective image forming units, are arranged side by side on one recording medium.

4. The image forming apparatus according to claim **1**, wherein in the mode,

after the color chart is output,

inputs of a target density of a target for which density is adjusted in the density of intermediate gradation of the color chart and the image forming unit as a reference are received.

5. The image forming apparatus according to claim **2**, wherein in the mode,

after the color chart is output, inputs of a target density of a target for which density is adjusted in the density of intermediate gradation of the color chart and the image forming unit as a reference are received.

6. The image forming apparatus according to claim **3**, wherein in the mode,

after the color chart is output,

inputs of a target density of a target for which density is adjusted in the density of intermediate gradation of the color chart and the image forming unit as a reference are received.

7. The image forming apparatus according to claim **4**, wherein in the mode,

a correction is performed for adjusting a density of the toner image of the same color formed by another image forming unit to a density of the toner image of the same color having the target density, formed by the image forming unit as the reference.

8. The image forming apparatus according to claim **5**, wherein in the mode,

a correction is performed for adjusting a density of the toner image of the same color formed by another image forming units to a density of the toner image of the same color having the target density, formed by the image forming unit as the reference.

9. The image forming apparatus according to claim **6**, wherein in the mode,

a correction is performed for adjusting a density of the toner image of the same color formed by another image forming units to a density of the toner image of the same color having the target density, formed by the image forming unit as the reference.

10. The image forming apparatus according to claim **4**, further comprising:

a detection device that detects a density of the toner image, wherein in the mode,

a reference patch image of the target density formed with the toner image of the image forming unit as the reference and a target patch image of the target density formed with the toner image of another image forming unit are formed, and the detection device is caused to perform detection,

a plurality of the target patch images having densities different from the target density are formed based on a density difference between the two patch images by the other image forming unit, and the detection device is caused to perform detection, and

an input density of the target density in a case where the image forming section of the same color of the other image forming unit forms the toner image is replaced with an input density of the target patch image having a density closest to the reference patch image.

11. The image forming apparatus according to claim **5**, further comprising:

a detection device that detects a density of the toner image,

wherein in the mode,

a reference patch image of the target density formed with the toner image of the image forming unit as the reference and a target patch image of the target density formed with the toner image of another image forming unit are formed, and the detection device is caused to perform detection,

a plurality of the target patch images having densities different from the target density are formed based on a density difference between the two patch images by the other image forming unit, and the detection device is caused to perform detection, and

an input density of the target density in a case where the image forming section of the same color of the other image forming unit forms the toner image is replaced with an input density of the target patch image having a density closest to the reference patch image.

12. The image forming apparatus according to claim **6**, further comprising:

a detection device that detects a density of the toner image,

wherein in the mode,

a reference patch image of the target density formed with the toner image of the image forming unit as the reference and a target patch image of the target density formed with the toner image of another image forming unit are formed, and the detection device is caused to perform detection,

a plurality of the target patch images having densities different from the target density are formed based on a density difference between the two patch images by the other image forming unit, and the detection device is caused to perform detection, and

an input density of the target density in a case where the image forming section of the same color of the other image forming unit forms the toner image is replaced with an input density of the target patch image having a density closest to the reference patch image.

13. The image forming apparatus according to claim **10**, wherein in the mode,

a density of the target patch image is changed to reform the target patch image until a density difference between the density of the target patch image and the target patch image having the density closest to the reference patch image falls within a predetermined range.

14. The image forming apparatus according to claim **11**, wherein in the mode,

a density of the target patch image is changed to reform the target patch image until a density difference between the density of the target patch image and the target patch image having the density closest to the reference patch image falls within a predetermined range.

15. The image forming apparatus according to claim **12**, wherein in the mode,

a density of the target patch image is changed to reform the target patch image until a density difference between the density of the target patch image and the target patch image having the density closest to the reference patch image falls within a predetermined range.

16. The image forming apparatus according to claim **7**, wherein in the mode,

after the inputs of the target density and the image forming unit as the reference are received,

the color chart is secondarily transferred to the recording medium and output again.

17. The image forming apparatus according to claim **8**, wherein in the mode,

after the inputs of the target density and the image forming unit as the reference are received,

the color chart is secondarily transferred to the recording medium and output again.

18. The image forming apparatus according to claim **9**, wherein in the mode,

after the inputs of the target density and the image forming unit as the reference are received,

the color chart is secondarily transferred to the recording medium and output again.

19. A non-transitory computer readable medium storing an image forming program causing a computer to execute a process comprising:

in response to an instruction to output a color chart of the same color, executing a mode in which the color chart of a toner image having a density of intermediate gradation, formed by a image forming section of the same color for each image forming unit, is secondarily transferred to a recording medium and output.

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