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(54) IMAGE-FORMING APPARATUS WITH REDUCED NUMBER OF MOTORS FOR MOVING DEVELOPING ROLLERS AND ALTERING ROTATION SPEED RATIO OF DEVELOPING ROLLERS TO PHOTOSENSITIVE DRUMS

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G03G 15/08 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/0822*** (2013.01)

(57) **ABSTRACT**

An image-forming apparatus includes: a process motor; a developing motor; a sheet conveying device; first and second photosensitive drums rotatable by a driving force from the process motor; first and second developing rollers and first and second cams each rotatable by a driving force from the developing motor; a switching mechanism, and a controller. Rotation of each cam causes each developing roller to move between a contact position in contact with the corresponding photosensitive drum and a separated position away from the corresponding photosensitive drum. The controller allows the switching mechanism to transmit the driving force from the developing motor to each cam such that a timing of contact between the second developing roller and the second photosensitive drum in a low speed mode is coincident with or earlier than a timing of contact between the second developing roller and the second photosensitive drum in a normal mode.

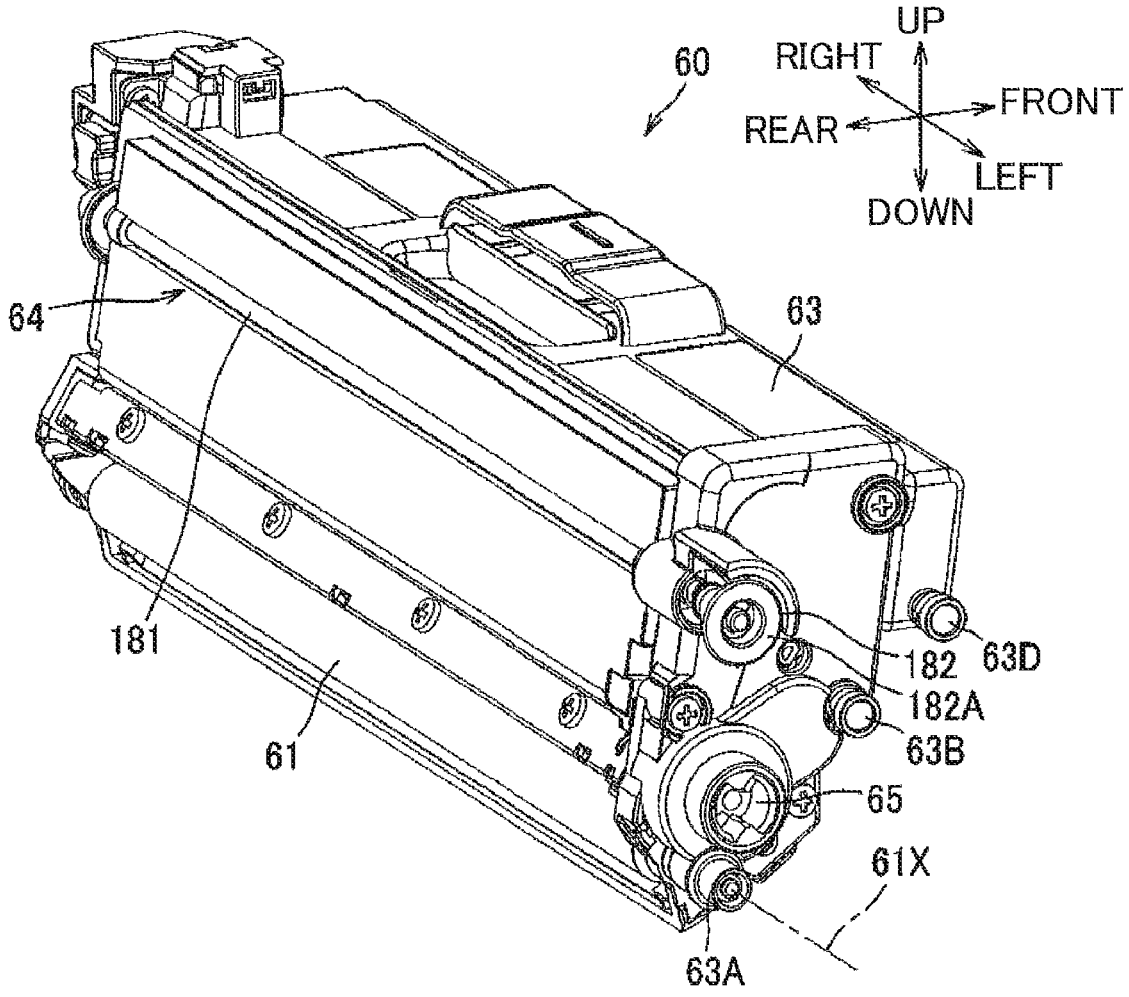


FIG. 1

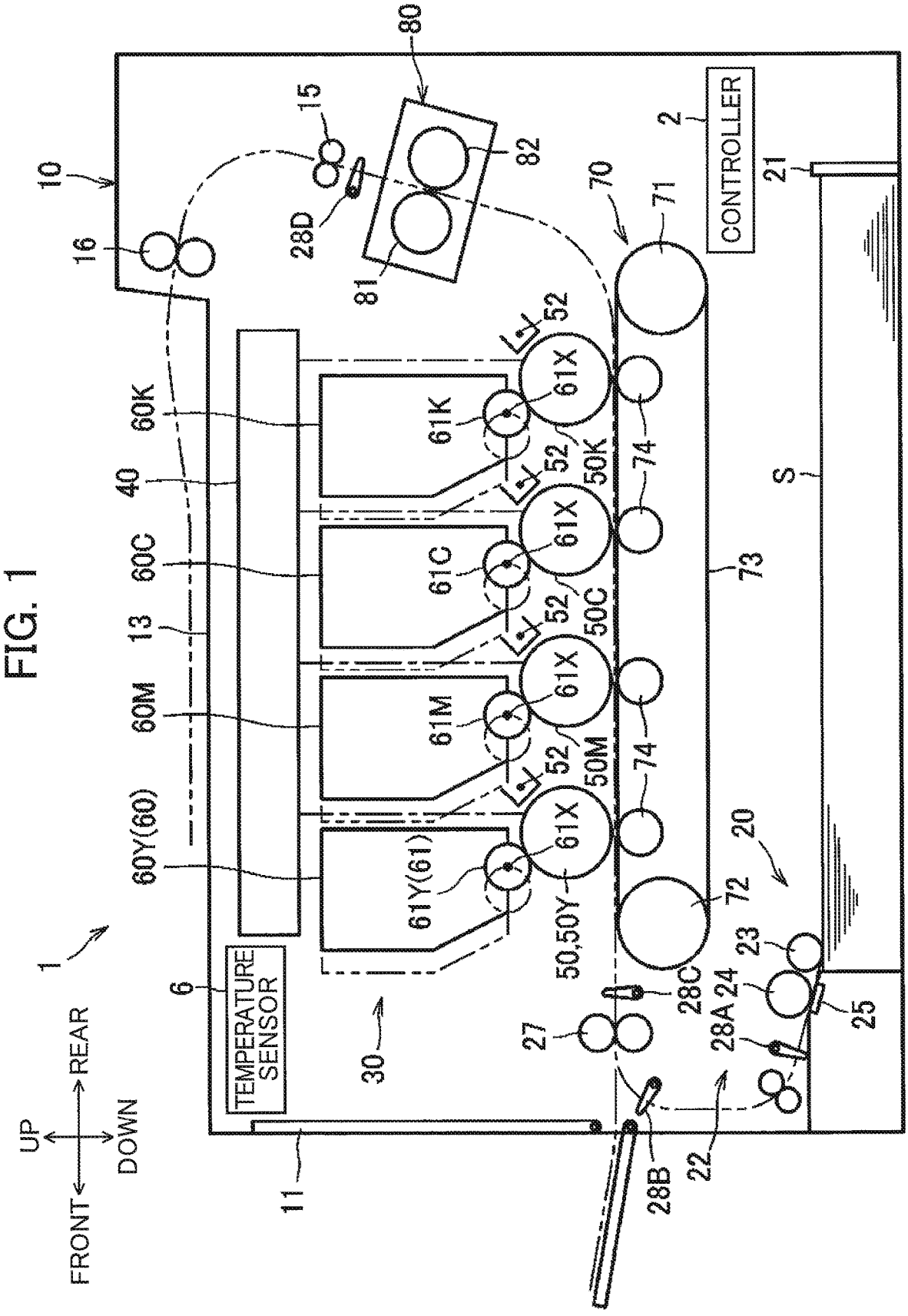

80
15
10
16
28D
81
82
2
CONTROLLER
21
70
71
52
61X
61K
60K
40
50K
74
S
60C
61C
73
13
50C
60M
61M
50M
60Y(60)
61Y(61)
20
50,50Y
72
23
1
6
TEMPERATURE SENSOR
28C
24
25
27
28A
30
UP
REAR
DOWN
FRONT
11
28B
22

FIG. 2

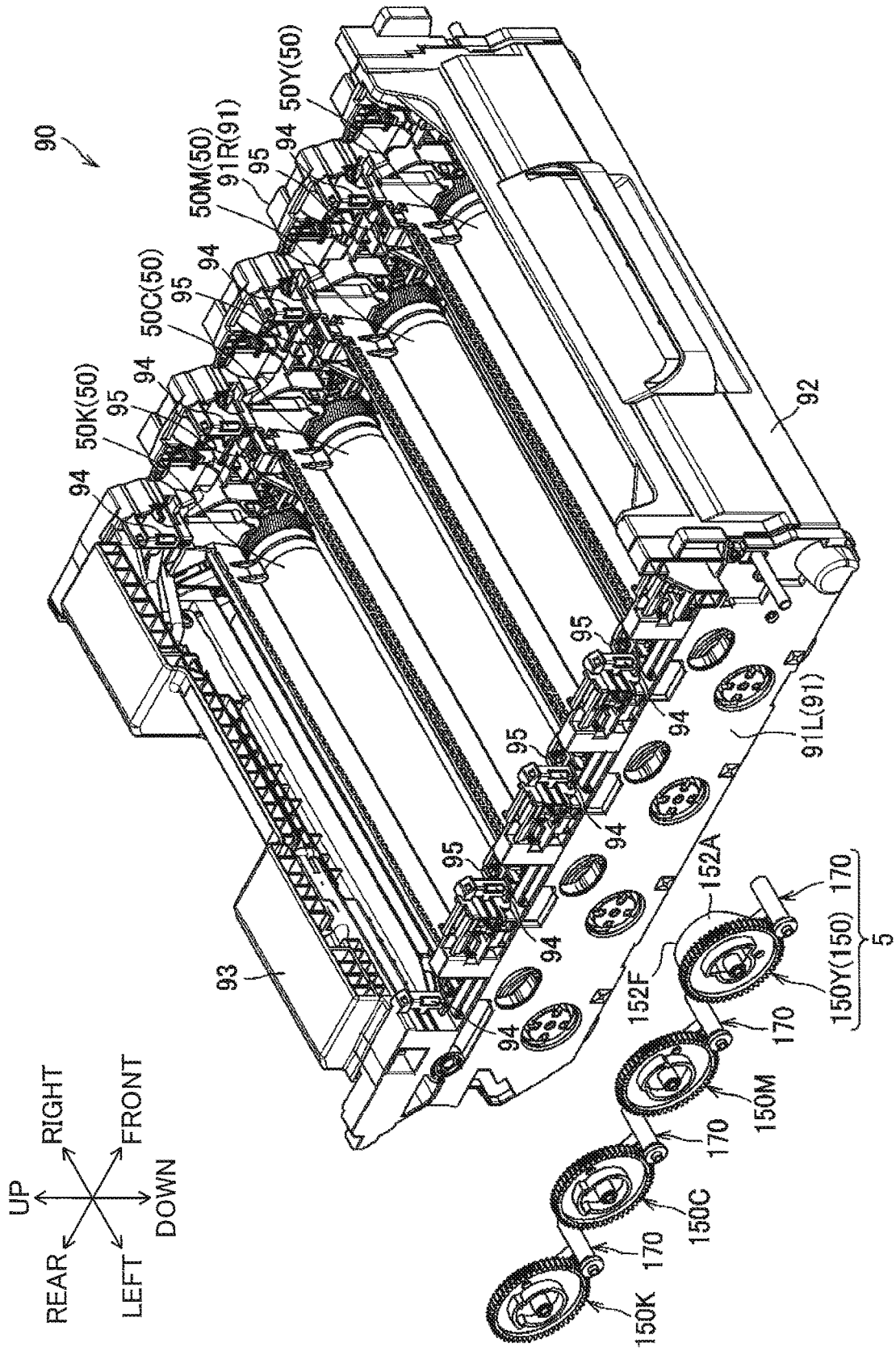

90
50Y(50)
94
95
91R(91)
50M(50)
50C(50)
50K(50)
92
91L(91)
93
152A
152F
150Y(150)
170
5
150M
150C
150K
UP
RIGHT
FRONT
REAR
LEFT
DOWN

FIG. 3A

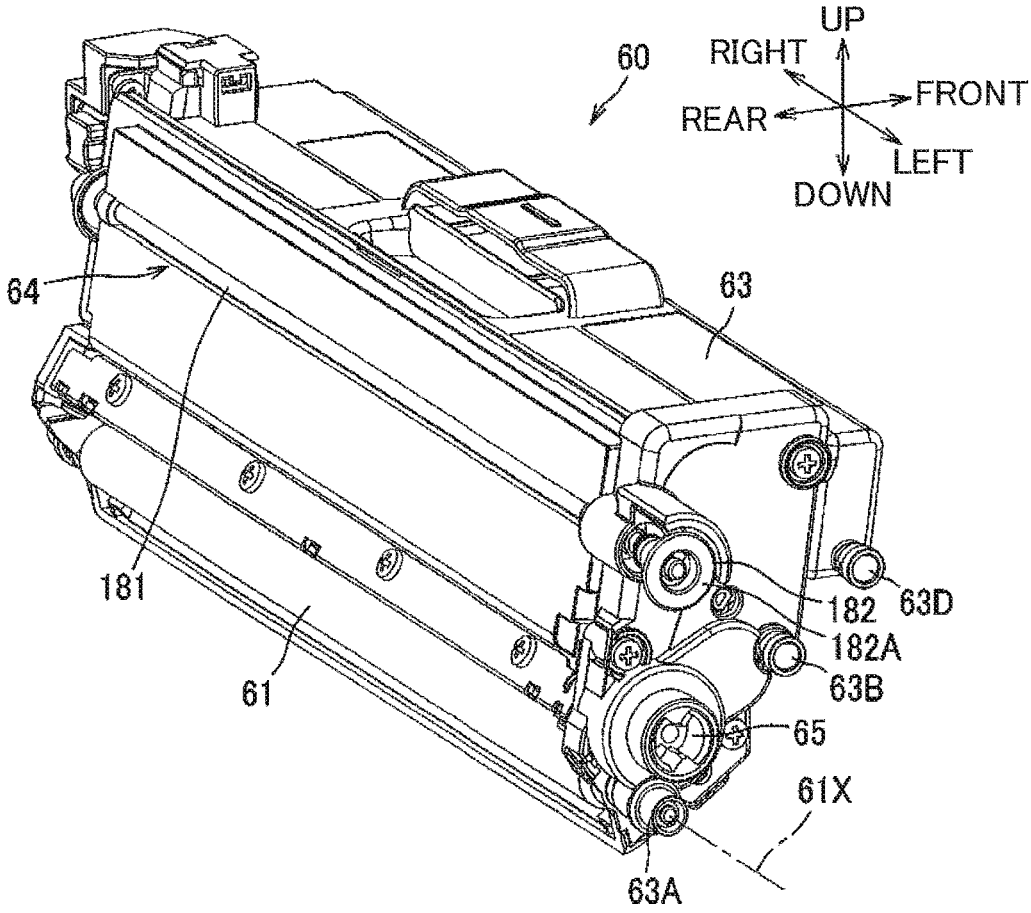
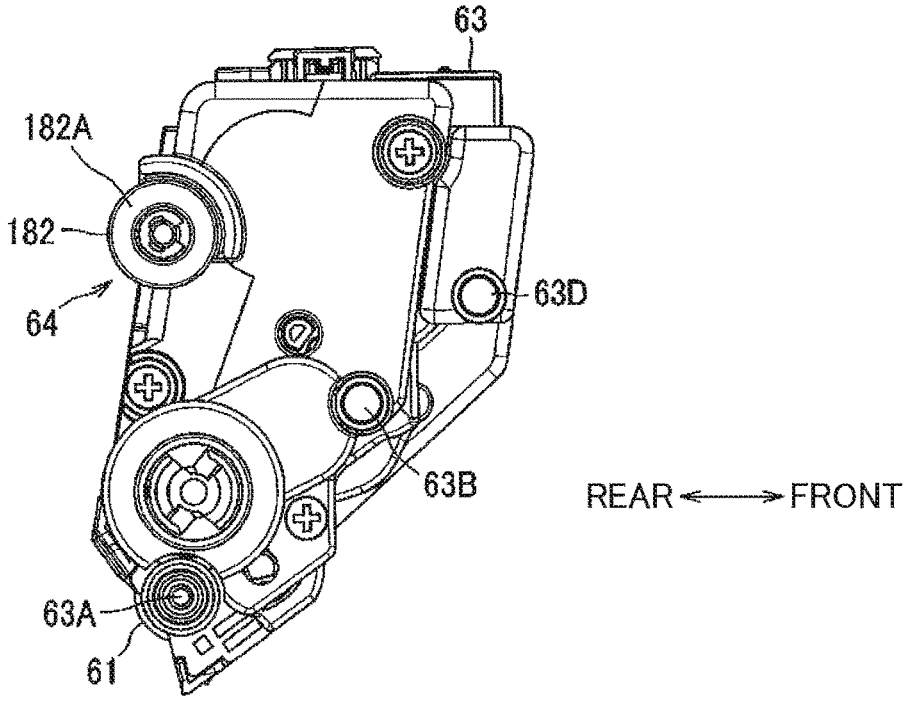

UP
RIGHT
FRONT
REAR
LEFT
DOWN
60
64
63
181
61
182
63D
182A
63B
65
61X
63A

FIG. 3B


63
182A
182
64
63D
63B
63A
61
REAR
FRONT

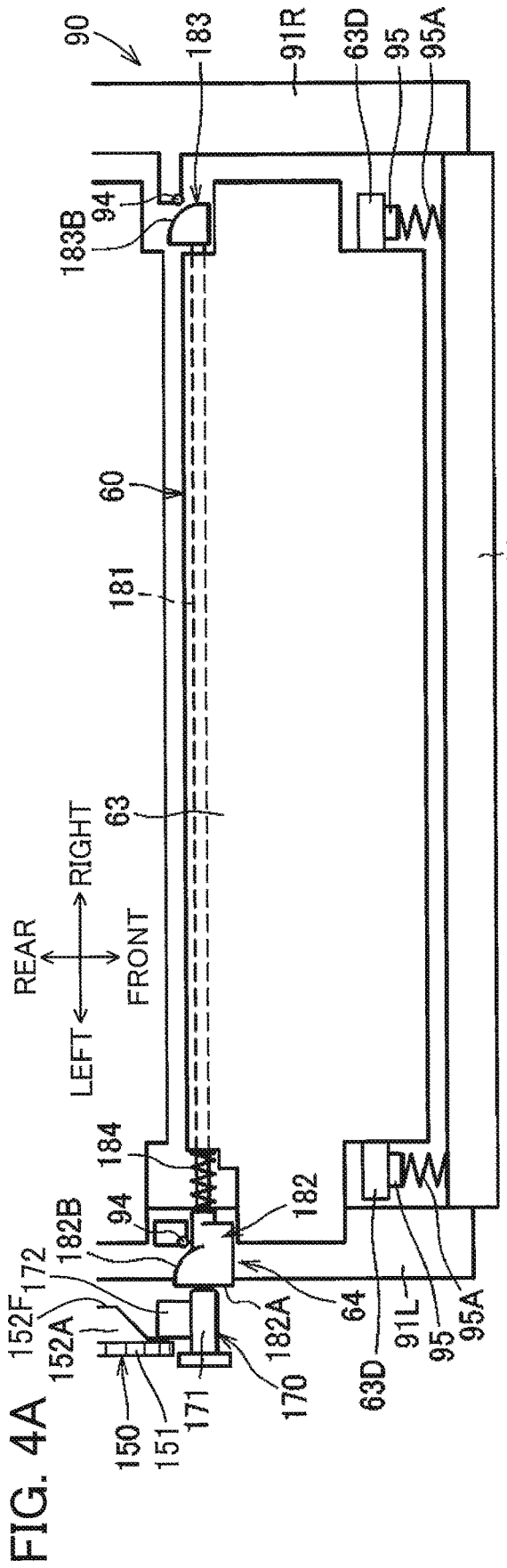

90
183
91R
63D
95
95A
183B
94
60
181
92
63
REAR
RIGHT
FRONT
LEFT
184
182
182B
94
172
152F
152A
H
150
151
171
170
182A
64
63D
91L
95
95A

FIG. 4A

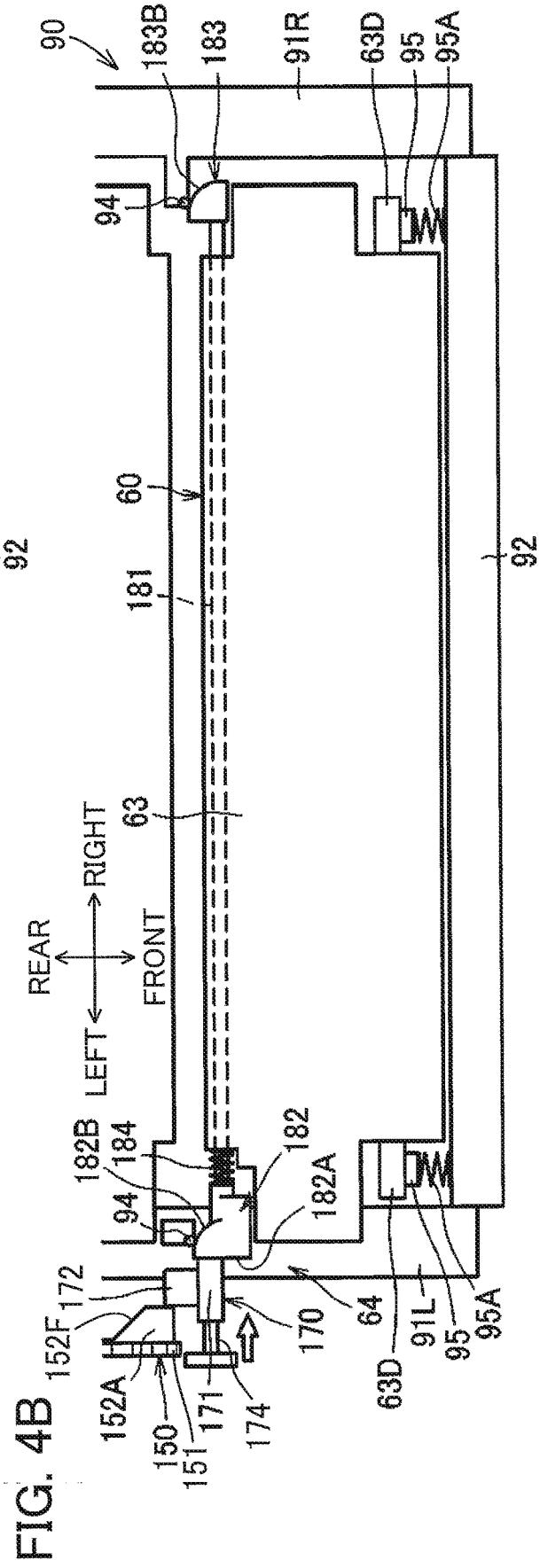

90
183B
183
91R
63D
95
95A
94
60
181
92
63
REAR
RIGHT
FRONT
LEFT
182B
184
182
182A
94
172
152F
152A
H
150
151
171
174
170
64
63D
91L
95
95A

FIG. 4B

FIG. 5

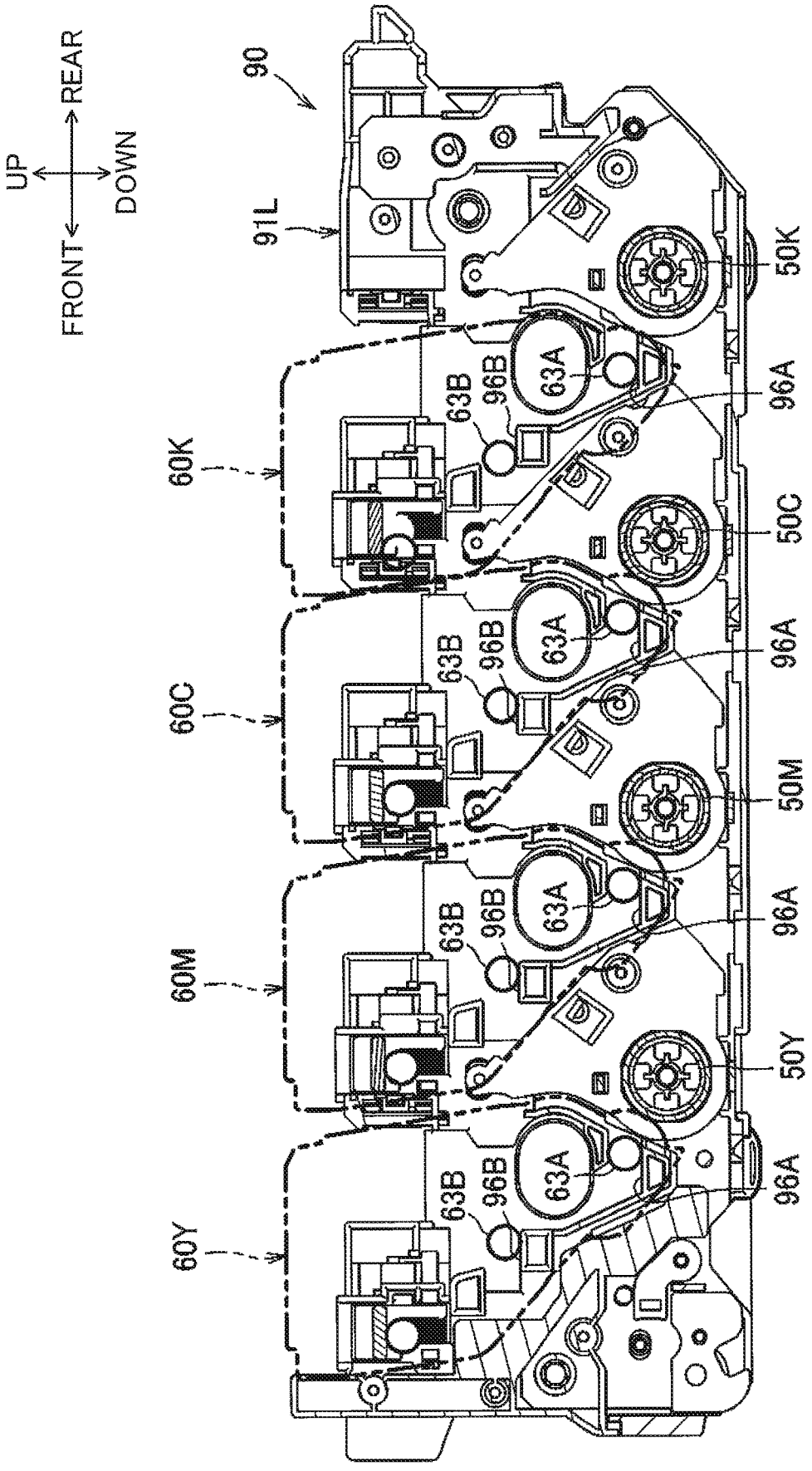

UP
REAR
FRONT
DOWN
90
91L
50K
50C
50M
50Y
60K
60C
60M
60Y
63A
63B
96B
96A

FIG. 6

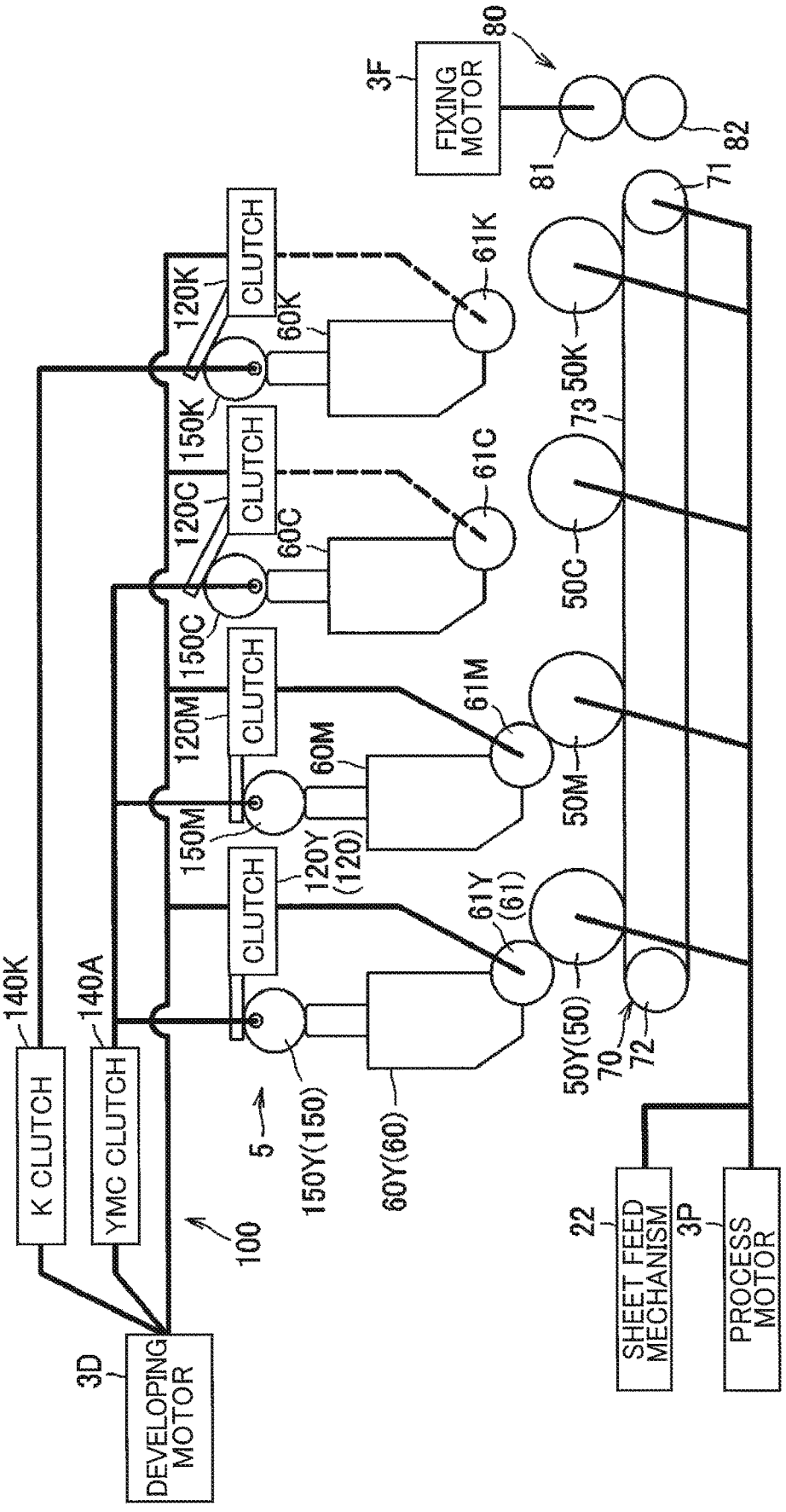

3D
DEVELOPING MOTOR
140K
K CLUTCH
140A
YMC CLUTCH
100
5
150Y(150)
60Y(60)
61Y (61)
50Y(50)
70
72
120Y (120)
150M
CLUTCH
60M
61M
50M
120M
150C
CLUTCH
60C
61C
50C
120C
150K
CLUTCH
60K
61K
50K
73
71
3F
FIXING MOTOR
80
81
82
22
SHEET FEED MECHANISM
3P
PROCESS MOTOR

FIG. 7

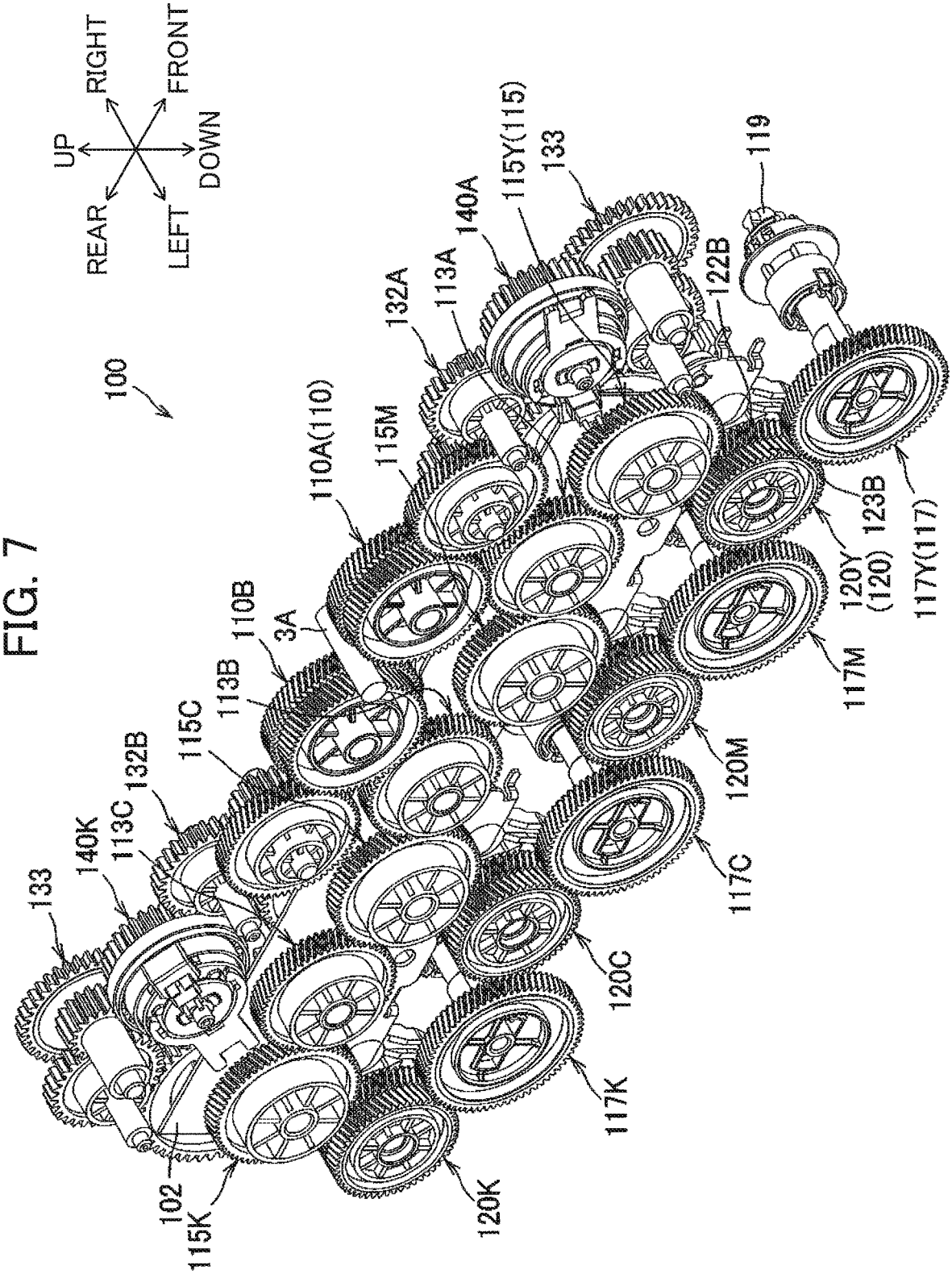

UP
RIGHT
FRONT
REAR
LEFT
DOWN
100
102
115K
120K
117K
120C
117C
120M
117M
120Y
(120)
123B
117Y(117)
122B
119
133
115Y(115)
140A
113A
132A
115M
110A(110)
3A
110B
113B
115C
132B
113C
140K
133

FIG. 8

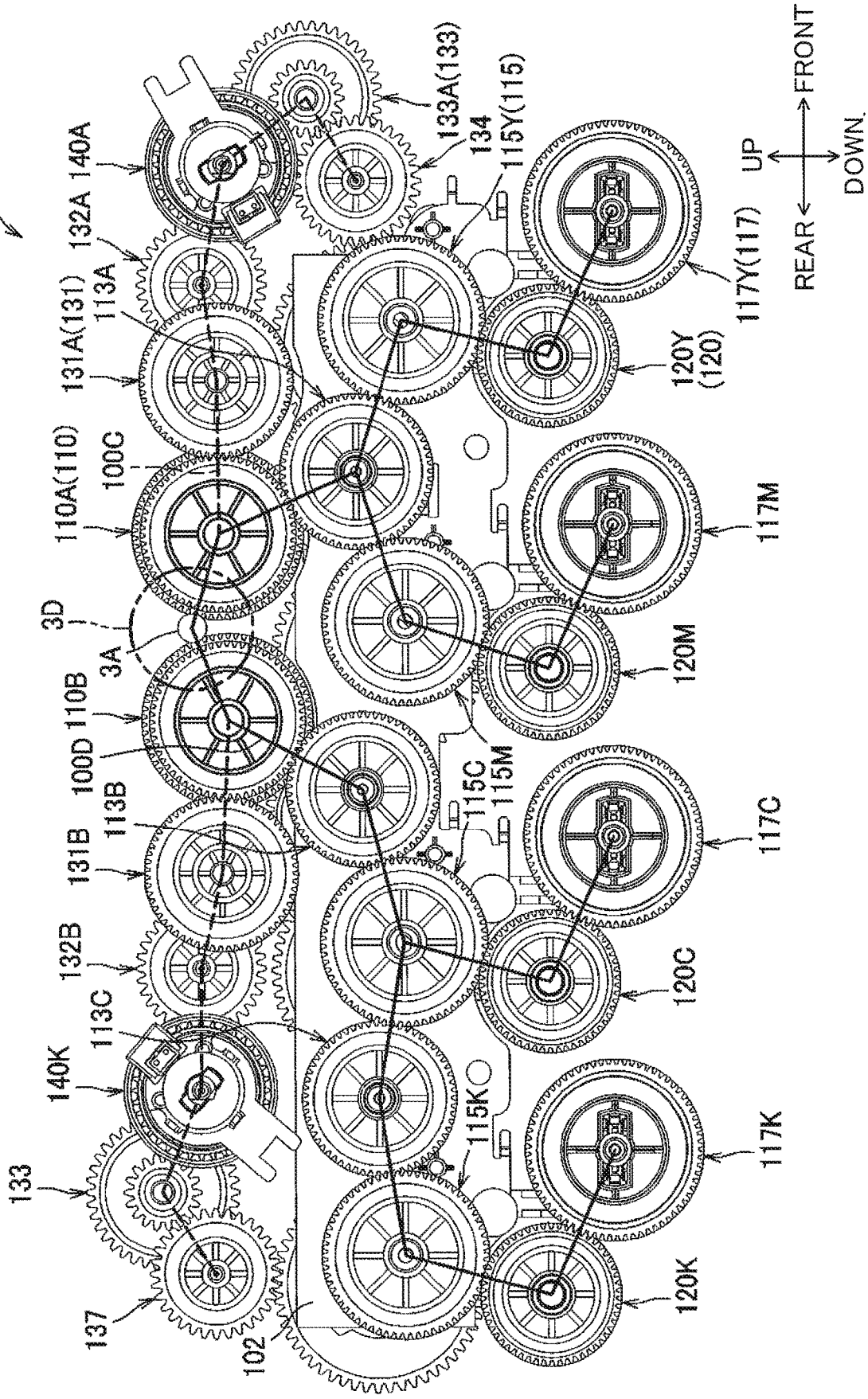

100
140A
132A
131A(131)
113A
110A(110)
100C
3D
3A
110B
100D
113B
131B
132B
113C
140K
133
137
102
133A(133)
134
115Y(115)
117Y(117)
120Y
(120)
117M
120M
115C
115M
117C
120C
115K
117K
120K
UP
DOWN
REAR
FRONT

FIG. 9

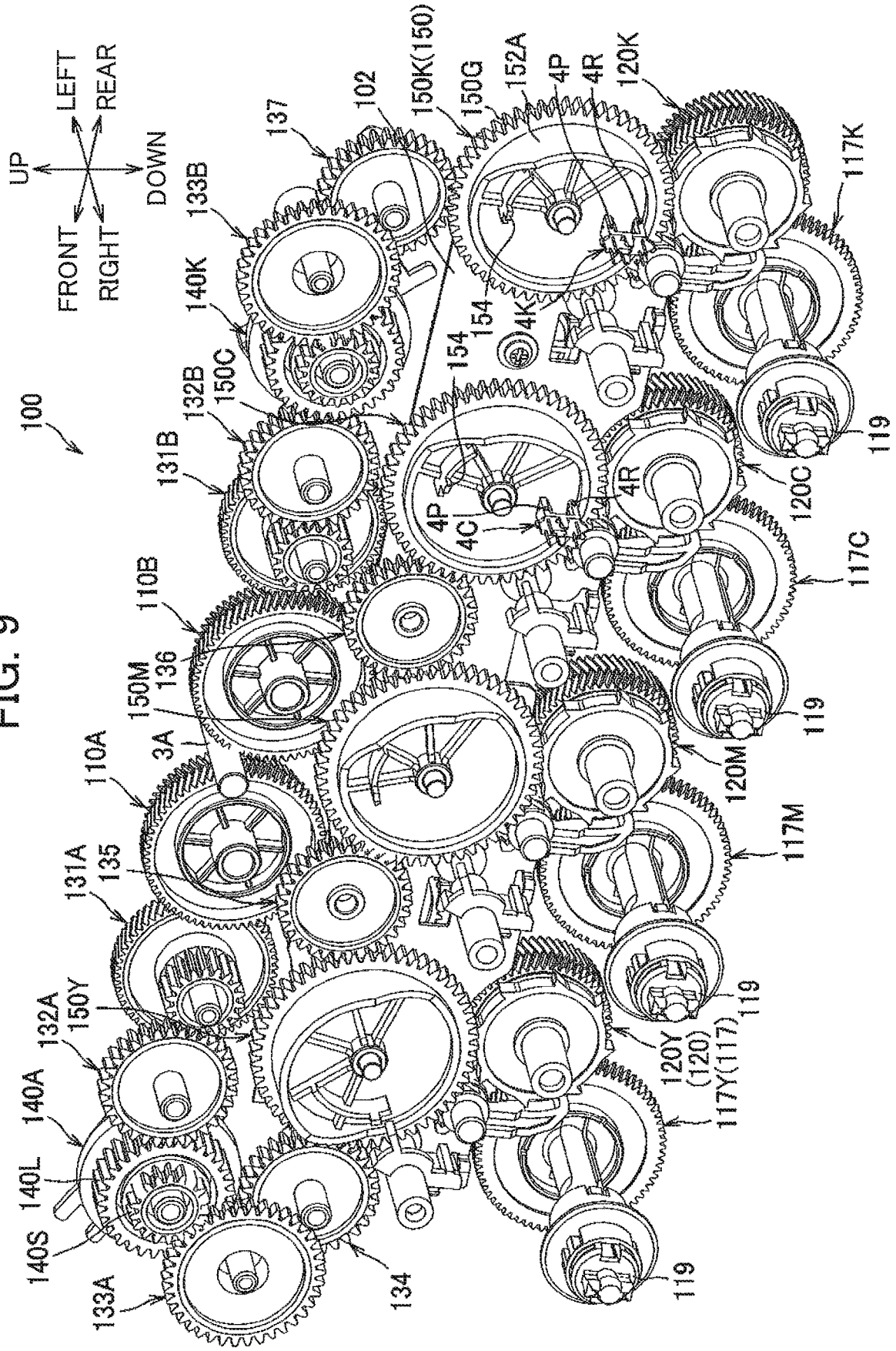

UP
LEFT
REAR
FRONT
RIGHT
DOWN
100
102
137
150K(150)
150G
152A
4P
4R
120K
117K
133B
140K
154
4K
132B
150C
131B
4P
4C
4R
120C
119
117C
110B
150M
136
3A
110A
120M
117M
131A
135
132A
150Y
140A
140L
140S
133A
134
120Y
(120)
117Y(117)

FIG. 10

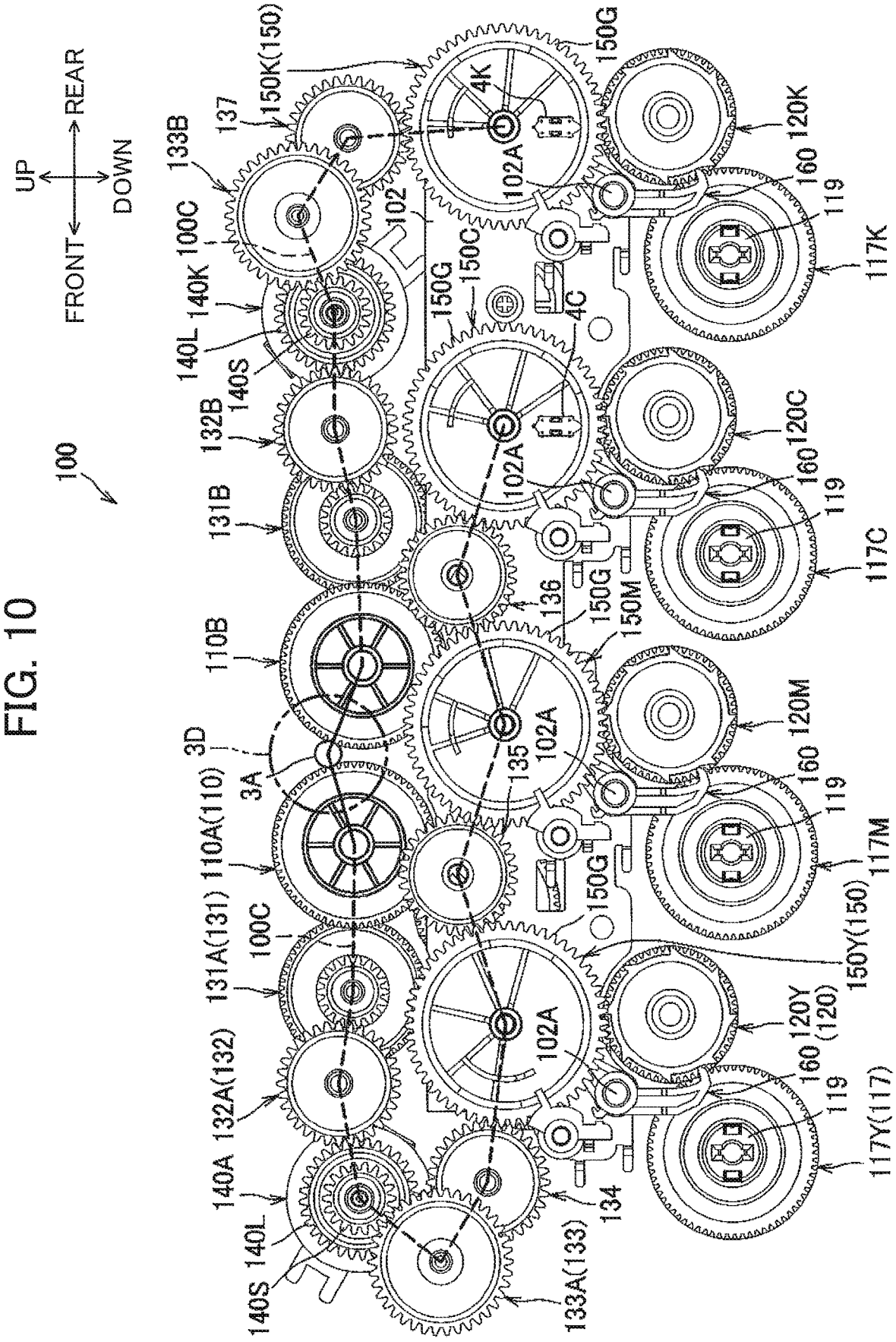

UP
REAR
FRONT
DOWN
100
150K(150)
137
133B
100C
140K
140L
140S
132B
131B
110B
3D
3A
110A(110)
131A(131)
100C
132A(132)
140A
140L
140S
133A(133)
134
102
150G
150C
4C
102A
4K
150G
120K
160
119
117K
120C
136
150M
135
120M
150Y(150)
120Y
(120)
117Y(117)
117C
117M

FIG. 11A

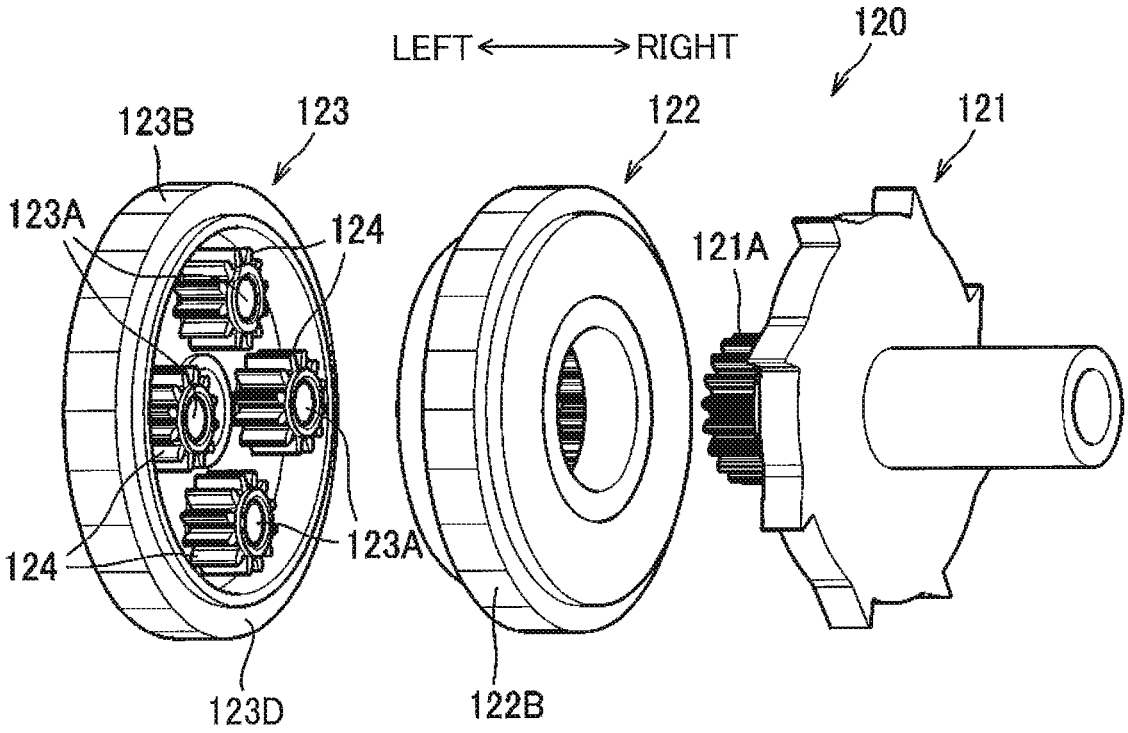


FIG. 11B

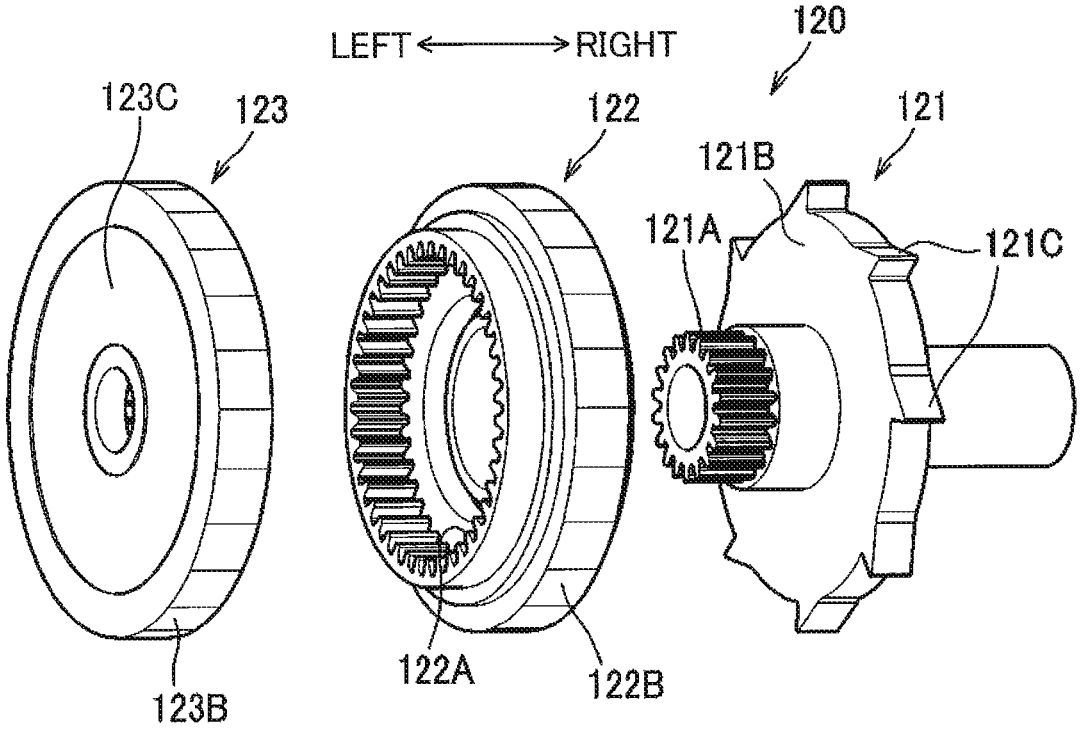


FIG. 12A

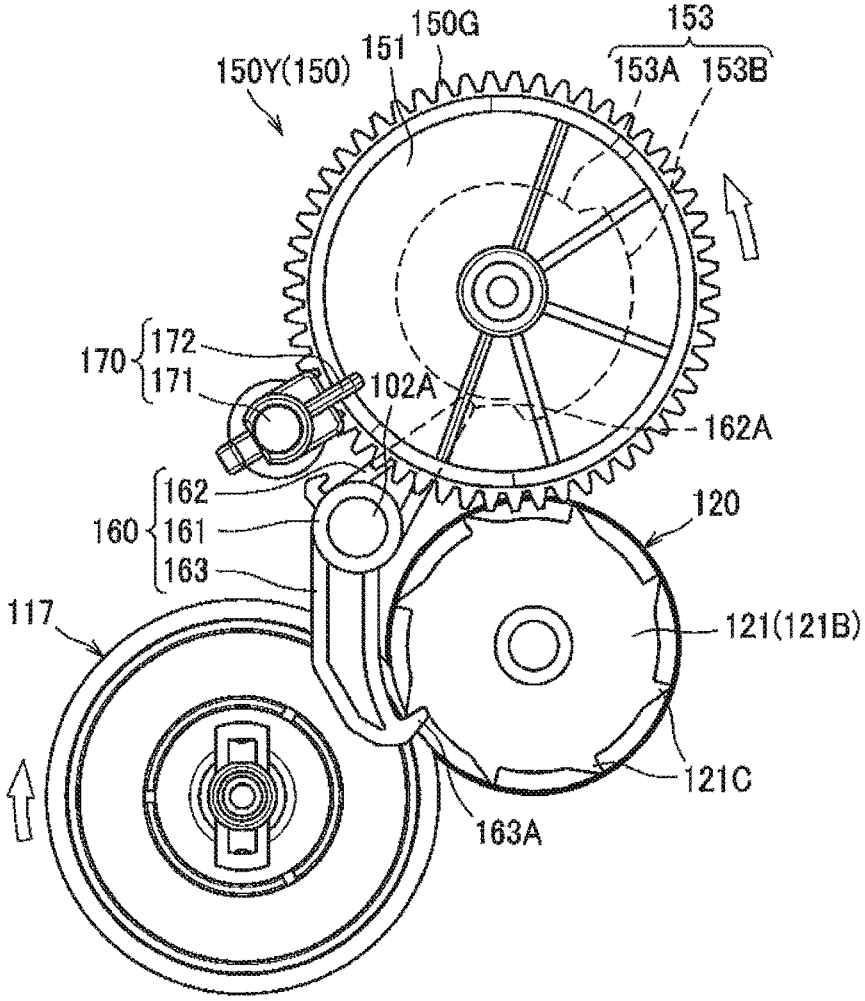


FIG. 12B

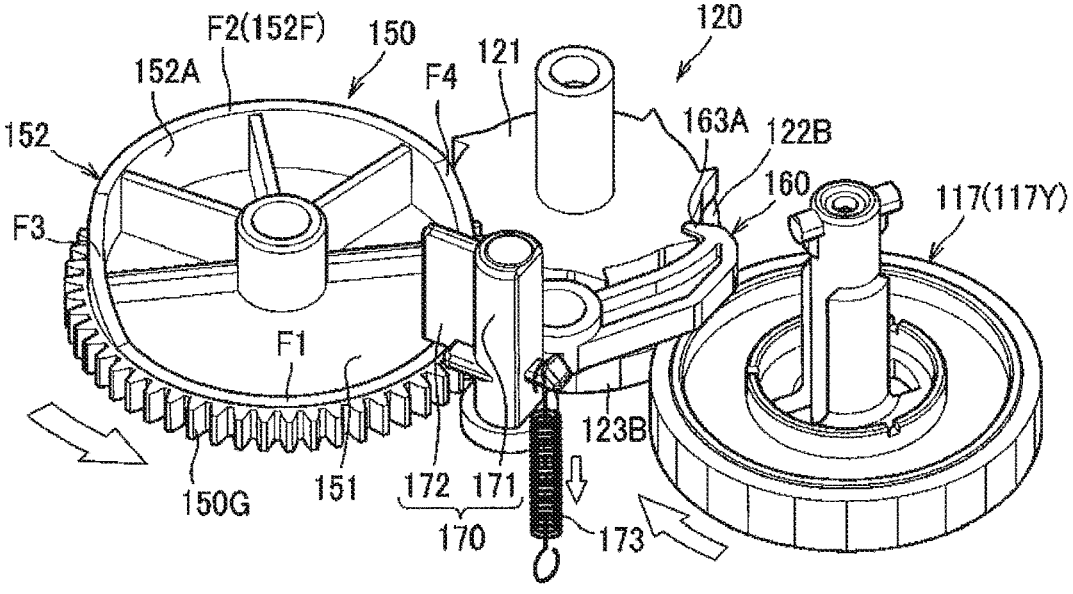


FIG. 13A

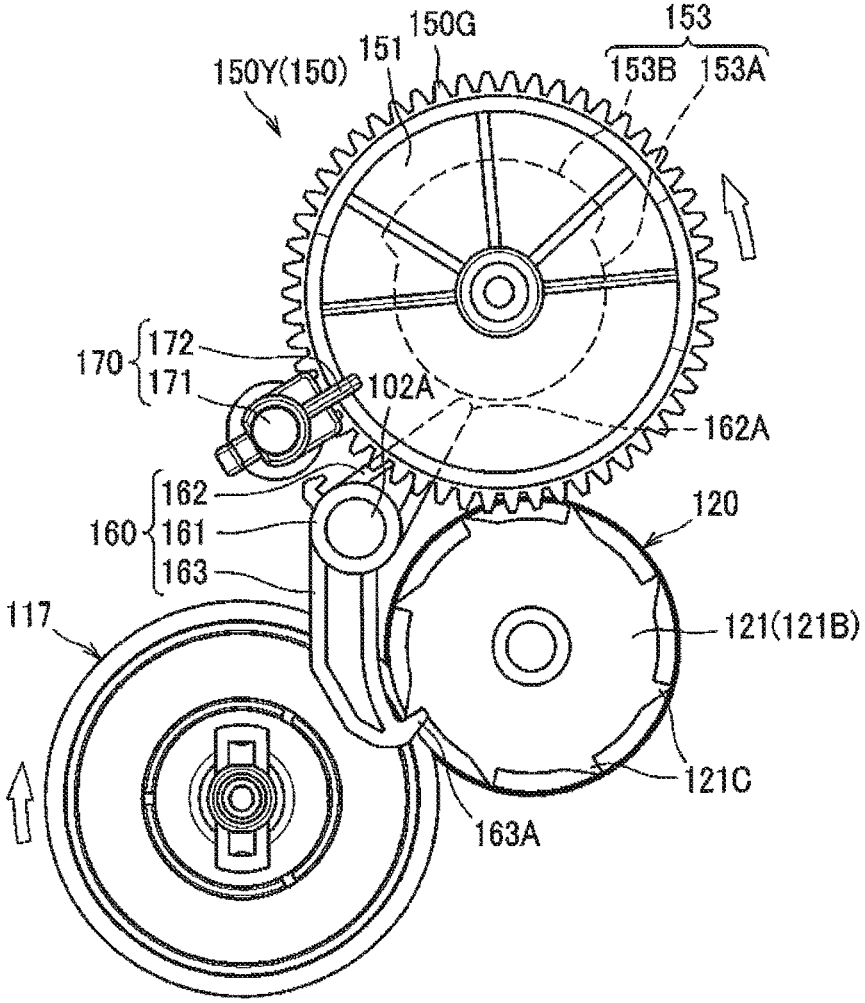


FIG. 13B

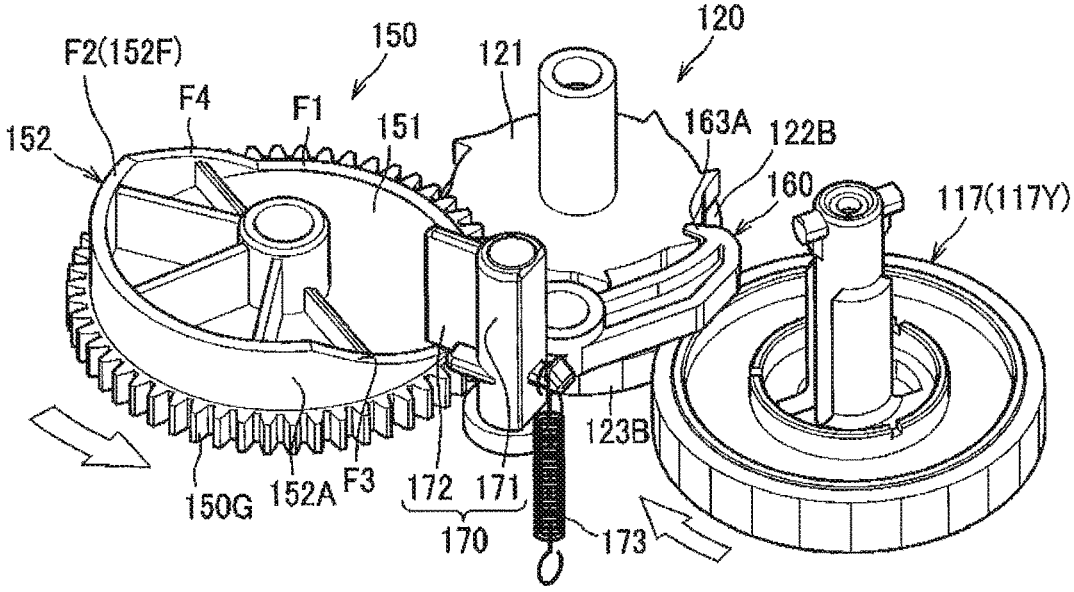


FIG. 14A

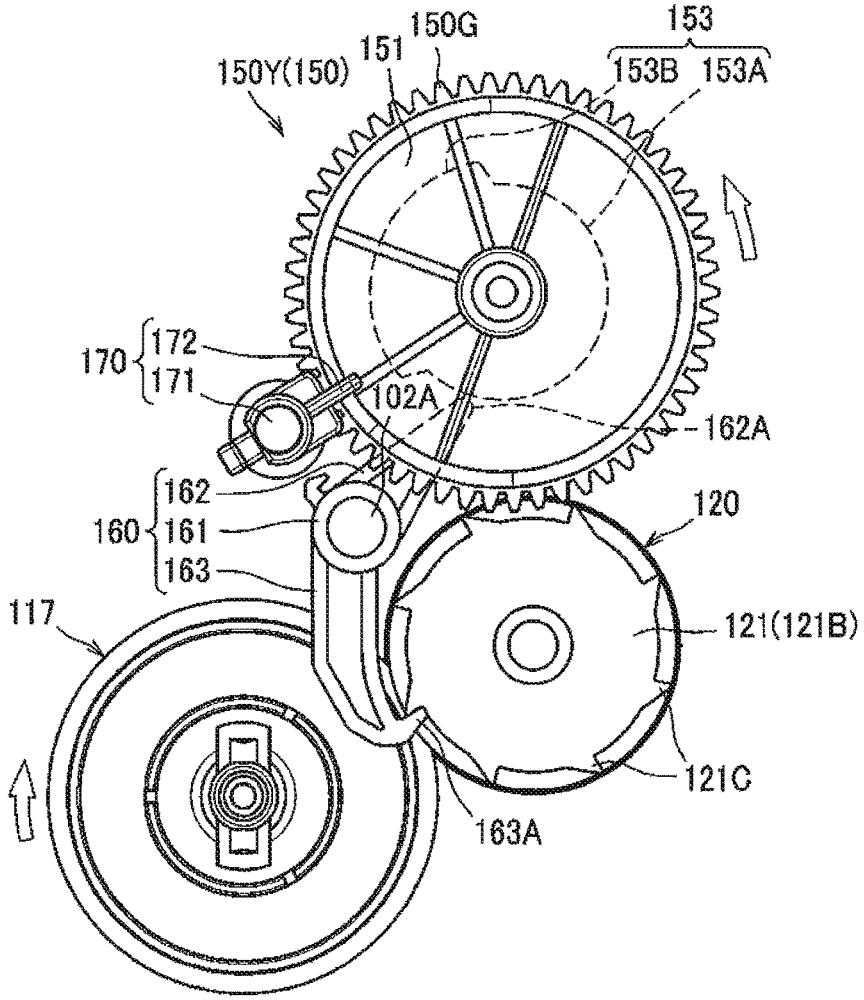


FIG. 14B

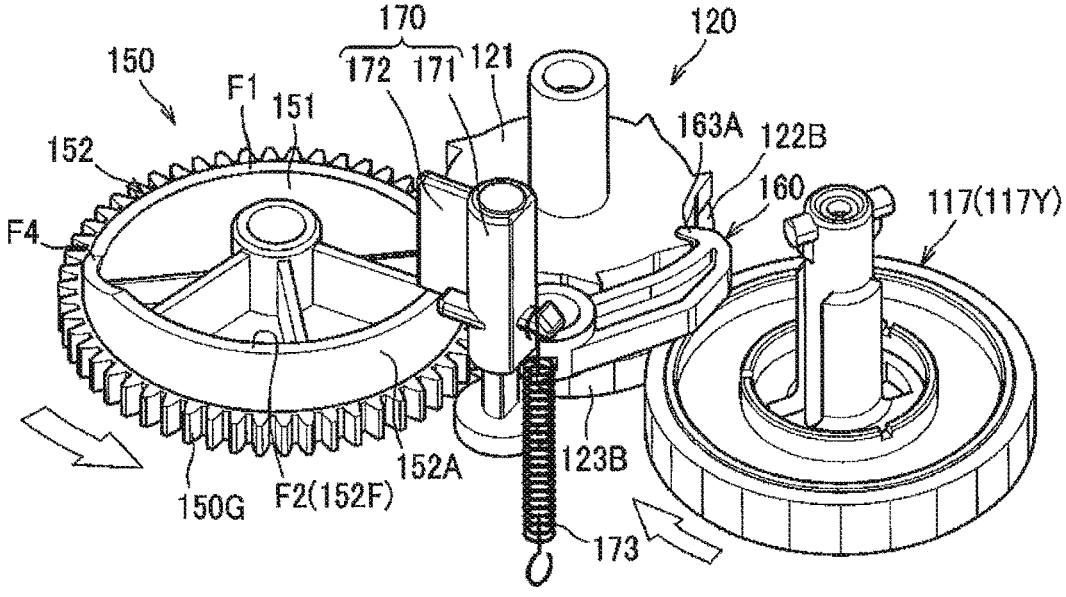


FIG. 15A

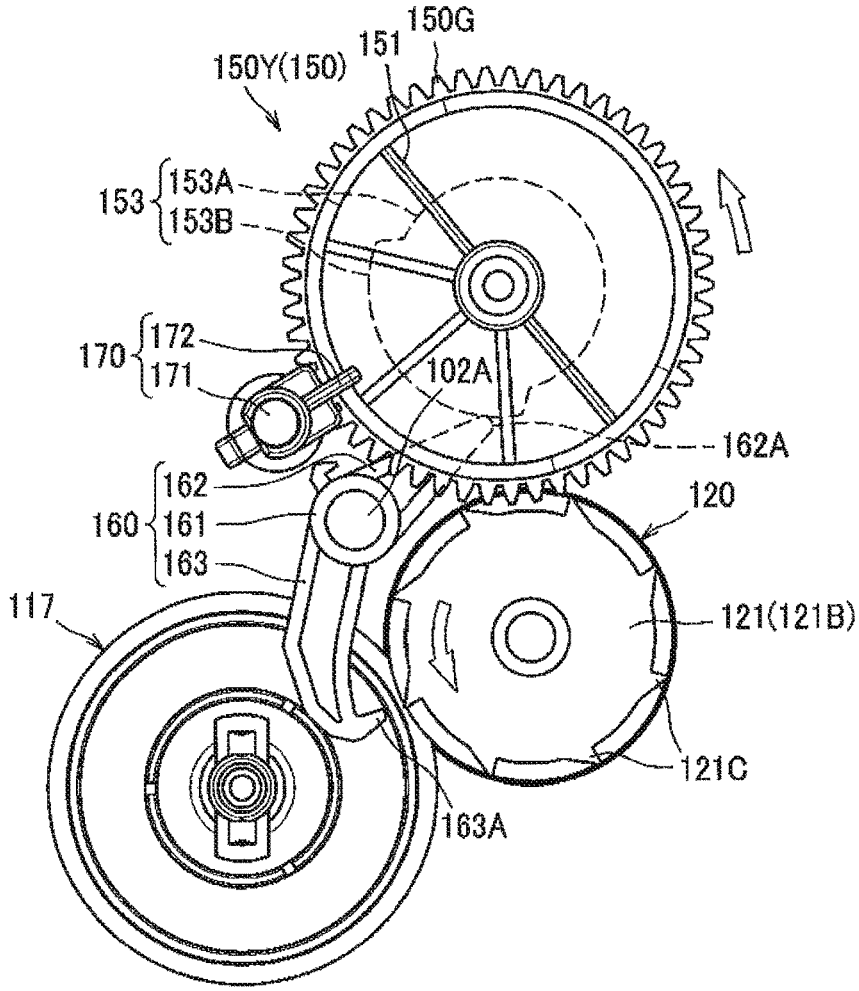


FIG. 15B

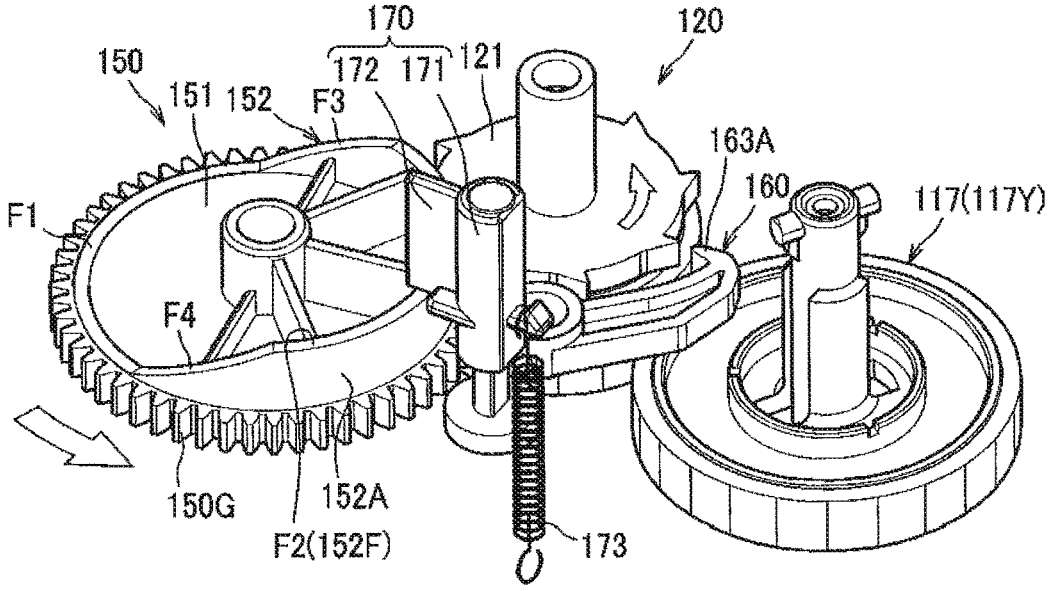


FIG. 16A

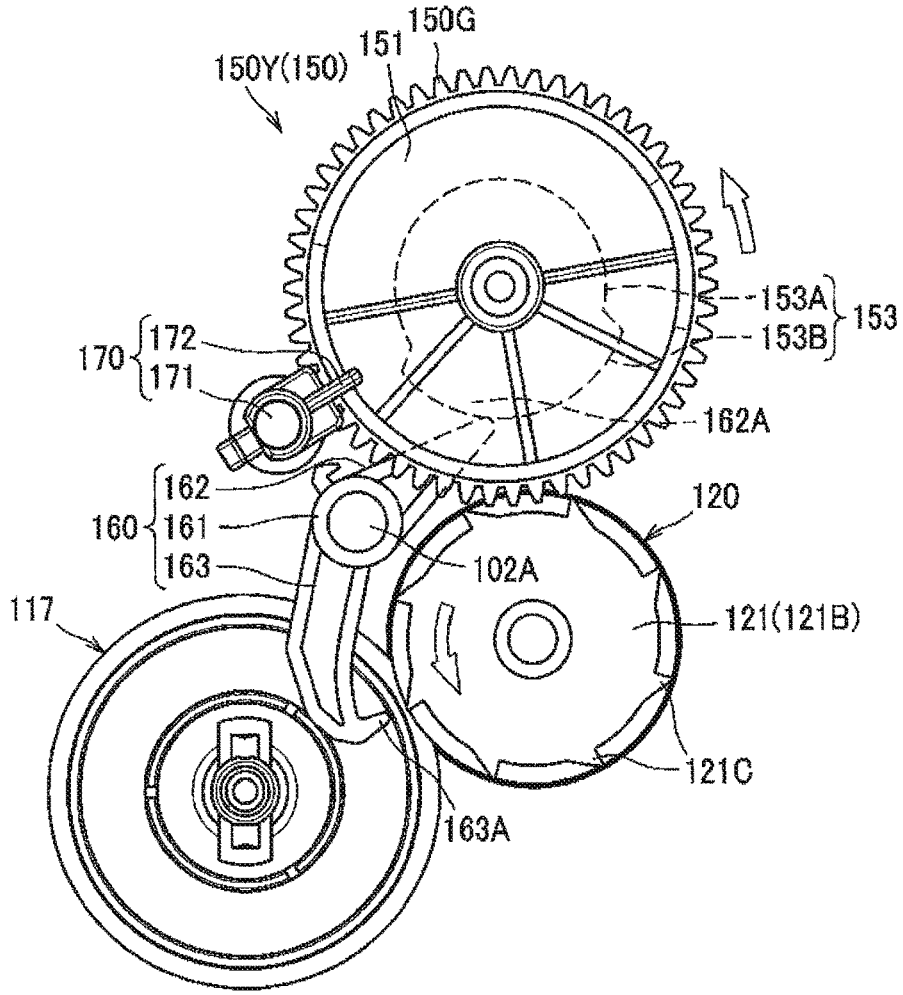


FIG. 16B

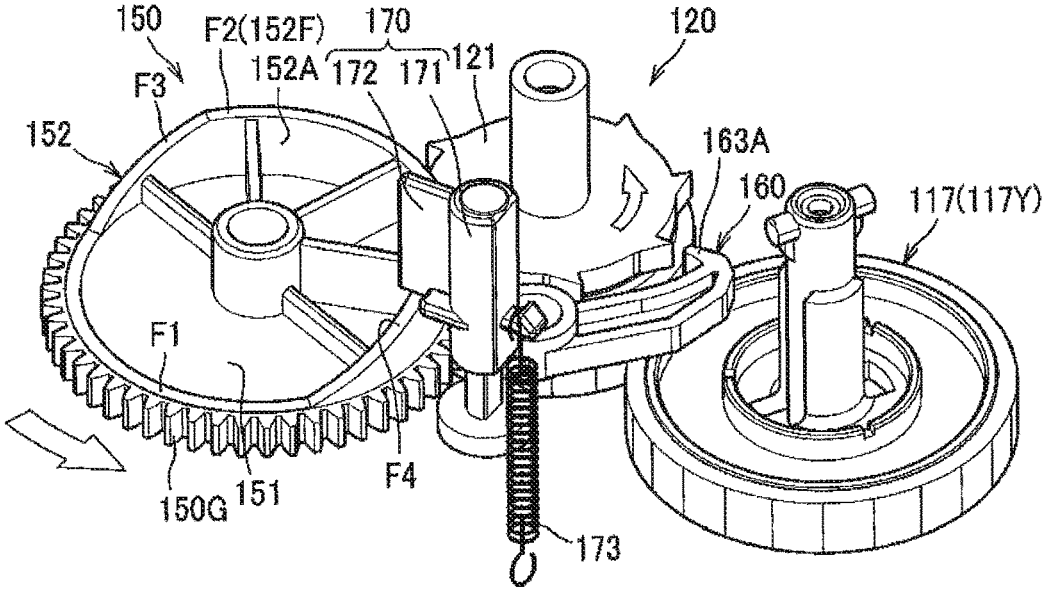


FIG. 17A

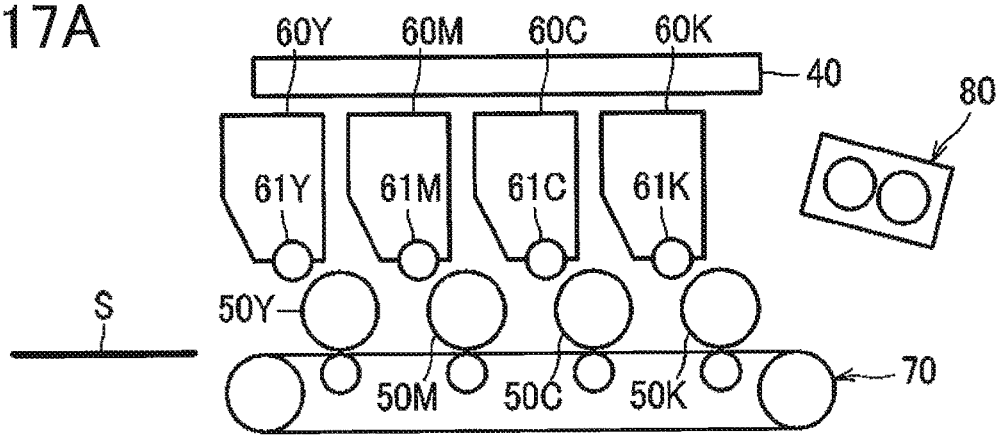


FIG. 17B

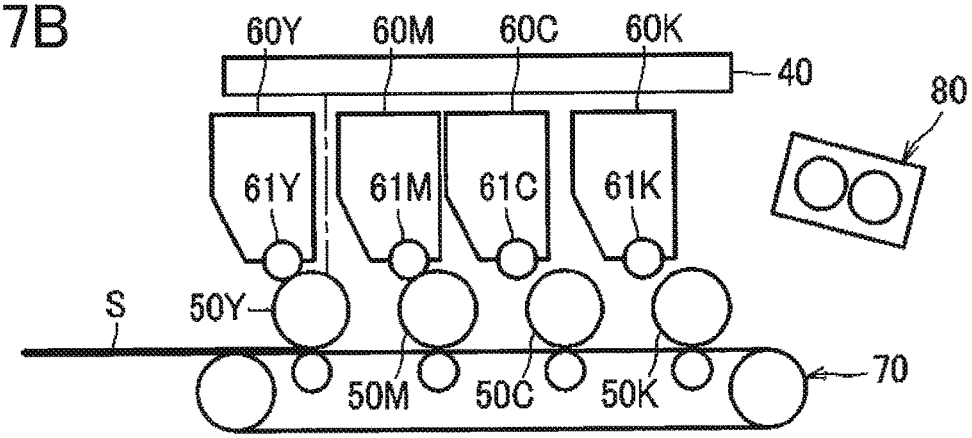


FIG. 17C

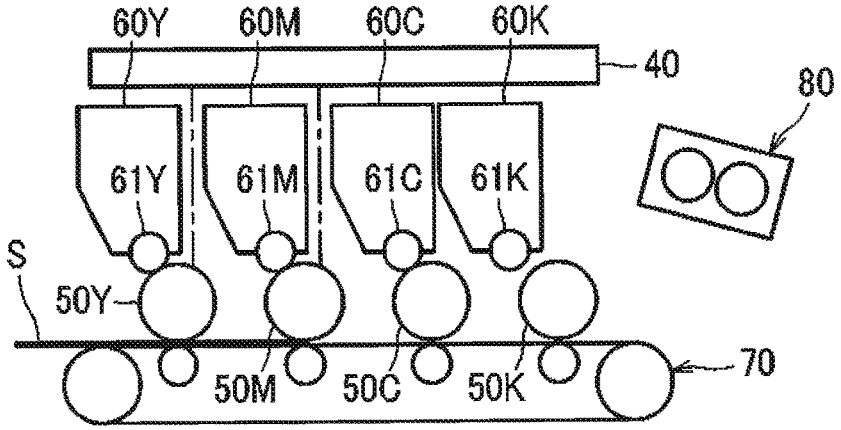


FIG. 17D

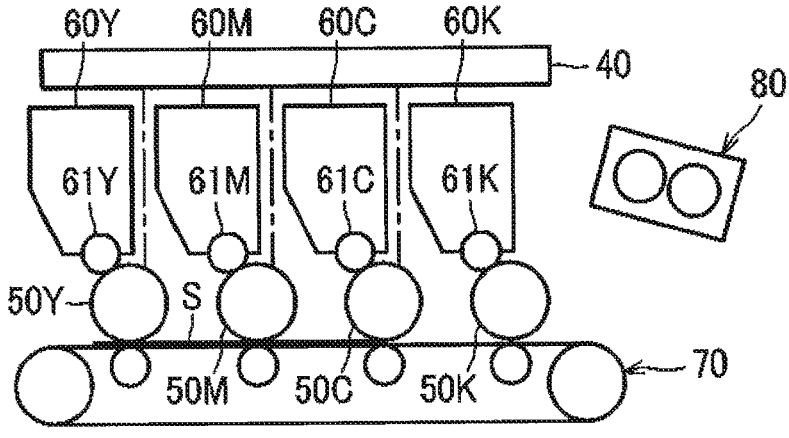


FIG. 18A

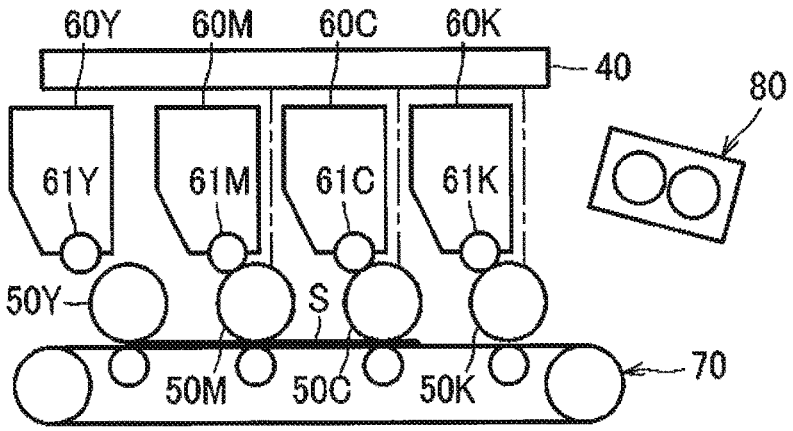


FIG. 18B

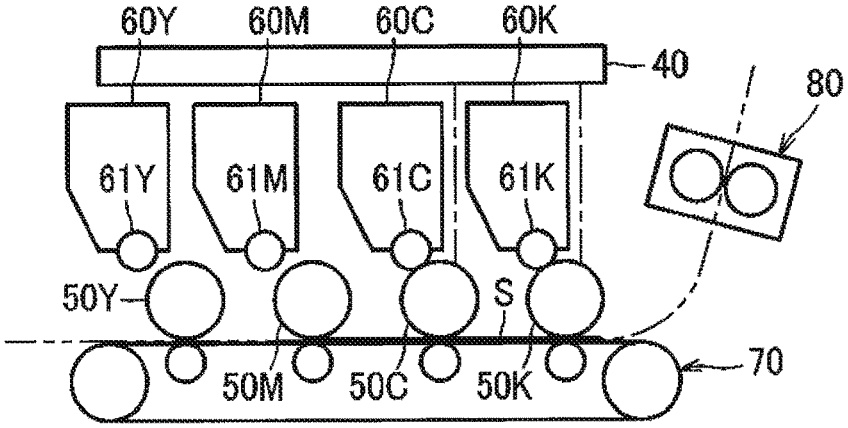


FIG. 18C

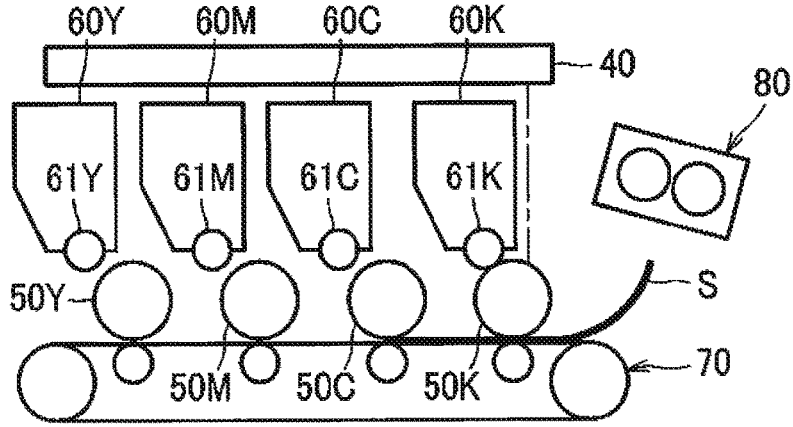


FIG. 18D

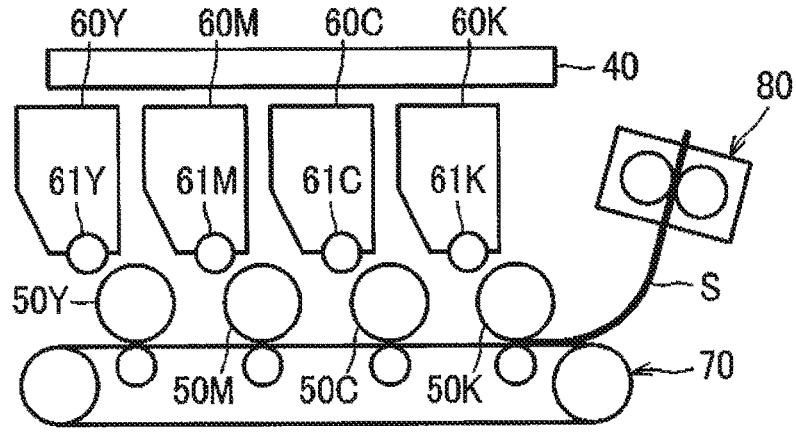


FIG. 19

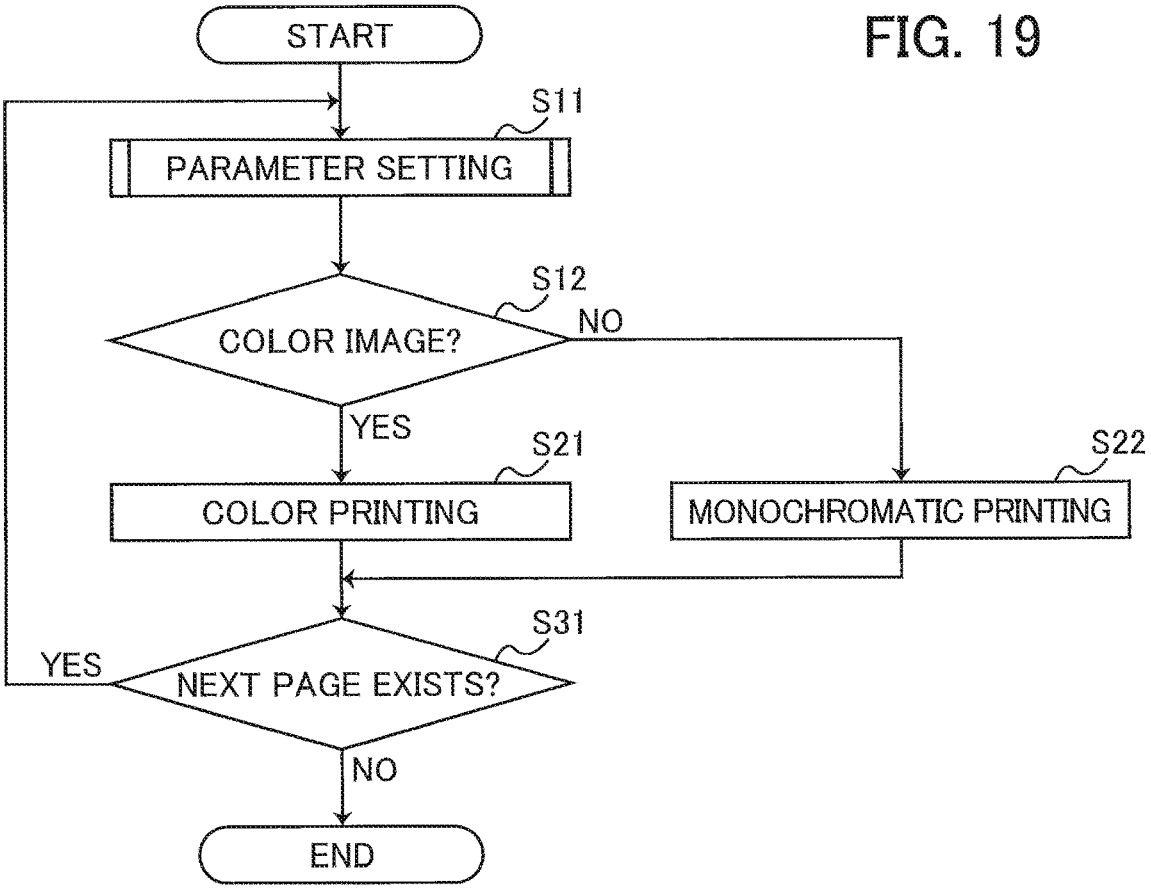

START
S11
PARAMETER SETTING
S12
COLOR IMAGE?
NO
YES
S21
COLOR PRINTING
S22
MONOCHROMATIC PRINTING
S31
YES
NEXT PAGE EXISTS?
NO
END

FIG. 20

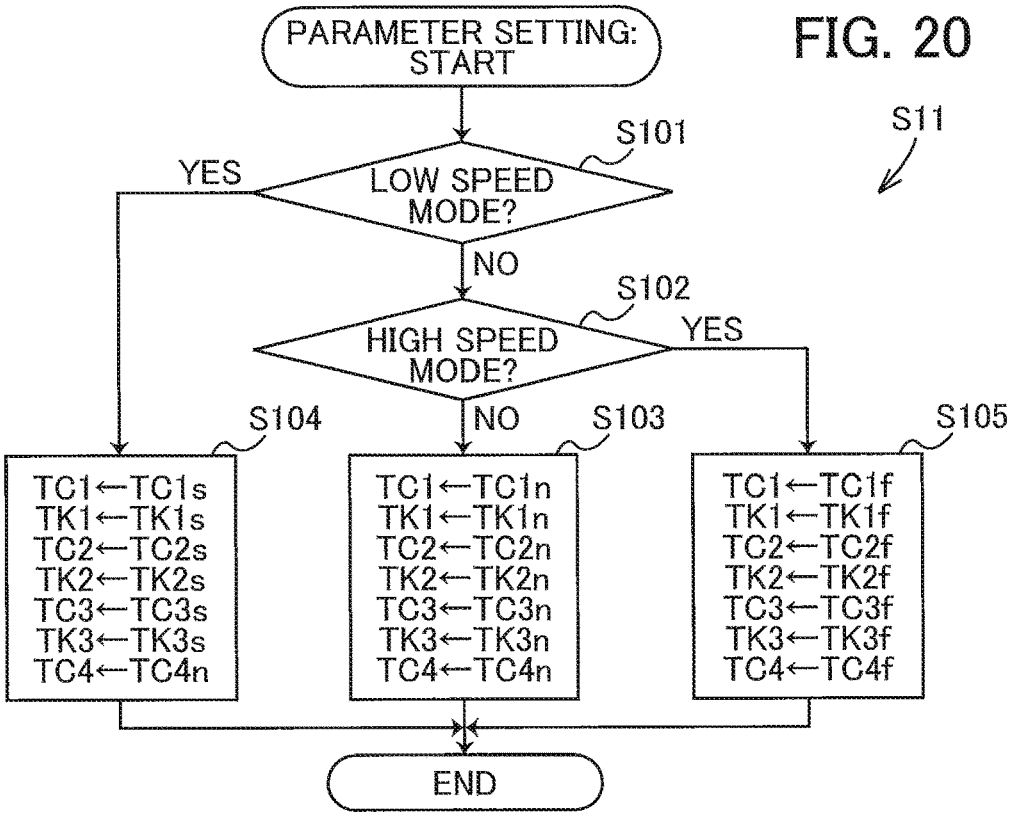

PARAMETER SETTING: START
S11
S101
YES
LOW SPEED MODE?
NO
S102
HIGH SPEED MODE?
YES
NO
S104
S103
S105
TC1←TC1s
TK1←TK1s
TC2←TC2s
TK2←TK2s
TC3←TC3s
TK3←TK3s
TC4←TC4n
TC1←TC1n
TK1←TK1n
TC2←TC2n
TK2←TK2n
TC3←TC3n
TK3←TK3n
TC4←TC4n
TC1←TC1f
TK1←TK1f
TC2←TC2f
TK2←TK2f
TC3←TC3f
TK3←TK3f
TC4←TC4f
END

FIG. 21A

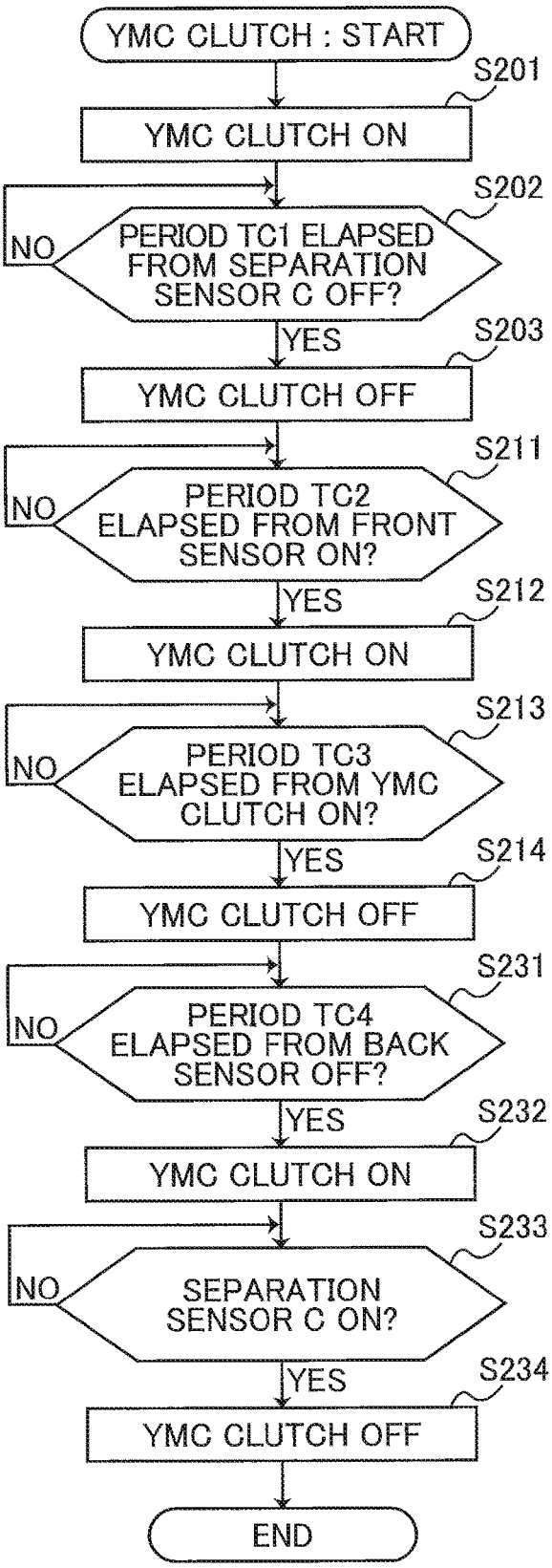


FIG. 21B

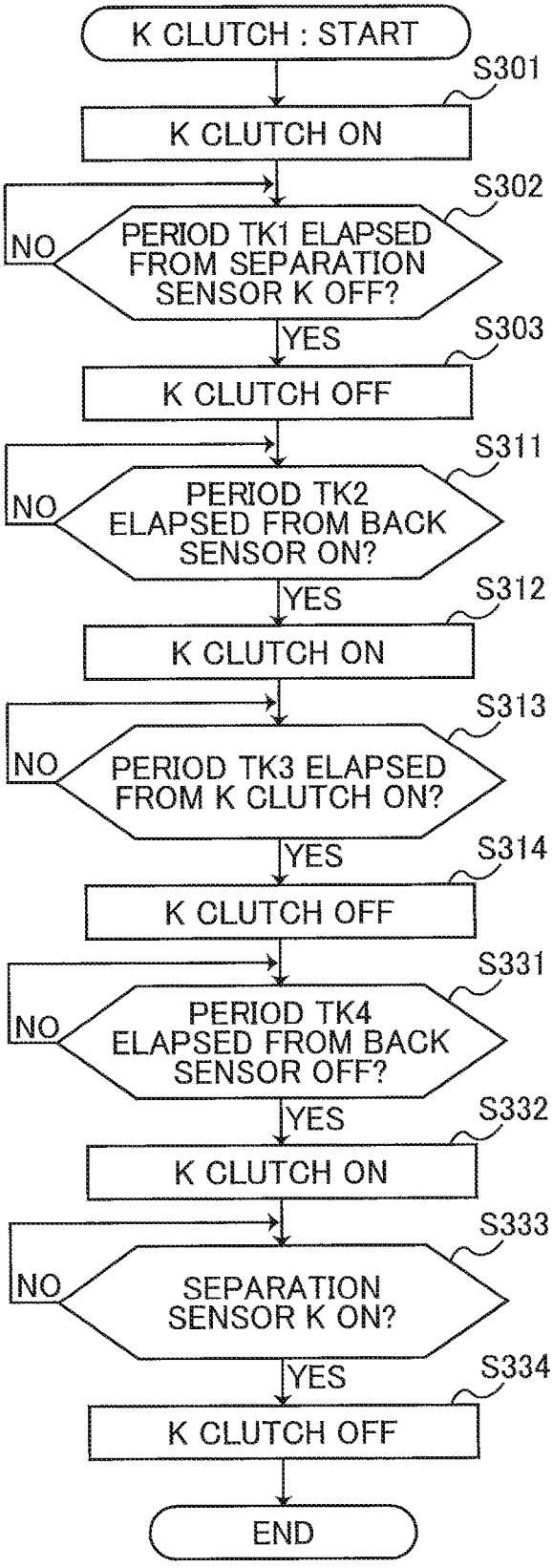


FIG. 22

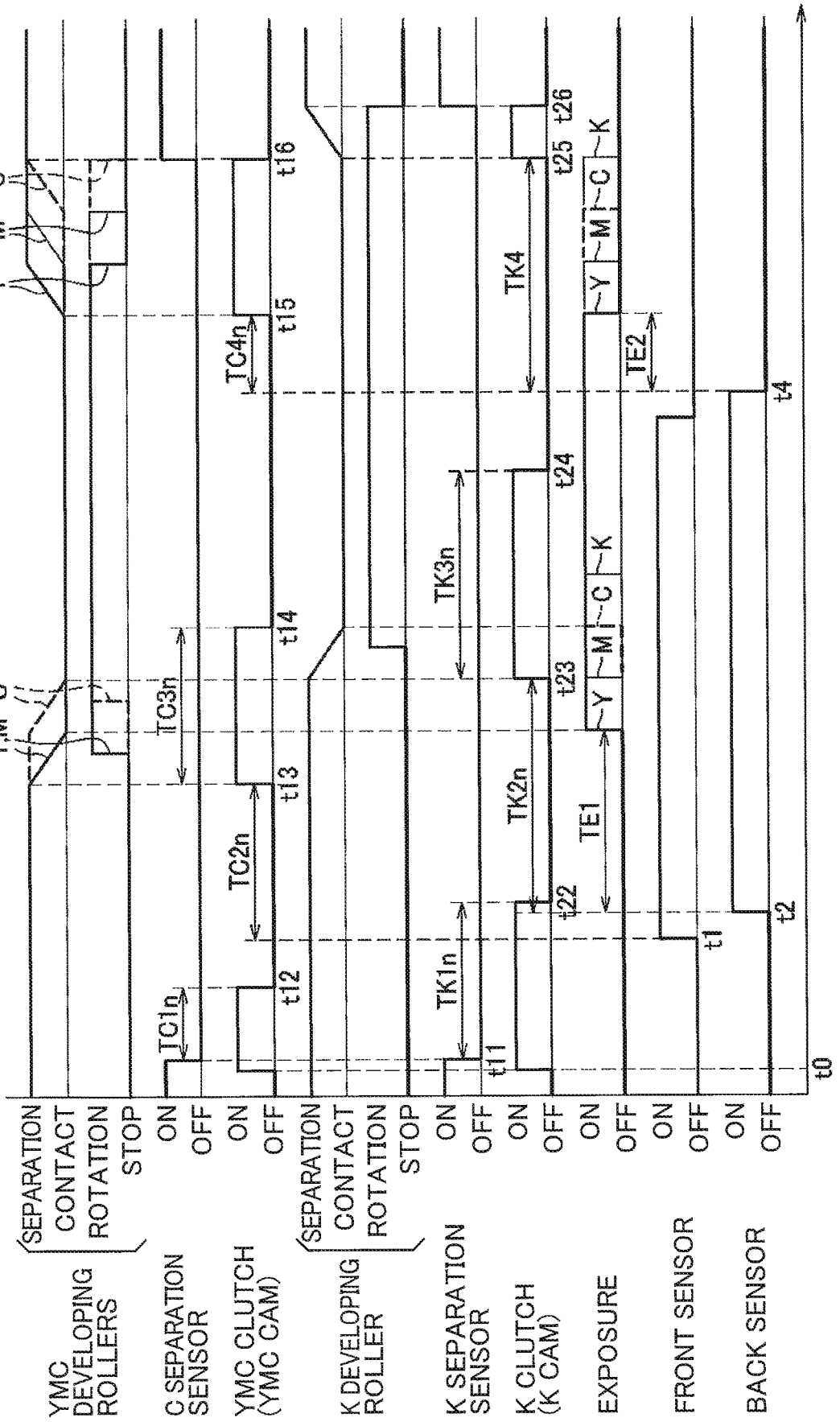

YMC DEVELOPING ROLLERS
SEPARATION
CONTACT
ROTATION
STOP
C SEPARATION SENSOR
ON
OFF
YMC CLUTCH (YMC CAM)
ON
OFF
K DEVELOPING ROLLER
SEPARATION
CONTACT
ROTATION
STOP
K SEPARATION SENSOR
ON
OFF
K CLUTCH (K CAM)
ON
OFF
EXPOSURE
ON
OFF
FRONT SENSOR
ON
OFF
BACK SENSOR
ON
OFF
Y M C
Y,M C
TC1n
TC2n
TC3n
TC4n
TK1n
TK2n
TK3n
TK4
TE1
TE2
t0
t1
t2
t4
t11
t12
t13
t14
t15
t16
t22
t23
t24
t25
t26
Y
M
C
K

FIG. 23

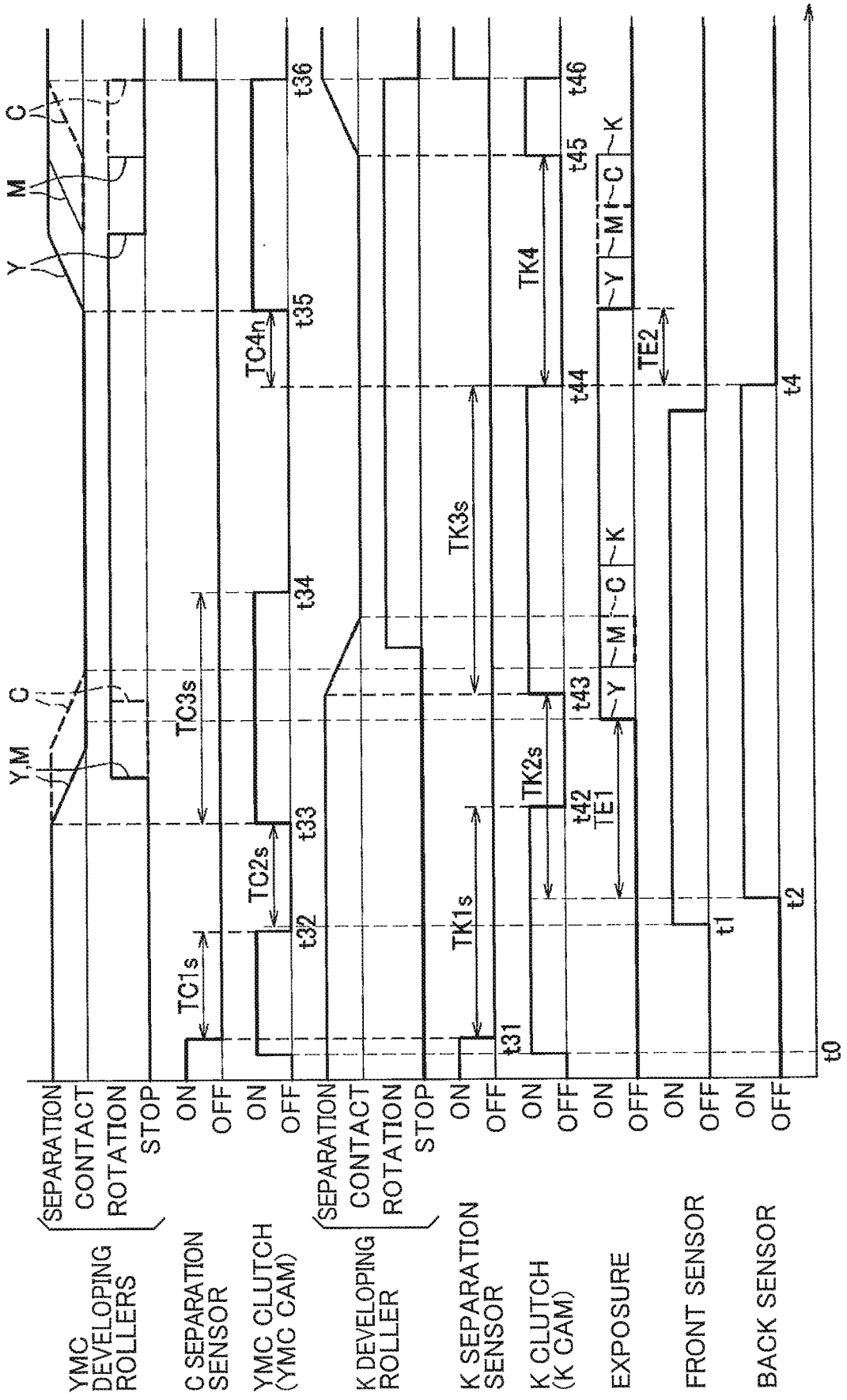
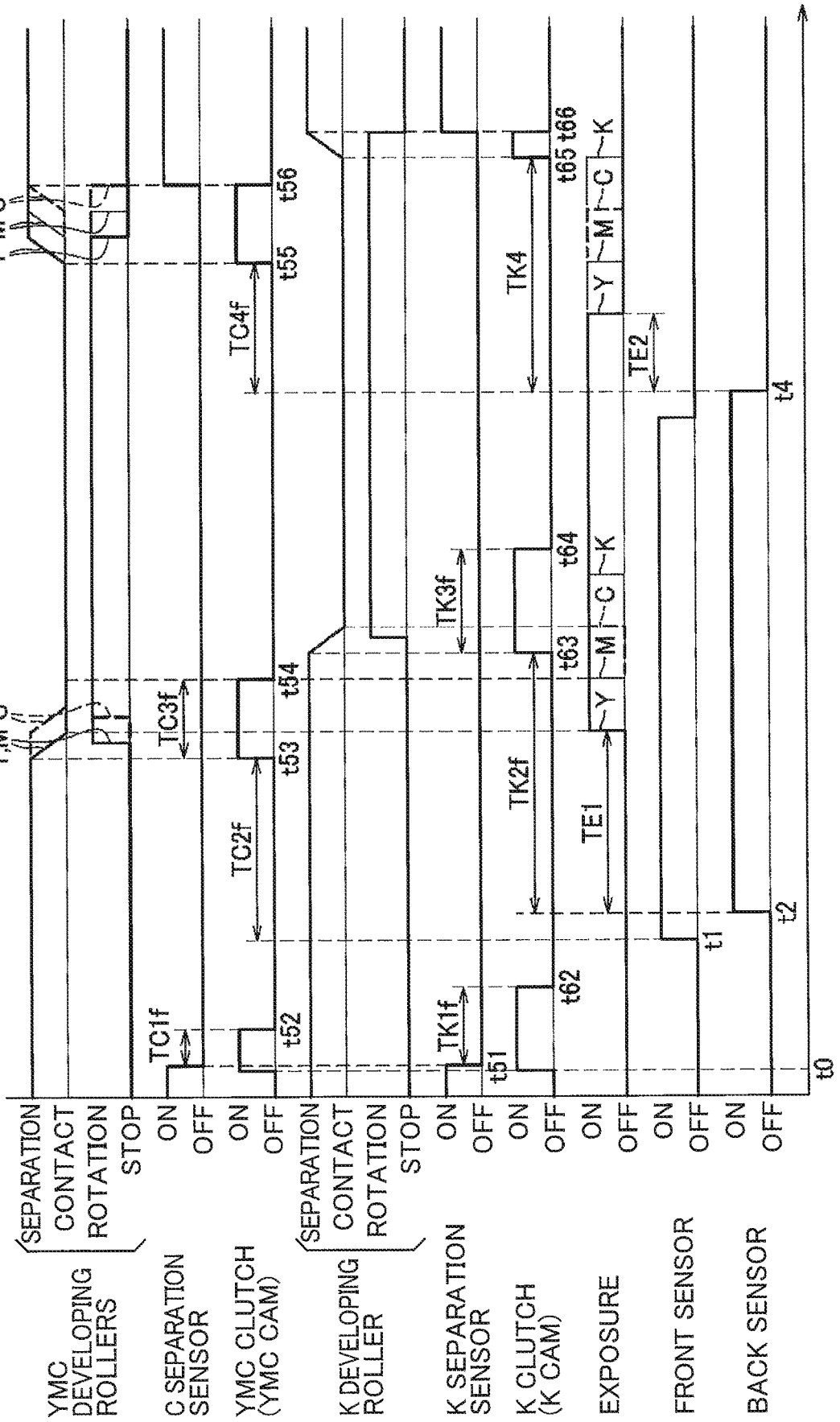

YMC DEVELOPING ROLLERS
SEPARATION
CONTACT
ROTATION
STOP
C SEPARATION SENSOR
ON
OFF
YMC CLUTCH (YMC CAM)
ON
OFF
K DEVELOPING ROLLER
SEPARATION
CONTACT
ROTATION
STOP
K SEPARATION SENSOR
ON
OFF
K CLUTCH (K CAM)
ON
OFF
EXPOSURE
ON
OFF
FRONT SENSOR
ON
OFF
BACK SENSOR
ON
OFF
Y,M
C
Y
M
C
TC1s
TC3s
TC2s
TC4n
TK1s
TK3s
TK2s
TK4
TE1
TE2
t0
t1
t2
t31
t32
t33
t34
t35
t36
t42
t43
t44
t45
t46
t4
Y
M
C
K

FIG. 24


YMC DEVELOPING ROLLERS
SEPARATION
CONTACT
ROTATION
STOP
C SEPARATION SENSOR
ON
OFF
YMC CLUTCH (YMC CAM)
K DEVELOPING ROLLER
K SEPARATION SENSOR
K CLUTCH (K CAM)
EXPOSURE
FRONT SENSOR
BACK SENSOR
Y,M,C
Y M C
TC1f
TC2f
TC3f
TC4f
TK1f
TK2f
TK3f
TK4
TE1
TE2
t0
t1
t2
t4
t51
t52
t53
t54
t55
t56
t62
t63
t64
t65 t66
Y
M
C
K

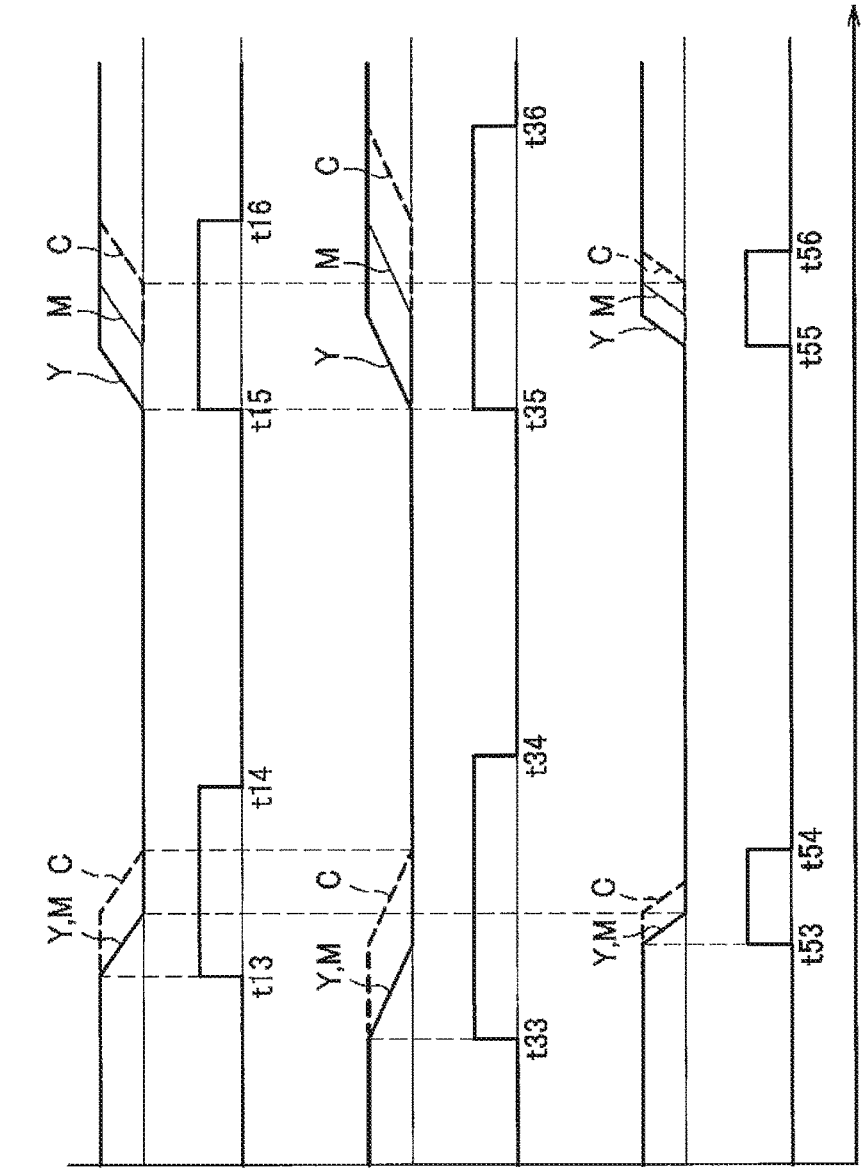


FIG. 25A

FIG. 25B

FIG. 25C

IMAGE-FORMING APPARATUS WITH REDUCED NUMBER OF MOTORS FOR MOVING DEVELOPING ROLLERS AND ALTERING ROTATION SPEED RATIO OF DEVELOPING ROLLERS TO PHOTOSENSITIVE DRUMS

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from Japanese Patent Application No. 2019-105636 filed Jun. 5, 2019. The entire content of the priority application is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to an electrophotographic image-forming apparatus including a photosensitive drum and a developing roller.

BACKGROUND

[0003] Japanese Patent Application Publication No. 2012-128017 discloses an electro-photographic image-forming apparatus configured to form a toner image on a photosensitive drum by a contact development system. This image-forming apparatus includes a mechanism for moving a developing roller between a contact position in contact with the photosensitive drum and a separated position separated therefrom in accordance with a rotation of a cam. The image-forming apparatus further includes a stepping motor for rotating the cam, and a main motor for driving an image-forming unit including the developing roller and the photosensitive drum.

SUMMARY

[0004] In an image-forming apparatus adopting the contact development system for forming a toner image on a photosensitive drum, alteration in rotation speed ratio of the photosensitive drum to the developing roller is desirable depending on installation environment ambient to the image-forming apparatus and working conditions of the apparatus. Such alteration would be achievable by providing a motor for driving the developing roller and another motor for driving the photosensitive drum.

[0005] However, according to the above-described conventional image-forming apparatus in which the developing roller is brought into contact with and separated from the photosensitive drum by the rotation of the cam, an additional motor for rotating the cam is already provided. Therefore, the number of motors may be increased if separate motors would be provided for varying the rotation speed ratio of the photosensitive drum to the developing roller.

[0006] In view of the foregoing, it is an object of the present disclosure to provide an image-forming apparatus capable of altering a rotation speed ratio between a photosensitive drum and a developing roller without an increase in number of motors, while realizing contact/separation of the developing roller relative to the photosensitive drum.

[0007] In order to attain the above and other objects, according to one aspect, the disclosure provides an image-forming apparatus including: a process motor; a sheet conveying device; a first photosensitive drum; a second photosensitive drum; a developing motor; a first developing roller; a second developing roller; a first cam; a second cam; a switching mechanism; and a controller. The sheet conveying device is configured to convey a sheet in a sheet conveying direction upon receipt of a driving force from the process motor. The first photosensitive drum is rotatable upon receipt of the driving force from the process motor. The second photosensitive drum is rotatable upon receipt of the driving force from the process motor and is positioned downstream of the first photosensitive drum in the sheet conveying direction. The first developing roller is rotatable upon receipt of a driving force from the developing motor. The first developing roller is movable between a contact position in contact with the first photosensitive drum and a separated position away from the first photosensitive drum. The second developing roller is rotatable upon receipt of the driving force from the developing motor. The second developing roller is movable between a contact position in contact with the second photosensitive drum and a separated position away from the second photosensitive drum. The first cam is rotatable in a prescribed rotational direction upon receipt of the driving force from the developing motor. Rotations of the first cam cause the first developing roller to move between the contact position and the separated position relative to the first photosensitive drum. The second cam is rotatable in the prescribed rotational direction upon receipt of the driving force from the developing motor. Rotations of the second cam cause the second developing roller to move: from the contact position to the separated position after movement of the first developing roller from the contact position to the separated position; and from the separated position to the contact position after movement of the first developing roller from the separated position to the contact position. The switching mechanism is switchable between a transmission state and a cut-off state to control transmission of the driving force from the developing motor to the first cam and the second cam. The transmission state allows the transmission of the driving force from the developing motor to the first cam and the second cam. The cut-off state interrupts the transmission of the driving force from the developing motor to the first cam and the second cam. The controller is configured to provide control to the developing motor, the process motor and the switching mechanism to execute a normal mode and a low speed mode. The controller is configured to rotate the developing motor at a first rotation speed and rotate the process motor at a second rotation speed in the normal mode. The controller is configured to rotate the developing motor at a rotation speed slower than the first rotation speed and rotate the process motor at the second rotation speed in the low speed mode. The controller is configured to control the switching mechanism to be at the transmission state, for moving each of the first developing roller and the second developing roller from the separated position to the contact position, such that a timing at which the second developing roller comes in contact with the second photosensitive drum in the low speed mode is coincident with or earlier than a timing at which the second developing roller comes in contact with the second photosensitive drum in the normal mode.

[0008] According to another aspect, the disclosure provides an image-forming apparatus including: a process motor; a sheet conveying device; a first photosensitive drum; a second photosensitive drum; a developing motor; a first developing roller; a second developing roller; a first cam; a second cam; a switching mechanism; and a controller. The sheet conveying device is configured to convey a sheet in a

sheet conveying direction. The first photosensitive drum is rotatable upon receipt of a driving force from the process motor. The second photosensitive drum is rotatable upon receipt of the driving force from the process motor and is positioned downstream of the first photosensitive drum in the sheet conveying direction. The first developing roller is rotatable upon receipt of a driving force from the developing motor. The first developing roller is movable between a contact position in contact with the first photosensitive drum and a separated position away from the first photosensitive drum. The second developing roller is rotatable upon receipt of the driving force from the developing motor. The second developing roller is movable between a contact position in contact with the second photosensitive drum and a separated position away from the second photosensitive drum. The first cam is rotatable in a prescribed rotational direction upon receipt of the driving force from the developing motor. Rotations of the first cam cause the first developing roller to move between the contact position and the separated position. The second cam is rotatable in the prescribed rotational direction upon receipt of the driving force from the developing motor. Rotations of the second cam cause the second developing roller to move: from the separated position to the contact position after movement of the first developing roller from the separated position to the contact position; and from the contact position to the separated position after movement of the first developing roller from the contact position to the separated position. The switching mechanism is switchable between a transmission state and a cut-off state to control transmission of the driving force from the developing motor to the first cam and the second cam. The transmission state allows the transmission of the driving force from the developing motor to the first cam and the second cam. The cut-off state prevents the transmission of the driving force from the developing motor to the first cam and the second cam. The controller is configured to control rotations of the developing motor and the process motor to execute a first mode and a second mode. The controller is configured to rotate the developing motor at a first rotation speed and rotate the process motor at a second rotation speed in the first mode. The controller is configured to rotate the developing motor at a third rotation speed different from the first rotation speed and rotate the process motor at the second rotation speed in the second mode.

[0009] According to still another aspect, the disclosure provides an image-forming apparatus including: a first photosensitive drum; a first developing roller; a first cam; a second photosensitive drum; a second developing roller; a second cam; a process motor; a developing motor; and a controller. The first developing roller is movable between: a first contact position where the first developing roller is in contact with the first photosensitive drum; and a first separated position where the first developing roller is separated from the first photosensitive drum. The first cam is configured to move the first developing roller between the first contact position and the first separated position. The second developing roller is movable between: a second contact position where the second developing roller is in contact with the second photosensitive drum; and a second separated position where the second developing roller is separated from the second photosensitive drum. The second cam is configured to move the second developing roller between the second contact position and the second separated position. The process motor is configured to drive the first photosensitive drum and the second photosensitive drum. The developing motor is configured to drive the first developing roller, the first cam, the second developing roller, and the second cam. The controller is configured to control the developing motor and the process motor in: a first mode in which the process motor rotates at a first process speed and the developing motor rotates at a first developing speed; and a second mode in which the process motor rotates at a second process speed and the developing motor rotates at a second developing speed slower than the first developing speed, a ratio of the first process speed to the first developing speed in the first mode being different from a ratio of the second process speed to the second developing speed in the second mode.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The particular features and advantages of the embodiment(s) as well as other objects will become apparent from the following description taken in connection with the accompanying drawings, in which:

[0011] FIG. **1** is a schematic view illustrating an overall configuration of an image-forming apparatus according to an embodiment;

[0012] FIG. **2** is a perspective view of a support member, cams, and cam followers in the image-forming apparatus according to the embodiment;

[0013] FIG. **3**A is a perspective view of a developing cartridge to be accommodated in the image-forming apparatus according to the embodiment;

[0014] FIG. **3**B is a side view of the developing cartridge of FIG. **3**A;

[0015] FIG. **4**A is a schematic top view illustrating the developing cartridge and components in the vicinity thereof for description of a slide member of the developing cartridge, and particularly illustrating a state where the cam follower is at a standby position in the image-forming apparatus according to the embodiment;

[0016] FIG. **4**B is a schematic top view illustrating the developing cartridge and the components in the vicinity thereof for description of the slide member, and particularly illustrating a state where the cam follower is at an operating position in the image-forming apparatus according to the embodiment;

[0017] FIG. **5** is a side view of a side frame of the support member, and particularly illustrating an inner surface of the side frame to which the developing cartridge is attachable in the image-forming apparatus according to the embodiment;

[0018] FIG. **6** is a block diagram schematically illustrating a system for transmitting a driving force from each motor in the image-forming apparatus according to the embodiment;

[0019] FIG. **7** is a perspective view illustrating a power transmission mechanism as viewed from an upper left side thereof;

[0020] FIG. **8** is a side view of the power transmission mechanism as viewed in an axial direction thereof (from a left side);

[0021] FIG. **9** is a perspective view illustrating the power transmission mechanism as viewed from an upper right side thereof;

[0022] FIG. **10** is a side view of the power transmission mechanism as viewed in the axial direction (from a right side);

[0023] FIG. **11**A is an exploded perspective view illustrating a clutch as viewed from a sun gear side thereof in the image-forming apparatus according to the embodiment;

[0024] FIG. **11**B is an exploded perspective view illustrating the clutch as viewed from a carrier side thereof in the image-forming apparatus according to the embodiment;

[0025] FIG. **12**A is a view illustrating a separation mechanism, a lever, the clutch, and a coupling gear in a state where a developing roller is at a contact position and the clutch is at a transmission state as viewed in the axial direction in the image-forming apparatus according to the embodiment;

[0026] FIG. **12**B is a perspective view illustrating the separation mechanism, the lever, the clutch, and the coupling gear in the state where the developing roller is at the contact position and the clutch is at the transmission state;

[0027] FIG. **13**A is a view illustrating the separation mechanism, the lever, the clutch, and the coupling gear in a state where the cam rotates from the state of FIG. **12**A and the developing roller corresponding to the color of yellow is at the contact position to perform image formation as viewed in the axial direction;

[0028] FIG. **13**B is a perspective view illustrating the separation mechanism, the lever, the clutch, and the coupling gear in the state where the cam rotates from the state of FIG. **12**A and the developing roller corresponding to the color of yellow is at the contact position to perform image formation;

[0029] FIG. **14**A is a view illustrating the separation mechanism, the lever, the clutch, and the coupling gear in a state where the cam further rotates from the state of FIG. **13**A and the developing roller is at a separated position thereof and the clutch is at the transmission state as viewed in the axial direction;

[0030] FIG. **14**B is a perspective view illustrating the separation mechanism, the lever, the clutch, and the coupling gear in the state where the cam further rotates from the state of FIG. **13**A and the developing roller is at the separated position and the clutch is at the transmission state;

[0031] FIG. **15**A is a view illustrating the separation mechanism, the lever, the clutch, and the coupling gear in a state where the cam further rotates from the state of FIG. **14**A and the developing roller is at the separated position and the clutch is at a cut-off state as viewed in the axial direction;

[0032] FIG. **15**B is a perspective view illustrating the separation mechanism, the lever, the clutch, and the coupling gear in the state where the cam further rotates from the state of FIG. **14**A and the developing roller is at the separated position and the clutch is at the cut-off state;

[0033] FIG. **16**A is a view illustrating the separation mechanism, the lever, the clutch, and the coupling gear in a state where the cam further rotates from the state of FIG. **15**A and the developing roller corresponding to the color of yellow temporarily stops rotating immediately before starting to move to the contact position as viewed in the axial direction;

[0034] FIG. **16**B is a perspective view illustrating the separation mechanism, the lever, the clutch, and the coupling gear in the state where the cam further rotates from the state of FIG. **15**A and the developing roller corresponding to the color of yellow temporarily stops rotating immediately before starting to move to the contact position;

[0035] FIGS. **17**A through **17**D are views for description of contacting/separating operations of the developing rollers in the image-forming apparatus according to the embodiment;

[0036] FIGS. **18**A through **18**D are views for description of the contacting/separating operations of the developing rollers in the image-forming apparatus according to the embodiment after the states of FIGS. **17**A through **17**D;

[0037] FIG. **19** is a flowchart illustrating an example of processing to be initiated upon receipt of a print job in the image-forming apparatus according to the embodiment;

[0038] FIG. **20** is a flowchart illustrating an example of processing to set parameters in the image-forming apparatus according to the embodiment;

[0039] FIG. **21**A is a flowchart illustrating an example of processing to control a YMC clutch in the image-forming apparatus according to the embodiment;

[0040] FIG. **21**B is a flowchart illustrating an example of processing to control a K clutch in the image-forming apparatus according to the embodiment;

[0041] FIG. **22** is a timing chart for description of operations of the developing rollers and control to the YMC clutch and K clutch in response to output from each sensor for performing color printing in a normal mode in the image-forming apparatus according to the embodiment;

[0042] FIG. **23** is a timing chart for description of operations of the developing rollers and control to the YMC clutch and K clutch in response to output from each sensor for performing color printing in a low speed mode in the image-forming apparatus according to the embodiment;

[0043] FIG. **24** is a timing chart for description of operations of the developing rollers and control to the YMC clutch and K clutch in response to output from each sensor for performing color printing in a high speed mode in the image-forming apparatus according to the embodiment;

[0044] FIG. **25**A is a timing chart for description of operations of the YMC clutch (YMC cam) and the developing rollers for the colors of yellow, magenta and cyan for performing color printing in the normal mode in the image-forming apparatus according to the embodiment;

[0045] FIG. **25**B is a timing chart for description of operations of the YMC clutch (YMC cam) and the developing rollers for the colors of yellow, magenta and cyan for performing color printing in the low speed mode in the image-forming apparatus according to the embodiment; and

[0046] FIG. **25**C is a timing chart for description of operations of the YMC clutch (YMC cam) and the developing rollers for the colors of yellow, magenta and cyan for performing color printing in the high speed mode in the image-forming apparatus according to the embodiment.

DETAILED DESCRIPTION

[0047] An image-forming apparatus **1** according to one embodiment of the disclosure will be described with reference to the accompanying drawings. The image-forming apparatus **1** of the present embodiment is a color printer.

[0048] In the following description, directions with respect to the image-forming apparatus **1** will be referred to assuming that the image-forming apparatus **1** is disposed in an orientation in which it is intended to be used. Specifically, a left side, a right side, an upper side, and a lower side in FIG. **1** will be referred to as a front side, a rear side, an upper side, and a lower side of the image-forming apparatus **1**, respectively. Further, a near side and a far side in FIG. **1** will

be referred to as a right side and a left side of the image-forming apparatus **1**, respectively.

[0049] <Overall Structure of Image-Forming Apparatus **1**>

[0050] Referring to FIG. **1**, the image-forming apparatus **1** includes a housing **10** within which a sheet feed unit **20**, an image-forming unit **30**, and a controller **2** are mainly provided.

[0051] The housing **10** is formed with a front opening, and includes a front cover **11** for opening and closing the front opening. Further, the housing **10** has an upper surface functioning as a discharge tray **13**.

[0052] The sheet feed unit **20** is positioned at a lower internal portion of the housing **10**. The sheet feed unit **20** includes: a sheet tray **21** for accommodating a stack of sheets S; and a sheet feed mechanism **22** configured to supply each sheet S from the sheet tray **21** toward the image-forming unit **30**. The sheet feed mechanism **22** includes a sheet feed roller **23**, a separation roller **24**, a separation pad **25**, and a pair of registration rollers **27**.

[0053] Incidentally, in the present disclosure, the sheet S is an example of an image-forming medium on which an image can be formed by the image-forming apparatus **1**. For example, plain paper, an envelope, a post card, thin paper, thick paper, calendered paper, a resin sheet, and a seal are available as the sheet S.

[0054] In the sheet feed unit **20**, the sheets S accommodated in the sheet tray **21** are configured to be fed by the sheet feed roller **23**, and then separated one by one by the separation roller **24** and the separation pad **25**. Subsequently, a position of a leading edge of each sheet S is configured to be regulated by the registration rollers **27** whose rotation is halted, and the sheet S is then configured to be supplied to the image-forming unit **30** by the rotation of the registration rollers **27**. Hereinafter, a direction in which the sheet S is configured to be conveyed inside the housing **10** (depicted in a phantom line in FIG. **1**) will be defined as a sheet conveying direction.

[0055] Further, a plurality of sheet sensors is provided upstream of photosensitive drums **50** (described later) in the sheet conveying direction each for detecting passage of the sheet S therethrough. Specifically, these sheet sensors include a sheet feed sensor **28**A, a front sensor **28**B, and a back sensor **28**C.

[0056] The sheet feed sensor **28**A is positioned downstream of the separation roller **24** in the sheet conveying direction. The sheet feed sensor **28**A is configured to detect passage of the sheet S delivered from the sheet tray **21**. The front sensor **28**B is positioned downstream of the sheet feed sensor **28**A and upstream of the registration rollers **27** in the sheet conveying direction. The front sensor **28**B is configured to contact the sheet S conveyed from the sheet feed sensor **28**A to detect passage of the sheet S. The back sensor **28**C is positioned downstream of the registration rollers **27** and upstream of the photosensitive drums **50**.

[0057] The image-forming unit **30** includes an exposure device **40**, a plurality of photosensitive drums **50**, a plurality of developing cartridges **60**, a conveying device **70**, and a fixing device **80**.

[0058] The exposure device **40** includes a laser diode, a deflector, lenses, and mirrors those not illustrated. The exposure device **40** is configured to emit laser beams to expose surfaces of the respective photosensitive drums **50** to scan the surfaces.

[0059] The photosensitive drums **50** include: a Y photosensitive drum **50**Y for a first color of yellow; a M photosensitive drum **50**M for a second color of magenta; a C photosensitive drum **50**C for a third color of cyan; and a K photosensitive drum **50**K for a fourth color of black. Throughout the specification and drawings, in a case where colors must be specified, members or components corresponding to the colors of yellow, magenta, cyan and black are designated by adding "Y", "M", "C" and "K", respectively. On the other hand, in a case where distinction of colors is unnecessary, "Y", "M", "C" and "K" will not be added.

[0060] The photosensitive drums **50** are arrayed in the sheet conveying direction, i.e., in a rearward direction. Specifically, the Y photosensitive drum **50**Y is positioned most upstream in the sheet conveying direction among the array of the photosensitive drums **50**. The K photosensitive drum **50**K is positioned most downstream in the sheet conveying direction among the array of the photosensitive drums **50**. Further, the C photosensitive drum **50**C is positioned downstream of the Y photosensitive drum **50**Y in the sheet conveying direction, and specifically, positioned between the Y photosensitive drum **50**Y and the K photosensitive drum **50**K in the sheet conveying direction. Further, the M photosensitive drum **50**M is positioned between the Y photosensitive drum **50**Y and the C photosensitive drum **50**C in the sheet conveying direction. That is, the photosensitive drums **50**Y, **50**M, **50**C and **50**K are arranged in this order toward downstream in the sheet conveying direction.

[0061] Four of the developing cartridges **60** are provided in one-to-one correspondence with the four photosensitive drums **50**. Specifically, the developing cartridges **60** include: a Y developing cartridge **60**Y including a Y developing roller **61**Y for supplying toner of the first color (yellow) to the Y photosensitive drum **50**Y; a M developing cartridge **60**M including a M developing roller **61**M for supplying toner of the second color (magenta) to the M photosensitive drum **50**M; a C developing cartridge **60**C including a C developing roller **61**C for supplying toner of the third color (cyan) to the C photosensitive drum **50**C; and a K developing cartridge **60**K including a K developing roller **61**K for supplying toner of the fourth color (black) to the K photosensitive drum **50**K. The developing rollers **61**Y, **61**M, **61**C and **61**K are arranged in this order toward downstream in the sheet conveying direction.

[0062] Each developing cartridge **60** is movable between a contact position where the developing roller **61** is in contact with the corresponding photosensitive drum **50** (indicated by a solid line in FIG. **1**) and a separated position where the developing roller **61** is separated from the corresponding photosensitive drum **50** (indicated by a dashed line in FIG. **1**).

[0063] Further, in a state where the M developing roller **61**M, the C developing roller **61**C and the K developing roller **61**K are respectively at their separated positions, each of the M developing cartridge **60**M, the C developing cartridge **60**C and the K developing cartridge **60**K is overlapped with a path of the laser beam for irradiating the photosensitive drum **50** positioned immediately upstream thereof in the sheet conveying direction. Specifically, the M developing cartridge **60**M is overlapped with the path of the laser beam directing to the Y photosensitive drum **50**Y when the M developing roller **61**M is at the separated position.

Likewise, the C developing cartridge **60**C is overlapped with the path of the laser beam directing to the M photosensitive drum **50**M when the C developing roller **61**C is at the separated position; and the K developing cartridge **60**K is overlapped with the path of the laser beam directing to the C photosensitive drum **50**C when the K developing roller **61**K is at the separated position.

[0064] As illustrated in FIG. **2**, the photosensitive drums **50** are rotatably supported by a support member **90**. Further, the support member **90** detachably supports the four developing cartridges **60**. The support member **90** is attachable to and detachable from the housing **10** through the front opening when the front cover **11** is opened. Detailed structures of the support member **90** and the developing cartridges **60** will be described later.

[0065] Turning back to FIG. **1**, the conveying device **70** is positioned between the sheet tray **21** and the photosensitive drums **50** in an upward/downward direction. The conveying device **70** includes a drive roller **71**, a driven roller **72**, an endless belt as a conveyer belt **73**, and four transfer rollers **74**. The conveyer belt **73** is mounted over the drive roller **71** and the driven roller **72** under tension, and has an outer peripheral surface facing each of the photosensitive drums **50**. Each transfer roller **74** is positioned within a loop of the conveyer belt **73** to nip the conveyer belt **73** in cooperation with corresponding one of the photosensitive drums **50**. The sheet S is configured to be conveyed as the conveyer belt **73** circulates while the sheet S is mounted on an upper portion of the outer peripheral surface of the conveyer belt **73**, and at the same time, a toner image formed on each photosensitive drum **50** is transferred onto the sheet S, sequentially.

[0066] The fixing device **80** is positioned rearward of the photosensitive drum **50**K and the conveying device **70**. The fixing device **80** includes a heat roller **81** and a pressure roller **82** positioned in confrontation with the heat roller **81**. A sheet discharge sensor **28**D is positioned downstream of the fixing device **80** in the sheet conveying direction to detect that the sheet S moves past the sensor **28**D. A pair of conveyer rollers **15** is also positioned above the fixing device **80**, and a pair of discharge rollers **16** is positioned above the conveyer rollers **15**.

[0067] In the image-forming unit **30**, a peripheral surface of each photosensitive drum **50** is uniformly charged by a corresponding charger **52** provided at the support member **90**, and is then exposed to light by the laser beam irradiated from the exposure device **40**. Thus, an electrostatic latent image on a basis of image data is formed on the peripheral surface of each photosensitive drum **50**.

[0068] Further, toner accommodated in each developing cartridge **60** is carried on a peripheral surface of each developing roller **61**, and is then supplied from each developing roller **61** to the electrostatic latent image on the peripheral surface of each photosensitive drum **50** when the developing roller **61** comes into contact with the corresponding photosensitive drum **50**. Hence, a toner image is formed on the peripheral surface of each photosensitive drum **50**.

[0069] Subsequently, the toner image formed on each photosensitive drum **50** is transferred onto the sheet S while the sheet S fed onto the conveyer belt **73** moves past positions between each photosensitive drum **50** and the corresponding transfer roller **74**. Then, the toner image transferred onto the sheet S is thermally fixed to the sheet S while the sheet S passes between the heat roller **81** and the pressure roller **82**. The sheet S discharged from the fixing device **80** is then discharged onto the discharge tray **13** by the conveyer rollers **15** and the discharge rollers **16**.

[0070] <Support Member **90**, Developing Cartridges **60** and Separation Mechanisms **5**>

[0071] Referring to FIG. **2**, the support member **90** includes: a pair of side frames **91** positioned away from each other in an axial direction of each photosensitive drum **50**; a front connection frame **92** connecting front end portions of the respective side frames **91**; and a rear connection frame **93** connecting rear end portions of the respective side frames **91**. The pair of side frames **91** includes a right side frame **91**R and a left side frame **91**L. The chargers **52** (FIG. **1**) are also provided in the support member **90**. Each charger **52** is positioned to face corresponding one of the photosensitive drums **50** for charging the same.

[0072] The image-forming apparatus **1** further includes four separation mechanisms **5** (FIG. **2**) each configured to move the developing roller **61** between the contact position in contact with the corresponding photosensitive drum **50** and the separated position away from the corresponding photosensitive drum **50**.

[0073] Specifically, each separation mechanism **5** includes: a cam **150** (Y cam **150**Y, M cam **150**M, C cam **150**C, or K cam **150**K); and a cam follower **170**. The cam **150** is rotatable about a rotation axis parallel to an axis **61**X (FIG. **1**) of the corresponding developing roller **61**.

[0074] The cam **150** is configured to rotate in a predetermined rotational direction rotatable in a predetermined rotational direction upon receipt of a driving force transmitted from a developing motor **3**D (FIG. **6**). The cam **150** includes a first cam portion **152**A protruding rightward, i.e., inward in a direction of the rotation axis **61**X of the developing roller **61** (hereinafter simply referred to as "axial direction"). The first cam portion **152**A has an end face (right end face) serving as a cam surface **152**F.

[0075] The cam follower **170** is movable between: an operating position (illustrated in FIG. **4**B) in contact with the cam surface **152**F for positioning the developing roller **61** at the separated position; and a standby position (illustrated in FIG. **4**A) for positioning the developing roller **61** at the contact position. The cam follower **170** is configured to be slidingly moved in the axial direction (rightward) to the operating position while being in contact with the cam surface **152**F to apply a pressing force to the corresponding developing cartridge **60**, thereby separating the developing roller **61** from the corresponding photosensitive drum **50**. While the cam follower **170** is at the standby position, the developing roller **61** is in contact with the corresponding photosensitive drum **50** and the cam follower **170** is separated from the developing cartridge **60** in the axial direction.

[0076] Turning back to FIG. **2**, each cam **150** and the cam follower **170** corresponding thereto are provided for each of the developing cartridges **60**. Each pair of the cam **150** and the cam follower **170** is positioned leftward of the left side frame **91**L, i.e., outward of the left side frame **91**L in a leftward/rightward direction. The cam **150** and the cam follower **170** will be described in detail later.

[0077] Counterpart abutment portions **94** are provided four each on respective upper portions of the side frames **91**R and **91**L of the support member **90**. The counterpart abutment portions **94** are configured to abut slide members **64** (FIG. **3**A) of the corresponding developing cartridges **60**, as will be described later. Each counterpart abutment portion

94 is in a form of a roller rotatable about an axis extending in the upward/downward direction.

[0078] The support member 90 also includes a plurality of pressure members 95 two each for each of the developing cartridges 60. For each developing cartridge 60, two of the pressure members 95 are positioned one each outward of the corresponding photosensitive drum 50 in the axial direction of the same. Each of the pressure members 95 is urged rearward by a spring 95A (FIGS. 4A and 4B). In accordance with the attachment of the developing cartridge 60 to the support portion 90, each of the pressure members 95 presses the corresponding developing cartridge 60 (specifically, a protrusion 63D of the developing cartridge 60 (FIGS. 3A through 4B) as will be described later) by an urging force of the spring 95A, to permit the corresponding developing roller 61 to be in pressure contact with the corresponding photosensitive drum 50.

[0079] As illustrated in FIGS. 3A and 3B, the developing cartridge 60 includes a casing 63, the slide member 64, and a coupling 65.

[0080] The casing 63 is configured to store toner of the corresponding color therein. The casing 63 has one side surface in the axial direction (left end surface) provided with a first protruding portion 63A and a second protruding portion 63B.

[0081] The first and second protruding portions 63A and 63B protrude outward in the axial direction, or in the direction of the rotation axis 61X from the left end surface of the casing 63. The first protruding portion 63A is coaxial with the rotation axis 61X of the developing roller 61. The second protruding portion 63B is positioned away from the first protruding portion 63A by a predetermined distance. In the present embodiment, the second protruding portion 63B is positioned diagonally above the first protruding portion 63A. That is, the second protruding portion 63B is positioned higher than the first protruding portion 63A.

[0082] The first and second protruding portions 63A and 63B are provided as rollers rotatable about their axes extending in parallel to the axial direction of the rotation axis 61. Although not illustrated, the first and second protruding portions 63A and 63B are also provided at another side surface of the casing 63 in the axial direction (right end face) at positions symmetrical with the first and second protruding portions 63A and 63B provided at the one side surface (left end surface).

[0083] Further, the above-described protrusion 63D configured to be pressed by the pressure member 95 is also positioned frontward and upward of the first and second protruding portions 63A and 63B. The protrusion 63D protrudes outward in the axial direction from each side surface of the casing 63 in the axial direction.

[0084] The coupling 65 is configured to be engaged with a coupling shaft 119 of a power transmission mechanism 100 described later. Rotational driving force is configured to be inputted into the coupling 65 from the coupling shaft 119.

[0085] The slide member 64 is slidably movable in the axial direction relative to the casing 63 upon application of the pressing force from the corresponding cam follower 170. As illustrated in FIGS. 4A and 4B, the slide member 64 includes a shaft 181, a first abutment member 182 fixed to one end (left end) of the shaft 181, and a second abutment member 183 fixed to another end (right end) of the shaft 181. The casing 63 is formed with a hole extending in the axial direction. The shaft 181 extends through the hole and is slidably supported by the casing 63.

[0086] Referring to FIGS. 3A through 4B, the first abutment member 182 has a pressure receiving surface 182A and a sloped surface 182B. The pressure receiving surface 182A is a left end face of the first abutment member 182, that is, an end face thereof in the axial direction. The sloped surface 182B extends from the pressure receiving surface 182A to be sloped with respect to the axial direction. The pressure receiving surface 182A is configured to be pressed by the corresponding cam follower 170. When the slide member 64 is pressed in the axial direction by the cam follower 170, the sloped surface 182B is configured to abut against the corresponding counterpart abutment portion 94 of the support member 90 to urge the developing cartridge 60 in a direction parallel to the sheet conveying direction, thereby moving the developing cartridge 60 to the position as illustrated in FIG. 4B. The sloped surface 182B is sloped in a curved fashion to extend gradually frontward toward the right. That is, the sloped surface 182B is sloped in a direction from the photosensitive drum 50 toward the corresponding developing roller 61 (frontward) as extending in a direction from the one end (left end) to the other end (right end) of the shaft 181 in the axial direction.

[0087] The second abutment member 183 has a sloped surface 183B similar to the sloped surface 182B of the first abutment member 182. The second sloped surface 183B is configured to abut against the counterpart abutment portion 94 of the support member 90 when the slide member 64 is pressed in the axial direction by the corresponding cam follower 170, thereby urging the developing cartridge 60 in the direction parallel to the sheet conveying direction (frontward direction) to move the developing cartridge 60 to the position as illustrated in FIG. 4B.

[0088] A spring 184 is interposed between the first abutment member 182 and the casing 63 to urge the slide member 64 leftward, i.e., outward in the axial direction (in a direction from the other end (right end) to the one end (left end) of the shaft 181). The spring 184 is a compression spring disposed over the shaft 181.

[0089] As illustrated in FIG. 5, the side frame 91L of the support member 90 has an inner surface provided with four first support surfaces 96A and four second support surfaces 96B one each for each developing cartridge 60. One of the first support surfaces 96A and one of the second support surfaces 96B support the first protruding portion 63A and the second protruding portion 63B of the corresponding developing cartridge 60 from below when the developing roller 61 is moved from the contact position to the separated position. The first support surface 96A and the second support surface 96B respectively extend in the sheet conveying direction (i.e., from the front to the rear).

[0090] Each first support surface 96A is positioned to support the corresponding first protruding portion 63A. The first support surface 96A is configured to guide the developing roller 61 and to fix a position thereof in the upward/downward direction when the developing cartridge 60 is attached to the support member 90. Each second support surface 96B is positioned upward of the first support surface 96A to support the second protruding portion 63B when the developing cartridge 60 is attached to the support member 90. Although not illustrated, the first and second support surfaces 96A and 96B are also provided at an inner surface

of the right side frame **91**R at positions symmetrical with the first and second support surfaces **96**A and **96**B of the left side frame **91**L.

[0091] Referring to FIG. **5**, when the developing roller **61** is positioned at the contact position in contact with the corresponding photosensitive drum **50**, the first protruding portion **63**A is positioned at a rear region of the corresponding first support surface **96**A (see the first protruding portions **63**A of the developing cartridges **60**Y, **60**M and **60**C). When the developing roller **61** is at the separated position away from the corresponding photosensitive drum **50**, the first protruding portion **63**A is positioned at a front region of the corresponding first support surface **96**A (see the first protruding portion **63**A of the developing cartridge **60**K).

[0092] In this way, the developing roller **61** is moved in a direction opposite to the sheet conveying direction (toward upstream in the sheet conveying direction, or frontward) when the separation mechanism **5** moves the developing roller **61** from the contact position to the separated position.

[0093] Next, details of the cam **150** and cam follower **170** will be described.

[0094] As illustrated in FIGS. **12**A and **12**B, each cam **150** includes a disc portion **151**, a gear portion **150**G, an end face cam **152**, and a clutch control cam **153**. The cam **150** is configured to rotate to move the corresponding developing roller **61** between the contact position and the separated position.

[0095] The disc portion **151** is generally circular plate shaped, and is rotatably supported by a support plate **102** (FIGS. **7**-**10**) fixed to the housing **10** of the image-forming apparatus **1**. The gear portion **150**G is provided on an outer peripheral surface of the disc portion **151**. The end face cam **152** constitutes one of components of the corresponding separation mechanism **5**.

[0096] The end face cam **152** includes the above-described first cam portion **152**A protruding rightward from the disc portion **151**. The end face cam **152** has the cam surface **152**F which is the protruding end face (right end face) of the first cam portion **152**A.

[0097] The cam surface **152**F includes a first holding surface F**1**, a second holding surface F**2**, a first guide surface F**3**, and a second guide surface F**4**. In other words, the first holding surface F**1**, the second holding surface F**2**, first guide surface F**3** and second guide surface F**4** altogether constitute the cam surface **152**F.

[0098] The first holding surface F**1** is a flat surface configured to hold the corresponding cam follower **170** at its standby position. The second holding surface F**2** is a flat surface configured to hold the corresponding cam follower **170** at its operating position.

[0099] The first guide surface F**3** connects the first holding surface F**1** and the second holding surface F**2** together and is inclined with respect to the first holding surface F**1**. The first guide surface F**3** is configured to guide movement of the corresponding cam follower **170** from the first holding surface F**1** to the second holding surface F**2** in accordance with the rotation of the cam **150**. The second guide surface F**4** connects the second holding surface F**2** and the first holding surface F**1** together and is inclined with respect to the first holding surface F**1**. The second guide surface F**4** is configured to guide movement of the corresponding cam follower **170** from the second holding surface F**2** to the first holding surface F**1** in accordance with the rotation of the cam **150**.

[0100] The clutch control cam **153** includes a base portion **153**A having a generally columnar shape, and a second cam portion **153**B protruding radially outwardly from the base portion **153**A. The clutch control cam **153** is integral with and coaxial with the disc portion **151**, and hence, the second cam portion **153**B rotates together with the cam **150**. The clutch control cam **153** is configured to provide control to a clutch **120** (see FIG. **6**) of the power transmission mechanism **100** to switch a power transmission status of the clutch **120** between a transmission state and a cut-off state, in cooperation with a lever **160** (FIG. **10**) of the power transmission mechanism **100**. Details of the power transmission mechanism **100** will be described later.

[0101] The cam follower **170** includes a slide shaft portion **171**, and a contact portion **172**. The slide shaft portion **171** is slidable relative to a shaft **174** (FIG. **4**B) fixed to the housing **10** so as to be movable in the axial direction. The slide shaft portion **171** is urged by a spring **173** (an urging member) in such a direction that the contact portion **172** is in contact with the cam surface **152**F of the cam **150**. Hence, the cam follower **170** is urged toward the standby position.

[0102] Specifically, the spring **173** is a tension spring having one end portion engaged with the slide shaft portion **171** and another end portion engaged with a spring attaching portion (not illustrated) provided in the housing **10**. The contact portion **172** protrudes radially outward from the slide shaft portion **171** and extends in the axial direction. The contact portion **172** has one axial end face (left end face) facing the cam surface **152**F and contactable with the cam surface **152**F.

[0103] As illustrated in FIG. **9**, the cams **150**Y, **150**M, **150**C and **150**K have generally the same configuration as one another except that a length of the first cam portion **152**A of the cam **150**Y in a rotational direction thereof is greater than a length of the first cam portion **152**A of each of the remaining cams **150**M, **150**C and **150**K in a rotational direction thereof.

[0104] Each of the cams **150**C and **150**K is further provided with a counterpart detection portion **154** protruding from the disc portion **151** in the axial direction at a position radially inward of the corresponding first cam portion **152**A.

[0105] Further, the housing **10** is provided with separation sensors **4**C and **4**K corresponding to the colors of black and cyan. The separation sensors **4**C and **4**K are phase sensors or displacement sensors for detecting phases or rotational positions of the cams **150**C and **150**K, respectively. The separation sensors **4**C and **4**K are configured to output separation signals in response to a timing where the cams **150**C and **150**K are positioned within a predetermined phase range indicative of the developing rollers **61**C and **61**K being at the separated positions, respectively. The separation sensors **4**C and **4**K are configured not to output the separation signals in response to a timing where the cams **150**C and **150**K are positioned outside of the predetermined phase range. In the present embodiment, for simplification, output of the separation signal will be referred to as an ON state, and non-output of the separation signal will be referred to as an OFF state. A voltage level of the ON state may be higher or lower than that of the OFF state.

[0106] Each of the separation sensors **4**K and **4**C includes a light emitting portion **4**P configured to emit detection light, and a light receiving portion **4**R configured to receive the detection light. In a state where the counterpart detection portion **154** is positioned between the light emitting portion

4P and the light receiving portion 4R to block the detection light so that the light receiving portion 4R cannot receive the detection light, each separation sensor 4C, 4K is configured to output a signal indicative of being at the ON state (ON signal) to the controller 2. On the other hand, in a state where the counterpart detection portion 154 is displaced from a path of the detection light so that the light receiving portion 4R can receive the detection light, each separation sensor 4C, 4K is configured to output a signal indicative of being at the OFF state (OFF signal) to the controller 2.

[0107] Incidentally, each of the cam 150Y and 150M has a part having the same shape as the counterpart detection portion 154 of the cam 150C and 150K. However, separation sensors corresponding to these parts is not provided at the housing 10, and therefore, these parts do not function as the counterpart detection portion 154 does.

[0108] As illustrated in FIG. 6, the image-forming apparatus 1 further includes the developing motor 3D, a process motor 3P, a fixing motor 3F, and the power transmission mechanism 100 configured to transmit driving force of the developing motor 3D to the developing rollers 61.

[0109] The developing rollers 61 (61Y, 61M, 61C, 61K) and the cams 150 (150Y, 150M, 150C, 150K) are configured to be rotated upon receipt of driving force transmitted from the developing motor 3D. The sheet supply mechanism 22 is configured to be driven upon receipt of driving force transmitted from the process motor 3P. The photosensitive drums 50 (50K, 50M, 50C, 50K) are configured to be rotated upon receipt of the driving force transmitted from the process motor 3P.

[0110] Regarding the conveying device 70, the conveyer belt 73 is configured to be circularly moved upon transmission of the driving force to the drive roller 71 from the process motor 3P, thereby conveying the sheet S to the positions between each of the photosensitive drums 50 and the conveyer belt 73. The heat roller 81 of the fixing device 80 is configured to be rotated upon transmission of the driving force from the fixing motor 3F.

[0111] <Mechanisms for Performing Driving/Stop and Contact/Separation of Developing Rollers 61>

[0112] Next, a structure for driving and stopping the developing rollers 61, and a structure for moving the developing rollers 61 to come into contact with and to be separated from the photosensitive drums 50 will be described in detail.

[0113] As illustrated in FIGS. 7 and 8, the image-forming apparatus 1 further includes the power transmission mechanism 100 mechanically connected to the respective cams 150 each constituting part of each separation mechanism 5. The power transmission mechanism 100 is configured to transmit the driving force of the developing motor 3D to the developing rollers 61 while the developing rollers 61 are respectively at their contact positions, and is configured not to transmit the driving force of the developing motor 3D to the developing rollers 61 while these developing rollers 61 are respectively at their separated positions.

[0114] As best illustrated in FIG. 8, the power transmission mechanism 100 includes: a power transmission gear train 100D configured to transmit the driving force of the developing motor 3D to the respective developing rollers 61; and a transmission control gear train 100C configured to control transmission of the driving force in the power transmission gear train 100D. The power transmission gear train 100D is mechanically connected to the transmission control gear train 100C. In FIGS. 8 and 10, meshing engagement of the gears in the power transmission gear train 100D is indicated by a bold solid line, and meshing engagement of the gears in the transmission control gear train 100C is indicated by a bold broken line.

[0115] The power transmission gear train 100D includes: two first idle gears 110 (110A, 110B); three second idle gears 113A, 113B and 113C; four third idle gears 115 (115Y, 115M, 115C, 115K); four clutches 120 (120Y, 120M, 120C, 120K); and four coupling gears 117 (117Y, 117M, 117C, 117K). Each of these gears constituting the power transmission gear train 100D is supported by the support plate 102 or a frame (not illustrated) of the housing 10 so as to be rotatable about an axis extending in the axial direction.

[0116] Each coupling gear 117 includes the coupling shaft 119 rotatable integrally and coaxially therewith (FIG. 7). The coupling shaft 119 is movable in the axial direction of the corresponding photosensitive drum 50 in interlocking relation to the opening/closing movement of the front cover 11. The coupling shaft 119 is configured to be engaged with the coupling 65 (FIG. 3A) of the corresponding developing cartridge 60 in accordance with the closing motion of the front cover 11.

[0117] Detailed structures and functions of the clutches 120 will be described later.

[0118] In the power transmission gear train 100D, the coupling gear 117Y for the color of yellow is configured to receive the driving force from an output shaft 3A of the developing motor 3D through the first idle gear 110A, the second idle gear 113A, the third idle gear 115Y, and the clutch 120Y.

[0119] The coupling gear 117M for the color of magenta is configured to receive the driving force from the output shaft 3A of the developing motor 3D through the first idle gear 110A, the second idle gear 113A, the third idle gear 115M, and the clutch 120M.

[0120] The coupling gear 117C for the color of cyan is configured to receive the driving force from the output shaft 3A of the developing motor 3D through the first idle gear 110B, the second idle gear 113B, the third idle gear 115C, and the clutch 120C.

[0121] The coupling gear 117K for the color of black is configured to receive the driving force from the output shaft 3A of the developing motor 3D through the first idle gear 110B, the second idle gear 113B, the third idle gear 115C, the second idle gear 113C, the third idle gear 115K, and the clutch 120K.

[0122] As illustrated in FIGS. 9 and 10, the transmission control gear train 100C includes: two fourth idle gears 131 (131A, 131B); two fifth idle gears 132 (132A, 132B); a YMC clutch 140A; a K clutch 140K; two sixth idle gears 133 (133A, 133B); a seventh idle gear 134; an eighth idle gear 135; a ninth idle gear 136; a tenth idle gear 137; and the cams 150 (150Y, 150M, 150C, 150K). These gears constituting the transmission control gear train 100C are supported by the support plate 102 or the frame (not illustrated) of the housing 10 so as to be rotatable about their axes extending in the axial direction of the photosensitive drum 50.

[0123] The YMC clutch 140A is configured to perform change-over between transmission and cut-off of the driving force to the cams 150Y, 150M and 150C in the transmission control gear train 100C. Specifically, the YMC clutch 140A is configured to switch from the transmission state to the cut-off state and vice versa. In the transmission state, the

driving force of the developing motor **3**D is transmitted to the Y cam **150**Y, the M cam **150**M, and the C cam **150**C. In the cut-off state, the driving force of the developing motor **3**D is not transmitted to the Y cam **150**Y, the M cam **150**M, and the C cam **150**C. That is, the YMC clutch **140**A is configured to perform switching of the cams **150**Y, **150**M and **150**C between their rotating state and non-rotating state.

[0124] The YMC clutch **140**A includes a large diameter gear **140**L and a small diameter gear **140**S whose number of gear teeth is smaller than a number of gear teeth of the large diameter gear **140**L. The large diameter gear **140**L of the YMC clutch **140**A is in meshing engagement with the fifth idle gear **132**A, and the small diameter gear **140**S of the YMC clutch **140**A is in meshing engagement with the sixth idle gear **133**A.

[0125] The K clutch **140**K is configured to perform change-over, in the drive control gear train **100**C, between transmission and cut-off of driving force to the K cam **150**K. Specifically, the K clutch **140**K is configured to switch from the transmission state to the cut-off state and vice versa. In the transmission state, the driving force of the developing motor **3**D is transmitted to the K cam **150**K, while, in the cut-off state, the driving force of the developing motor **3**D is not transmitted to the K cam **150**K. In other words, the K clutch **140**K is configured to perform switching of the K cam **150**K between its rotating state and non-rotating state.

[0126] The K clutch **140**K includes a large diameter gear **140**L and a small diameter gear **140**S whose number of gear teeth is smaller than a number of gear teeth of the large diameter gear **140**L. The large diameter gear **140**L of the K clutch **140**K is in meshing engagement with the fifth idle gear **132**B, and the small diameter gear **140**S of the K clutch **140**K is in meshing engagement with the sixth idle gear **133**B.

[0127] An electromagnetic clutch is available as the YMC clutch **140**A and the K clutch **140**K. Upon receipt of power supply (turning ON), the large diameter gear **140**L and the small diameter gear **140**S integrally rotate together, and upon halting of the power supply (turning OFF), the large diameter gear **140**L idly rotates to prevent rotation of the small diameter gear **140**S. Incidentally, in the following description, power transmission state and cut-off state in the K clutch **140**K and the YMC clutch **140**A will be occasionally referred to "ON" and "OFF", respectively.

[0128] In the transmission control gear train **100**C, the Y cam **150**Y for the color of yellow receives the driving force of the developing motor **3**D through the first idle gear **110**A, the fourth idle gear **131**A, the fifth idle gear **132**A, the YMC clutch **140**A, the sixth idle gear **133**A, and the seventh idle gear **134**. Further, the M cam **150**M for the color of magenta receives the driving force from the Y cam **150**Y through the eighth idle gear **135**. Further, the C cam **150**C for the color of cyan receives the driving force from the M cam **150**M through the ninth idle gear **136**. Upon power supply to the YMC clutch **140**A, the cams **150**Y, **150**M and **150**C rotate concurrently, and the cams **150**Y, **150**M and **150**C stop rotating concurrently upon halting of the power supply to the YMC clutch **140**A.

[0129] On the other hand, the K cam **150**K for the color of black receives the driving force of the developing motor **3**D through the first idle gear **110**B, the fourth idle gear **131**B, the fifth idle gear **132**B, the K clutch **140**K, the sixth idle gear **133**B, and the tenth idle gear **137**. Upon power supply to the K clutch **140**K, the cam **150**K rotates, while the cam **150**K stops rotating upon halt of the power supply to the K clutch **140**K.

[0130] Next, the structures and functions of the clutches **120** will be described. Incidentally, all the four clutches **120**Y, **120**M, **120**C and **120**K have the same structure as one another.

[0131] As illustrated in FIGS. **11**A and **11**B, each clutch **120** includes a planetary gear mechanism. The clutch **120** is configured to perform change-over between the transmission state where the driving force of the developing motor **3**D is transmitted to the corresponding developing roller **61** and the cut-off state where the driving force of the developing motor **3**D is not transmitted to the developing roller **61**. Specifically, each clutch **120** includes: a sun gear **121** rotatable about an axis thereof; a ring gear **122**; a carrier **123**; and a plurality of (four) planetary gears **124** supported by the carrier **123**. The ring gear **122** and carrier **123** are rotatable coaxially about the axis of the sun gear **121**.

[0132] The sun gear **121** includes a gear portion **121**A, a disc portion **121**B rotatable integrally with the gear portion **121**A, and a plurality of pawls **121**C provided at an outer peripheral surface of the disc portion **121**B. The pawls **121**C have acute tip end portions each of which is inclined toward upstream in a rotational direction of the sun gear **121** along the outer peripheral surface. The ring gear **122** has an annular shape having an inner peripheral surface provided with an inner gear **122**A and an outer peripheral surface provided with an input gear **122**B.

[0133] The carrier **123** includes: a circular portion **123**C; an annular portion **123**D extending from an inner surface of the circular portion **123**C; four shaft portions **123**A each extending from the inner surface of the circular portion **123**C; and an output gear **123**B provided at an outer peripheral surface of the annular portion **123**D.

[0134] Each of the four planetary gears **124** is rotatably supported by one of the four shaft portions **123**A. Each planetary gear **124** is in meshing engagement with the gear portion **121**A of the sun gear **121**, and with the inner gear **122**A of the ring gear **122**.

[0135] As illustrated in FIG. **7**, the input gear **122**B of each clutch **120** is in meshing engagement with the corresponding third idle gear **115**, and the output gear **123**B is in meshing engagement with the corresponding coupling gear **117**.

[0136] In a state where the rotation of the sun gear **121** is stopped, the driving force inputted into the input gear **122**B can be transmitted to the output gear **123**B (the transmission state). On the other hand, in a state where the sun gear **121** is allowed to rotate, the driving force inputted into the input gear **122**B cannot be transmitted to the output gear **123**B (the cut-off state). In a state where the clutch **120** is at the cut-off state and the driving force is inputted into the input gear **122** while load is imparted on the output gear **123**B, the output gear **123**B does not rotate and the sun gear **121** idly rotates.

[0137] As illustrated in FIG. **10**, the power transmission mechanism **100** further includes a plurality of (four) the levers **160** corresponding to the respective four colors. Four support shafts **102**A are fixed to and extends from the support plate **102**. Each lever **160** is pivotally movably supported by the corresponding one of the support shafts **102**A. Each lever **160** is configured, in cooperation with the corresponding cam **150**, to engage the sun gear **121** of the planetary gear mechanism in the corresponding clutch **120**

to prevent the rotation of the sun gear **121** to provide the transmission state, and to disengage from the sun gear **121** to provide the cut-off state.

[0138] Specifically, as illustrated in FIG. **12**A, each lever **160** includes a rotation support portion **161**, a first arm **162** extending from the rotation support portion **161**, and a second arm **163** extending from the rotation support portion **161** in a direction different from an extending direction of the first arm **162**.

[0139] The rotation support portion **161** is hollow cylindrical. The corresponding support shaft **102**A of the support plate **102** is inserted in a hollow space of the rotation support portion **161**. Hence, the rotation support portion **161** is supported by the support shaft **102**A.

[0140] The second arm **163** has a tip end portion extending toward the outer peripheral surface of the disc portion **121**B of the sun gear **121** of the corresponding clutch **120**. The lever **160** is urged by a torsion spring (not illustrated) so that the tip end portion of the second arm **163** is urged toward the outer peripheral surface of the disc portion **121**B. A hook **163**A is provided at the tip end portion of the second arm **163**. The hook **163**A is configured to engage any one of the pawls **121**C of the sun gear **121** to prevent the sun gear **121** from rotating.

[0141] The first arm **162** has a tip end portion **162**A contactable with the second cam portion **153**B of the corresponding cam **150**. Specifically, the lever **160** is pivotally movable between an engagement position and a disengagement position. In the engagement position, the tip end portion **162**A is positioned in confrontation with the circular base portion **153**A, so that the hook **163**A is engaged with one of the pawls **121**C of the corresponding clutch **120** (see FIGS. **12**A-**14**B). In the disengagement position, the tip end portion **162**A of the first arm **162** comes into contact with the second cam portion **153**B to be urgingly moved by the same, so that the hook **163**A is disengaged from the pawl **121**C (see FIGS. **15**A-**16**B). The engagement position of the lever **160** separated from the second cam portion **153**B brings the clutch **120** into the transmission state, and the disengagement position of the lever **160** in contact with the second cam portion **153**B brings the clutch **120** into the cut-off state.

[0142] Operations of the lever **160**, the clutch **120**, the cam **150** and the cam follower **170** will be described with reference to FIGS. **12**A through **16**B. The components illustrated in these drawings are for the color of yellow. Components corresponding to the other colors have the same structure as the components illustrated in FIGS. **12**A through **16**B except for the difference in the phase of each cam **150**.

[0143] As illustrated in FIGS. **12**A and **12**B, the tip end portion **162**A of the first arm **162** is brought into confrontation with the circular base portion **153**A after the tip end portion **162**A is separated from the second cam portion **153**B. Hence, the hook **163**A of the second arm **163** is brought into engagement with one of the pawls **121**C of the sun gear **121** of the corresponding clutch **120** to position the lever **160** at its engagement position. Since the rotation of the sun gear **121** is stopped by the lever **160**, the clutch **120** is brought to the transmission state where the output gear **123**B rotates in accordance with the rotation of the input gear **122**B. Hence, the driving force of the developing motor **3**D can be transmitted to the developing roller **61**, and accordingly, the developing roller **61** is rotatable by the rotation of the developing motor **3**D through the power transmission gear train **100**D.

[0144] Further, the end face (left end face) of the contact portion **172** of the cam follower **170** is positioned on the first holding surface F**1** of the cam surface **152**F of the cam **150**. Therefore, the slide shaft portion **171** is positioned to be spaced away from the slide member **64** of the developing cartridge **60** in the axial direction (see FIGS. **4**A). Accordingly, the developing roller **61** is positioned at its contact position.

[0145] As illustrated in FIGS. **13**A and **13**B, in accordance with further rotation of the cam **150** from the state illustrated in FIGS. **12**A, and **12**B, the contact portion **172** of the cam follower **170** slidingly moves over the first holding surface F**1** of the cam **150** and approaches the first guide surface F**3**. Among the four cams **150**, in particular, in a case where the rotation of the Y cam **150**Y is to be stopped while the developing roller **61** is at the contact position, the rotation of the Y cam **150**Y is stopped when the contact portion **172** is at such a position in contact with the first guide surface F**3**, as illustrated in FIG. **13**B.

[0146] In order to separate the developing roller **61** away from the photosensitive drum **50**, the Y cam **150**Y is further rotated, so that the contact portion **172** of the cam follower **170** slidingly moves over the first guide surface F**3** and is brought into contact with the second holding surface F**2**, as illustrated in FIGS. **14**A and **14**B. Hence, the slide shaft portion **171** of the cam follower **170** pushes the slide member **64** of the corresponding developing cartridge **60** in the axial direction (rightward), so that the developing cartridge **60** is pushed frontward by the reaction force from the counterpart abutment portions **94** provided on the support member **90** (see FIG. **4**B).

[0147] The developing roller **61** is thus separated from the photosensitive drum **50** in a state where the contact portion **172** is positioned on a region of the first guide surface F**3**, the region being closer to the second holding surface F**2** than to the first holding surface F**1**. The separated position of the developing roller **61** is maintained as long as the contact portion **172** is positioned on the second holding surface F**2**.

[0148] As illustrated in FIGS. **15**A and **15**B, the cam **150** further rotates after the developing roller **61** is positioned at the separated position, so that the tip end portion **162**A of the first arm **162** of the lever **160** is brought into contact with the second cam portion **153**B. The lever **160** is pivotally moved by the first arm **162** being pushed by the second cam portion **153**B. Hence, the hook **163**A is disengaged from the pawl **121**C of the sun gear **121**, thereby providing the disengagement position of the lever **160**.

[0149] Since the lever **160** no longer stops rotation of the sun gear **121** of the clutch **120** at this time, the clutch **120** is switched to the cut-off state where the output gear **123**B does not perform power transmission during the rotation of the input gear **122**B. Accordingly, the driving force of the developing motor **3**D cannot be transmitted to the developing roller **61**. That is, the rotation of the developing motor **3**D does not cause rotation of the developing roller **61**, but only causes idle rotation of the sun gear **121**.

[0150] In order to maintain the separated position of the developing roller **61**, the rotation of the cam **150** is halted while the lever **160** is at the disengagement position illustrated in FIGS. **15**A and **15**B. For temporarily stopping the rotation of the Y cam **150**Y while the developing roller **61**Y is at the separated position, the Y cam **150**Y is further rotated

from the state illustrated in FIGS. **15**A and **15**B. Then, as illustrated in FIGS. **16**A and **16**B, the rotation of the Y cam **150**Y is stopped when the contact portion **172** reaches an end of the second holding surface F**2**, the end being immediately upstream of the second guide surface F**4**. That is, the contact portion **172** is stopped immediately before moving onto the second guide surface F**4** (before coming into contact with the second guide surface F**4**).

[0151] In order to move the developing roller **61** from the separated position to the contact position, the cam **150** is further rotated from the state illustrated in FIGS. **15**A and **15**B or FIGS. **16**A and **16**B. As a result, the contact portion **172** slidingly moves over the second guide surface F**4** and comes to the position in contact with the first holding surface F**1** by the urging force of the spring **173**, as illustrated in FIGS. **12**A and **12**B.

[0152] Accordingly, the cam follower **170** is moved in the axial direction away from the slide member **64**, so that the slide member **64** is moved leftward in FIG. **4**A by the urging force of the spring **184**. Thus, the developing cartridge **60** is returned to the state depicted in FIG. **4**A, i.e., to the contact position indicated by the solid line in FIG. **1** where the developing roller **61** is in contact with the photosensitive drum **50**. The developing roller **61** is brought into contact with the photosensitive drum **50** when the contact portion **172** moves past a region of the second guide surface F**4**, the region being adjacent to the second holding surface F**2** (see FIG. **16**B). As described above, the clutch **120** becomes transmission state when the lever **160** faces the circular base portion **153**A and is brought to the engagement position in engagement with the sun gear **121**.

[0153] In the image-forming apparatus **1**, in a case of performing color printing on the sheet S using the four developing rollers **61**Y, **61**M, **61**C and **61**K, these developing rollers **61** are successively moved from the separated position to the contact position in accordance with the movement of the sheet S, and these developing rollers **61** are then moved in sequence to the separated position from the contact position after termination of transfer of the toner image to the sheet S.

[0154] To this effect, the cams **150**Y, **150**M and **150**C are assembled so that the phases (angular positions) of the respective first cam portions **152**A are displaced from one another by a predetermined angle (see FIG. **9**). Specifically, the cams **150**M and **150**C have the same structure as each other. Further, the length of the first cam portion **152**A of the Y cam **150**Y in the rotational direction is greater than the length of each of the cams **150**M and **150**C in the rotational direction thereof.

[0155] Further, as illustrated in FIG. **9**, the phase or the angular position of an upstream end, in the rotational direction, of the first cam portion **152**A is coincident with each other with respect to the Y cam **150**Y and the M cam **150**M. Further, the phase or the angular position of an upstream end of the first cam portion **152**A of the C cam **150**C is displaced from the upstream end of the first cam portion **152**A of each of the Y cam **150**Y and the M cam **150**M by a predetermined angle. Still further, the phases or angular positions of downstream ends of the respective first cam portions **152**A are displaced from one another by a predetermined angle with respect to the Y cam **150**Y, the M can **150**M, and the C cam **150**C.

[0156] The structure of the K cam **150**K is identical to the structure of the cams **150**M and **150**C. The K cam **150**K is controlled by the controller **2** such that the K cam **150**K is configured to be operated at a timing (retardation in phase) later than a timing at which the C cam **150**C is operated by a predetermined angle.

[0157] With such a phase differential, the cams **150**Y, **150**M and **150**C are configured to rotate simultaneously upon transmission of the driving force from the developing motor **3**D, so that: the Y developing roller **61**Y moves from the separated position to the contact position by the Y cam **150**Y; the M developing roller **61**M moves from the separated position to the contact position by the M cam **150**M on or after movement of the Y developing roller **61**Y and prior to movement of the C developing roller **61**C; and the C developing roller **61**C moves from the separated position to the contact position by the C cam **150**C after the movements of the Y developing roller **61**Y and the M developing roller **61**M.

[0158] Specifically, in the present embodiment, the M developing roller **61**M is configured to be moved from the separated position to the contact position by the M cam **150**M substantially concurrently with the movement of the Y developing roller **61**Y; and the C developing roller **61**C is configured to be moved from the separated position to the contact position by the C cam **150**C after the movement of the M developing roller **61**M. Further, the K developing roller **61**K is configured to be moved from the separated position to the contact position by the K cam **150**K after the movement of the C developing roller **61**C.

[0159] Further, the cams **150**Y, **150**M and **150**C are configured to rotate simultaneously upon transmission of the driving force from the developing motor **3**D, so that: the Y developing roller **61**Y moves from the contact position to the separated position by the Y cam **150**Y; the M developing roller **61**M moves from the contact position to the separated position by the M cam **150**M on or after movement of the Y developing roller **61**Y and prior to movement of the C developing roller **61**C; and the C developing roller **61**C moves from the contact position to the separated position by the C cam **150**C after the movements of the Y developing roller **61**Y and the M developing roller **61**M.

[0160] Specifically, in the present embodiment, the M developing roller **61**M is configured to be moved from the contact position to the separated position by the M cam **150**M after the movement of the Y developing roller **61**Y; and the C developing roller **61**C is configured to be moved from the contact position to the separated position by the C cam **150**C after the movement of the M developing roller **61**M. Further, the K developing roller **61**K is configured to be moved from the contact position to the separated position by the K cam **150**K after the movement of the C developing roller **61**C.

[0161] <Operations of the Controller **2**>

[0162] The controller **2** is configured to control overall operations performed in the image-forming apparatus **1**. The controller **2** includes a CPU, a ROM, a RAM, and an input/output portion, and etc., and is configured to perform various processing by executing programs preliminarily stored. In the present embodiment, the controller **2** is configured to control the YMC clutch **140**A and the K clutch **140**K in response to signals transmitted from the sheet feed sensor **28**A, the front sensor **28**B, the back sensor **28**C, and separation sensors **4**K and **4**C, thereby controlling contact/separation of the developing rollers **61** relative to the photosensitive drums **50**.

[0163] The controller **2** permits each of the developing rollers **61**M, **61**C and **61**K to be positioned at the contact position prior to starting exposure to the photosensitive drum **50** positioned immediately upstream of the each of the developing rollers **61**M, **61**C and **61**K in the sheet conveying direction, since as described above, each of the developing cartridges **60**M, **60**C and **60**K is positioned to overlap with the path of light beam to be irradiated on the photosensitive drum **50** positioned immediately upstream of each developing cartridge **60** when each of the developing rollers **61**M, **61**C and **61**K is at the separated position.

[0164] That is, the developing rollers **61**M and **61**C are configured to be moved to the respective contact positions prior to start of the exposure to the upstream side photosensitive drums **50**Y and **50**M by setting the difference in length of the first cam portions **152**A among the cams **150**Y, **150**M and **150**C and by the mechanical setting as to displacement of the phases of the cams **150**Y, **150**M and **150**C.

[0165] Specifically, in order to move the M developing roller **61**M to the contact position prior to the exposure to the photosensitive drum **50**Y, the cams **150**Y and **150**M are configured such that the M developing roller **61**M contacts the M photosensitive drum **50**M at a timing concurrent with or prior to the timing of contact of the Y developing roller **61**Y with the Y photosensitive drum **60**Y.

[0166] For performing color printing, the controller **2** controls the K cam **150**K to be delayed by the predetermined angle against the C cam **150**C in association with the moving timing of the C developing roller **61**C. That is, for performing color printing, the controller **2** controls the K developing roller **61**K to move to the contact position prior to exposure to the C photosensitive drum **50**C.

[0167] Specifically, as illustrated in FIG. **17**A, the controller **2** permits all the developing rollers **61**Y, **61**M, **61**C and **61**K to be positioned at the respective separated positions prior to starting a printing operation. Then, as illustrated in FIG. **17**B, when the sheet S is about to arrive at the Y photosensitive drum **50**Y, the controller **2** controls the Y developing cartridge **60**Y and the M developing cartridge **60**M to simultaneously move for moving the developing rollers **61**Y and **61**M to the respective contact positions prior to start exposing the Y photosensitive drum **50**Y to the light beam. Specifically, the shapes and phases of the cams **150**Y and **150**M are designed to realize such movements of the developing rollers **61**Y and **61**M. Hence, development of the toner image on the Y photosensitive drum **50**Y by the Y developing roller **61**Y can be performed, and the toner image can be transferred to the sheet S.

[0168] Then, as illustrated in FIG. **17**C, when the sheet S is about to arrive at the M photosensitive drum **50**M, the C developing cartridge **60**C is then moved for moving the C developing roller **61**C to the contact position prior to start exposing the M photosensitive drum **50**M to the light beam. Specifically, the shape and phase of the C cam **150**C is designed to realize such movement of the developing roller **61**C. Therefore, development of the toner image on the M photosensitive drum **50**M by the M developing roller **61**M can be performed, and the toner image can be transferred to the sheet S.

[0169] Then, as illustrated in FIG. **17**D, when the sheet S is about to arrive at the C photosensitive drum **50**C, the K developing cartridge **60**K is moved for moving the K developing roller **61**K to the contact position prior to start exposing the C photosensitive drum **50**C to the light beam. Therefore, development of the toner image on the C photosensitive drum **50**C by the C developing roller **61**C can be performed, and the toner image can be transferred to the sheet S. Further, the development of the toner image on the K photosensitive drum **50**K by the K developing roller **61**K can be performed, since the K developing roller **61**K is at the contact position.

[0170] Then, as illustrated in FIG. **18**A, the controller **2** controls the Y developing cartridge **60**Y to move for moving the Y developing roller **61**Y to the separated position, after termination of the development on the Y photosensitive drum **50**Y by the Y developing roller **61**Y and prior to termination of the development on the M photosensitive drum **50**M by the M developing roller **61**M.

[0171] Then, as illustrated in FIG. **18**B, the M developing cartridge **60**M is moved for moving the M developing roller **61**M to the separated position, after termination of the development on the M photosensitive drum **50**M by the M developing roller **61**M and prior to termination of the development on the C photosensitive drum **50**C by the C developing roller **61**C.

[0172] Then, as illustrated in FIG. **18**C, the C developing cartridge **60**C is moved for moving the C developing roller **61**C to the separated position, after termination of the development on the C photosensitive drum **50**C by the C developing roller **61**C and prior to termination of the development on the K photosensitive drum **50**K by the K developing roller **61**K.

[0173] Then, as illustrated in FIG. **18**D, the controller **2** controls the K developing cartridge **60**K to move for moving the K developing roller **61**K to the separated position, after termination of the development on the K photosensitive drum **50**K by the K developing roller **61**K.

[0174] On the other hand, for performing a monochromatic printing employing only the K developing roller **61**K, the controller **2** controls the K developing cartridge **60**K to move for moving the K developing roller **61**K to the contact position prior to start of exposure to the K photosensitive drum **50**K, while maintaining the separated positions of the developing roller **61**Y, **61**M and **61**K. Then, the controller **2** controls the K developing cartridge **60**K to move for moving the K developing roller **61**K to the separated position after termination of the development on the K photosensitive drum **50**K by the K developing roller **61**K.

[0175] Further, the controller **2** controls contacting timing of the Y developing roller **61**Y and the K developing roller **61**K with the Y photosensitive drum **50**Y and the K photosensitive drum **50**K, respectively, in timed relation to conveying timing of the sheet S. That is, the controller **2** controls the cams **150**Y, **150**M, **150**C and **150**K to rotate upon receipt of a print job.

[0176] Further, the controller **2** controls the YMC clutch **140**A to stop rotations of the cams **150**Y, **150**M and **150**C at a temporary stop timing upon elapse of a first time period TC**1** from a timing at which the ON signal is not transmitted from the separation sensor **4**C (the timing at which the OFF signal is transmitted) and at which the Y developing roller **61**Y is out of contact with the Y photosensitive drum **50**Y.

[0177] Then, the controller **2** controls the YMC clutch **140**A to rotate the cams **150**Y, **150**M and **150**C to bring the Y developing roller **61**Y into contact with the Y photosensitive drum **50**Y for performing image development thereon at a restart timing upon elapse of a second time period TC**2**

from the timing at which the leading edge of the sheet S is detected by the front sensor **28**B.

[0178] Further, the controller **2** controls the K clutch **140**K to stop rotation of the K cam **150**K at the temporary stop timing upon elapse of a first time period TK**1** from the timing at which the ON signal is no longer acquired from the separation sensor **4**K (at which the separation sensor **4**K outputs the OFF signal) and at which the K developing roller **61**K is out of contact with the K photosensitive drum **50**K. Further, the controller **2** controls the K clutch **140**K to start rotation of the K cam **150**K at the restart timing upon elapse of a second time period TK**2** from the timing at which the back sensor **28**C detects the leading edge of the sheet S, so that the K developing roller **61**K contacts the K photosensitive drum **50**K for performing image development thereon.

[0179] Still further, in the image-forming apparatus **1**, the controller **2** is configured to switch a rotation speed of the developing motor **3**D in order to switch a rotation speed of the developing rollers **61**. Specifically, the controller **2** is configured to provide a first mode and a second mode. In the first mode, the developing motor **3**D rotates at a first rotation speed, the process motor **3**P rotates at a second rotation speed, and the fixing motor **3**F rotates at a fourth rotation speed. In the present embodiment, the first mode is referred to as a "normal mode".

[0180] On the other hand, in the second mode, the developing motor **3**D rotates at a third rotation speed different from the first rotation speed, the process motor **3**P rotates at the second rotation speed as in the normal mode, and the fixing motor **3**F rotates at the fourth rotation speed as in the normal mode. In the present embodiment, the second mode includes a low speed mode and a high speed mode. In the low speed mode, the third rotation speed is lower than the first rotation speed, while in the high speed mode, the third rotation speed is higher than the first rotation speed.

[0181] In this way, the controller **2** can provide: the normal mode in which the developing motor **3**D rotates at the first rotation speed; the low speed mode in which the developing motor **3**D rotates at the rotation speed lower than the first rotation speed; and the high speed mode in which the developing motor **3**D rotates at the rotation speed higher than the first rotation speed.

[0182] Incidentally, as described above, the controller **2** only changes the rotation speed of the developing motor **3**D, and does not change the rotation speeds of the process motor **3**P and the fixing motor **3**F. That is, the controller **2** does not change the conveying speed of the sheet S in switching of the modes.

[0183] In other words, a ratio of the rotation speed of the process motor **3**P to the rotation speed of the developing motor **3**D in the normal mode (i.e., the ratio of the second rotation speed to the first rotation speed in the first mode) is different from a ratio of the rotation speed of the process motor **3**P to the rotation speed of the developing motor **3**D in the low speed mode (i.e., the ratio of the second rotation speed to the third rotation speed slower than the first rotation speed in the low speed mode of the second mode). Further, the ratio of the rotation speed of the process motor **3**P to the rotation speed of the developing motor **3**D in the normal mode is also different from a ratio of the rotation speed of the process motor **3**P to the rotation speed of the developing motor **3**D in the high speed mode (i.e., the ratio of the second rotation speed to the third rotation speed higher than the first rotation speed in the high speed mode of the second mode).

[0184] The image-forming apparatus **1** further includes a temperature sensor **6** (FIG. **1**) configured to detect a temperature in the housing **10**. In a case where the temperature detected by the temperature sensor **6** is higher than a predetermined temperature, the controller **2** performs the normal mode, and in a case where the temperature in the housing **10** is equal to or lower than the predetermined temperature, the controller **2** performs the low speed mode.

[0185] Further, the controller **2** performs the low speed mode in a case of printing, for example, in a toner save mode in which the amount of toner supplied from the developing roller **61** to the corresponding photosensitive drum **50** per a unit of time is to be smaller than that in the normal mode. Further, the controller **2** performs the high speed mode in a case of printing with the amount of toner supplied from the developing roller **61** to the corresponding photosensitive drum **50** per unit of time being greater than that in the normal mode in order to heighten density of the image to be formed on the sheet S.

[0186] Incidentally, in the image-forming apparatus **1**, the driving force of the developing motor **3**D is transmitted not only to each of the developing rollers **61** but also to each of the cams **150** which moves the corresponding developing roller **61** between the contact position and the separated position. Therefore, in the low speed mode, not only the rotation speed of each developing roller **61** but also the rotation speed of each cam **150** are lower than those in the normal mode, which means that the moving speed of each developing roller **61** between the contact position and the separated position is also lower in the low speed mode than in the normal mode. Likewise, in the high speed mode, not only the rotation speed of the developing roller **61** but also the rotation speed of the cam **150** are higher than those in the normal mode, which means that the moving speed of each developing roller **61** between the contact position and the separated position is also higher in the high speed mode than in the normal mode.

[0187] In the present embodiment, in order to move the developing rollers **61**Y, **61**M and **61**C from the respective separated positions to the contact positions, the controller **2** controls the YCM clutch **140**A to be in the transmission state such that the timing at which the C developing roller **61**C contacts the C photosensitive drum **50**C in the low speed mode is coincident with or earlier than the timing at which the C developing roller **61**C contacts the C photosensitive drum **50**C in the normal mode. In the depicted embodiment, the controller **2** controls the YCM clutch **140**A to turn ON such that the timing at which the C developing roller **61**C contacts the C photosensitive drum **50**C in the low speed mode is coincident with the timing at which the C developing roller **61**C contacts the C photosensitive drum **50**C in the normal mode.

[0188] Specifically, in the normal mode illustrated in FIG. **22**, the controller **2** permits the YMC clutch **140**A to turn ON to start rotations of the cams **150**Y, **150**M and **150**C to thus start moving the developing rollers **61**Y, **61**M and **61**C from the respective separated positions toward the contact positions upon elapse of a second time period TC**2***n* from a timing t**1** at which the front sensor **28**B detects the leading edge of the sheet S (i.e., at a timing t**13**).

[0189] In contrast, in the low speed mode illustrated in FIG. **23**, the controller **2** permits the YMC clutch **140**A to turn ON to start rotations of the cams **150**Y, **150**M and **150**C to start moving the developing rollers **61**Y, **61**M and **61**C

from the respective separated positions to the contact positions at a timing t**33** which is earlier than the rotation start timing t**13** in the normal mode, the timing t**33** being upon elapse of a second time period TC**2***s* from the timing t**1** at which the front sensor **28**B detects the leading edge of the sheet S. The second time period TC**2***s* in the low speed mode is shorter than the second time period TC**2***n* in the normal mode. The second time period TC**2***s* in the low speed mode is set so that the timing at which the C developing roller **61**C contacts the C photosensitive drum **50**C in the low speed mode is coincident with the contacting timing in the normal mode.

[0190] Further, when the developing roller **61**K is to be moved from the separated position to the contact position, the controller **2** controls the K clutch **140**K to be rendered ON such that the timing at which the K developing roller **61**K contacts the K photosensitive drum **50**K in the low speed mode is coincident with the timing at which the K developing roller **61**K contacts the K photosensitive drum **50**K in the normal mode.

[0191] Specifically, in the normal mode illustrated in FIG. **22**, the controller **2** permits the K clutch **140**A to turn ON to start rotation of the K cam **150**K to thus start moving the developing roller **61**K from the separated position toward the contact position upon elapse of a second time period TK**2***n* from a timing t**2** at which the back sensor **28**C detects the leading edge of the sheet S.

[0192] In contrast, in the low speed mode illustrated in FIG. **23**, the controller **2** permits the K clutch **140**K to turn ON to start rotation of the K cam **150**K at a timing earlier than the rotation start timing in the normal mode to start moving the developing roller **61**K from the separated position toward the contact position upon elapse of a second time period TK**2***s* from the timing t**2** at which the back sensor **28**C detects the leading edge of the sheet S. The second time period TK**2***s* in the low speed mode is shorter than the second time period TK**2***n* in the normal mode. The second time period TK**2***s* in the low speed mode is set so that the timing at which the K developing roller **61**K contacts the K photosensitive drum **50**K in the low speed mode is coincident with the contacting timing in the normal mode.

[0193] Further, when the developing rollers **61**Y, **61**M and **61**C are to be moved from the respective contacts position to the separated positions, the controller **2** controls the YCM clutch **140**A to be in the transmission state such that the timing at which the Y developing roller **61**Y starts separation from the Y photosensitive drum **50**Y in the low speed mode is coincident with or later than the timing at which the Y developing roller **61**Y starts separation from the Y photosensitive drum **50**Y in the normal mode. In the present embodiment, the controller **2** controls the YMC clutch **140**A to turn ON such that the timing at which the Y developing roller **61**Y starts separation from the Y photosensitive drum **50**Y in the low speed mode is coincident with the timing at which the Y developing roller **61**Y starts separation from the Y photosensitive drum **50**Y in the normal mode.

[0194] Specifically, not only in the normal mode illustrated in FIG. **22** but also in the low speed mode illustrated in FIG. **23**, the controller **2** permits the YMC clutch **140**A to turn ON to start rotations of the respective cams **150**Y, **150**M and **150**C to thus start moving the developing rollers **61**Y, **61**M and **61**C from the respective contact positions toward the separated positions upon elapse of a fourth time period TC**4***n* from a timing t**4** at which the back sensor **28**C detects the trailing edge of the sheet S.

[0195] Further, when the K developing roller **61**K is to be moved from the contact position to the separated position, the controller **2** permits the K clutch **140**K to be rendered ON such that the timing at which the K developing roller **61**K starts separation from the K photosensitive drum **50**K in the low speed mode is coincident with the timing at which the K developing roller **61**K starts separation from the K photosensitive drum **50**K in the normal mode.

[0196] Specifically, not only in the normal mode but also in the low speed mode, the controller **2** permits the K clutch **140**K to turn ON to start rotation of the K cam **150**K to thus start moving the K developing roller **61**K from the contact position toward the separated position upon elapse of a fourth time period TK**4** from the timing t**4** at which the back sensor **28**C detects the trailing edge of the sheet S.

[0197] Further, in a case where the developing rollers **61**Y, **61**M and **61**C are to be moved from the separated positions to the contact positions, respectively, the controller **2** controls the YCM clutch **140**A to be at the transmission state such that the timing at which the Y developing roller **61**Y contacts the Y photosensitive drum **50**Y in the high speed mode is coincident with or earlier than the timing at which the Y developing roller **61**Y contacts the Y photosensitive drum **50**Y in the normal mode. In the present embodiment, the controller **2** controls the YCM clutch **140**A to turn ON such that the timing at which the Y developing roller **61**Y contacts the Y photosensitive drum **50**Y in the high speed mode is coincident with the timing at which the Y developing roller **61**Y contacts the Y photosensitive drum **50**Y in the normal mode.

[0198] Specifically, in the high speed mode illustrated in FIG. **24**, the controller **2** permits the YMC clutch **140**A to turn ON to start rotations of the respective cams **150**Y, **150**M and **150**C to thus start moving the developing rollers **61**Y, **61**M and **61**C respectively from the separated positions toward the contact positions upon elapse of a second time period TC**2***f* from the timing t**1** at which the front sensor **28**B detects the leading edge of the sheet S. The second time period TC**2***f* in the high speed mode is longer than the second time period TC**2***n* in the normal mode. The second time period TC**2***f* is set so that the timing at which the Y developing roller **61** contacts the Y photosensitive drum **50**Y in the high speed mode is coincident with the timing at which contacting timing in the normal mode.

[0199] Further, in the present embodiment, when the K developing roller **61**K is to be moved from the separated position to the contact position, the controller **2** controls the K clutch **140**K to be rendered ON such that the timing at which the K developing roller **61**K contacts the K photosensitive drum **50**K in the high speed mode is coincident with the timing at which the K developing roller **61**K contacts the K photosensitive drum **50**K in the normal mode.

[0200] Specifically, in the high speed mode illustrated in FIG. **24**, the controller **2** permits the K clutch **140**K to turn ON to start rotating the K cam **150**K at a timing later than the rotation start timing in the normal mode, to thus start moving the developing roller **61**K from the separated position toward the contact position upon elapse of a second time period TK**2***f* from the timing t**2** at which the back sensor **28**C detects the leading edge of the sheet S. The second time period TK**2***f* is longer than the second time period TK**2***n* in the normal mode. The second time period TK**2***f* is set so that

the timing at which the K developing roller **61**K contacts the K photosensitive drum **50**K in the high speed mode is coincident with the contacting timing in the normal mode.

[0201] Further, when the developing rollers **61**Y, **61**M and **61**C are to be moved respectively from the contact positions to the separated positions, the controller **2** controls the YCM clutch **140**A to be in the transmission state such that the timing at which the C developing roller **61**C starts separation from the C photosensitive drum **50**C in the high speed mode is coincident with or later than the timing at which the C developing roller **61**C starts separation from the C photosensitive drum **50**C in the normal mode. In the present embodiment, the controller **2** controls the YMC clutch **140**A to turn ON such that the timing at which the C developing roller **61**C starts separation from the C photosensitive drum **50**C in the highspeed mode is coincident with the timing at which the C developing roller **61**C starts separation from the C photosensitive drum **50**C in the normal mode.

[0202] Specifically, in the high speed mode, the controller **2** permits the YMC clutch **140**A to turn ON to start rotations of the cams **150**Y, **150**M and **150**C at a timing later than the rotation start timing in the normal mode, to thus start movement of the developing rollers **61**Y, **61**M and **61**C respectively from the contact positions toward the separated positions upon elapse of a fourth time period TC**4***f* from the timing t**4** at which the back sensor **28**C detects the trailing edge of the sheet S. The fourth time period TC**4***f* is longer than the fourth time period TC**4***n* in the normal mode, and is set so that the timing at which the C developing roller **61**C starts separation from the C photosensitive drum **50**C in the high speed mode is coincident with the separation start timing in the normal mode.

[0203] Further, when the K developing roller **61**K is to be moved from the contact position to the separated position, the controller **2** controls the K clutch **140**K to be rendered ON such that the timing at which the K developing roller **61**K starts separation from the K photosensitive drum **50**K in the high speed mode is coincident with the timing at which the K developing roller **61**K starts separation from the K photosensitive drum **50**K in the normal mode.

[0204] Specifically, not only in the high mode but also in the normal mode (and in the low speed mode), the controller **2** permits the K clutch **140**K to turn ON to start rotation of the K cam **150**K to thus start moving the K developing roller **61**K from the contact position toward the separated position upon elapse of the fourth time period TK**4** (which is also set in the normal mode) from the timing t**4** at which the back sensor **28**C detects the trailing edge of the sheet S.

[0205] Next, an example of processing to be executed by the controller **2** will be described with reference to FIGS. **19** through **24**.

[0206] FIG. **19** illustrates an example of process configured to be executed by the controller **2** upon receipt of a print job. Upon receipt of a print job, the controller **2** first determines in which mode image formation should be performed on a first page contained in the print job, and sets various parameters according to the mode (in S**11**). The controller **2** then determines whether or not color image is to be printed on the first page (in S**12**).

[0207] In a case where the color image is to be formed (S**12**: YES), the routine proceeds to S**21** to execute color printing process. On the other hand, in a case where a monochromatic image is to be printed (S**12**: No), the routine proceeds to S**22** to execute a monochromatic printing process. Upon completion of image formation on the first page in the steps S**21** or S**22**, the controller **2** determines whether the print job contains data of a subsequent page (S**31**). In a case where printing on the next page is required (S**31**: YES), the routine returns back to S**11**, whereas in a case where the print job does not contain data of the next page (S**31**: NO), the processing is terminated.

[0208] FIG. **20** illustrates details on the parameter setting step of S**11** in FIG. **19**.

[0209] In a case where the mode for image formation is determined to be the normal mode (S**101**: NO and S**102**: NO), the routine proceeds to S**103** where: TC**1***n* is set as the first time period TC**1**; TK**1***n* is set as the first time period TK**1**; TC**2***n* is set as the second time period TC**2**; TK**2***n* is set as the second time period TK**2**; TC**3***n* is set as the third time period TC**3**; TK**3***n* is set as the third time period TK**3**; and TC**4***n* is set as the fourth time period TC**4**. Incidentally, in the present embodiment, the fourth time period TK**4** is a fixed value.

[0210] In a case where the mode for image formation is determined to be the low speed mode (S**101**: YES), the routine proceeds to S**104** where: the first time period TC**1** is set to TC**1***s*; the first time period TK**1** is set to TK**1***s*; the second time period TC**2** is set to TC**2***s*; the second time period TK**2** is set to TK**2***s*; the third time period TC**3** is set to TC**3***s*; the third time period TK**3** is set to TK**3***s*; and the fourth time period TC**4** is set to the TC**4***n* which is equal to the fourth time period in the normal mode.

[0211] In a case where the mode for image formation is determined to be the high speed mode, (S**101**: NO and S**102**: YES), the routine proceeds to S**105** where: the first time period TC**1** is set to TC**1***f*; the first time period TK**1** is set to TK**1***f*; the second time period TC**2** is set to TC**2***f*; the second time period TK**2** is set to TK**2***f*; the third time period TC**3** is set to TC**3***f*; the third time period TK**3** is set to TK**3***f*; and the fourth time period TC**4** is set to the TC**4***f*.

[0212] Color Printing in the Normal Mode

[0213] Next, color printing process under the normal mode (the steps S**11**, S**12**: YES, and S**21** in FIG. **19**) will be described with reference to flowcharts illustrated in FIGS. **21**A and **21**B and a timing chart of FIG. **22**.

[0214] Incidentally, FIGS. **21**A through **22** and FIGS. **23** and **24** later mentioned illustrate processing performed for printing on a single sheet. Further, FIG. **21**A illustrates control to the YMC clutch **140**A, and FIG. **21**B illustrates control to the K clutch **140**K. Further, in the upper section of each of the timing charts in FIG. **22** through **24**, operation timing of the Y developing roller **61**Y is indicated by a bold line, and operation timings of the developing rollers **61**M and **61**C are respectively indicated by a normal line and a broken line those being partly overlapped with the bold line.

[0215] In case of color printing, all the developing rollers **61** are at the respective separated positions prior to an image forming operation. Referring to FIGS. **21**A, **21**B and **22**, the controller **2** permits the YMC clutch **140**A to turn ON (S**201**, timing t**0**) and permits the K clutch **140**K to turn ON (S**301**, timing t**0**) in order to successively move the developing rollers **61** to the respective contact positions. As a result, the cams **150**Y, **150**M, **150**C and **150**K start rotating, and immediately thereafter, the separation sensors **4**C and **4**K are turned OFF (timing t**11**).

[0216] Then, the controller **2** determines whether the first time period TC**1**(TC**1***n*) has elapsed from the timing t**1** at which the separation sensor **4**C for the color of cyan is

turned OFF during a period after starting conveying the sheet S and prior to arrival of the sheet S at the Y photosensitive drum **50**Y (S**202**). In a case where the first time period TC**1**(TC**1***n*) is determined to elapse (S**202**: YES), the controller **2** permits the YMC clutch **140**A to turn OFF (S**203**, timing t**12**) to stop rotation of the cams **150**Y, **150**M and **150**C at the temporary stop timing.

[0217] The first time period TC**1** is so set that, at the temporary stop timing, the contact portion **172** of the cam follower **170** for the color of yellow is positioned on a region of the second holding surface F**2** of the Y cam **150**Y, the region being closest to the second guide surface F**4**. Hence, immediately after the restart of rotation of the cams **150**Y, **150**M and **150**C, the cam follower **170** for the color of yellow is promptly moved to the second guide surface F**4**, so that the Y developing roller **61**Y starts moving to the contact position.

[0218] The controller **2** also determines whether the first time period TK**1**(TK**1***n*) has elapsed from the timing t**11** at which the separation sensor **4**K for the color of black is turned OFF prior to arrival of the sheet S at the K photosensitive drum **50**K (S**302** in FIG. **21**B). In a case where the first time period TK**1**(TK**1***n*) is determined to elapse (S**302**: YES), the controller **2** turns OFF the K clutch **140**K (S**303**, timing t**22**) to stop the rotation of the K cam **150**K at the temporary stop timing.

[0219] The first time period TK**1** is so set that, at the temporary stop timing, the contact portion **172** of the cam follower **170** for the color of black is positioned on a region of the second holding surface F**2** of the K cam **150**K, the region being closest to the second guide surface F**4**. Hence, after the restart of the rotation of the K cam **150**K, the cam follower **170** for the color of black is promptly moved onto the second guide surface F**4**, so that the K developing roller **61**K starts moving to the contact position. Incidentally, the first time period TK**1** is different from the first time period TC**1**.

[0220] Then, the controller **2** determines in S**211** whether the second time period TC**2**(TC**2***n*) has elapsed from the timing t**1** at which the front sensor **28**B is turned ON (at which the leading edge of the sheet S moves past the front sensor **28**B). In a case where the second time period TC**2** (TC**2***n*) has elapsed (S**211**: YES), the controller **2** turns on the YMC clutch **140**A in S**212** to restart the rotations of the cams **150**Y, **150**M and **150**C at the restart timing (timing t**13**). The second time period TC**2** is set so that the toner development on the Y photosensitive drum **50**Y by the Y developing roller **61**Y can be completed by the time the toner image is transferred from the photosensitive drum **50**Y to the conveyed sheet S.

[0221] Then, the controller **2** determines in S**311** whether the second time period TK**2**(TK**2***n*) has elapsed from the timing t**2** at which the back sensor **28**C is turned ON (at which the leading edge of the sheet S moves past the back sensor **28**C). In a case where the second time period TK**2** has elapsed (S**311**: YES), the controller **2** permits the K clutch **140**K to turn ON (S**312**, timing t**23**) to restart the rotation of the K cam **150**K. The second time period TK**2** is set so that the toner development on the K photosensitive drum **50**K by the K developing roller **61**K can be completed by the time the toner image is transferred from the K photosensitive drum **50**K to the conveyed sheet S.

[0222] Then, the controller **2** determines in S**213** whether the third time period TC**3**(TC**3***n*) has elapsed from the timing **13** at which the YMC clutch **140**A is turned ON. In a case where the third time period TC**3** is determined to have elapsed (S**213**: YES), the controller **2** permits the YMC clutch **140**A to turn OFF (S**214**, timing t**14**) to stop the rotations of the cams **150**Y, **150**M and **150**C.

[0223] The third time period TC**3** is set so that the contact portion **172** of the cam follower **170** for the color of yellow is positioned on a region of the first holding surface F**1** of the Y cam **150**Y at a time after the developing rollers **61**Y, **61**M and **61**C are all positioned at the respective contact positions, the region being closest to the first guide surface F**3**. Hence, after the restart of the rotation of the cams **150**Y, **150**M and **150**C, the cam follower **170** for the color of yellow is promptly moved to the first guide surface F**3**, so that the Y developing roller **61**Y starts moving to the separated position promptly.

[0224] Then, the controller **2** determines in S**313** whether the third time period TK**3**(TK**3***n*) has elapsed from the timing **23** at which the K clutch **140**K is turned ON. In a case where the third time period TK**3** is determined to have elapsed (S**313**: YES), the K clutch **140**K is turned OFF (S**314**, timing t**24**) to stop rotating the K cam **150**K.

[0225] The third time period TK**3** is set so that the contact portion **172** of the cam follower **170** for the color of black is positioned on a region of the first holding surface F**1**, the region being closest to the first guide surface F**3**, at a time after the K developing roller **61**K is positioned at the contact position. Hence, after the restart of the rotation of the K cam **150**K, the cam follower **170** for the color of black is promptly moved to the first guide surface F**3**, so that the K developing roller **61**K starts moving toward the separated position.

[0226] Incidentally, upon elapse of a predetermined time period TE**1** from the timing t**2** at which the back sensor **28**C is turned ON, the controller **2** permits the exposure unit **40** to successively emit light beams to successively start exposure to the respective photosensitive drums **50**Y, **50**M, **50**C and **50**K. In the normal mode, the Y developing roller **61**Y and the M developing roller **61**M move to their contact positions approximately concurrently with the start of the exposure to the Y photosensitive drum **50**Y; the C developing roller **61**C moves to the contact position approximately concurrently with the start of the exposure to the M photosensitive drum **50**M; and the K developing roller **61**K moves to the contact position approximately concurrently with the start of the exposure to the C photosensitive drum **50**C.

[0227] Then, the controller **2** determines in S**231** whether the fourth time period TC**4**(TC**4***n*) has elapsed from the timing t**4** at which the back sensor **28**C is turned OFF as a result of the detection of the trailing edge of the sheet S. In a case where the fourth time period TC**4** has elapsed (S**231**: YES), the controller **2** permits the YMC clutch **140**A to turn ON (S**232**, timing t**15**) to rotate the cams **150**Y, **150**M and **150**C to thus successively start separating the Y developing roller **61**Y, the M developing roller **61**M, and the C developing roller **61**C from the corresponding photosensitive drums **50**.

[0228] The fourth time period TC**4** is so set within which the Y developing roller **61**Y starts moving to the separated position after the completion of development on the Y photosensitive drum **50**Y by the Y developing roller **61**Y and immediately after the completion of image transfer from the Y photosensitive drum **50**Y to the sheet S.

[0229] Then, the controller **2** determines in S**233** whether the separation sensor **4**C for the color of cyan outputs the ON signal (separation signal). In a case the ON signal is outputted (S**233**: YES), the controller **2** permits the YMC clutch **140**A to turn OFF (S**234**, timing t**16**) to stop rotations of the cams **150**Y, **150**M and **150**C.

[0230] The controller **2** further determines in S**331** whether the fourth time period TK**4** has elapsed from the timing t**4** at which the back sensor **28**C is turned OFF. In a case where the fourth time period TK**4** has elapsed (S**331**: YES), the controller **2** permits the K clutch **140**K to turn ON (S**332**, timing t**25**) to rotate the K cam **150**K. The fourth time period TK**4** is so set within which the K developing roller **61**K starts moving to the separated position after completion of development on the K photosensitive drum **50**K by the K developing roller **61**K and immediately after the completion of image transfer from the K photosensitive drum **50**K to the sheet S.

[0231] Then, the controller **2** determines whether the separation sensor **4**K for the color of black outputs the ON signal in S**333**. If the ON signal is outputted (S**333**: YES), the controller **2** permits the K clutch **140**K to turn OFF (S**334**, timing t**26**) to stop the rotation of the K cam **150**K.

[0232] Incidentally, the controller **2** also controls the exposure unit **40** to terminate light irradiation to successively terminate the exposure to the respective photosensitive drums **50**Y, **50**M, **50**C and **50**K sequentially upon elapse of a predetermined time period TE**2** from the timing t**4** at which the back sensor **28**C is turned OFF. In the normal mode, the Y developing roller **61**Y starts moving toward the separated position approximately concurrently with the completion of the exposure to the Y photosensitive drum **50**Y; the M developing roller **61**M starts moving toward the separated position approximately concurrently with the completion of the exposure to the M photosensitive drum **50**M; the C developing roller **61**Y starts moving toward the separated position approximately concurrently with the completion of the exposure to the C photosensitive drum **50**C; and the K developing roller **61**K starts moving toward the separated position approximately concurrently with the completion of the exposure to the K photosensitive drum **50**K.

[0233] Color Printing in the Low Speed Mode

[0234] Next, color printing process under the low speed mode (the steps S**11**, S**12**: YES, and S**21** in FIG. **19**.) will be described with reference to a timing chart illustrated in FIG. **23**.

[0235] As described above, in the case of the low speed mode, in the parameter setting step in S**11** of FIG. **19**, the parameters (TC**1**, TK**1**, TC**2**, TK**2**, TC**3**, TK**3** and TC**4**) are set to those for the low speed mode in S**104** (TC**1***s*, TK**1***s*, TC**2***s*, TK**2***s*, TC**3***s*, TK**3***s* and TC**4***n*), as the routine process to S**104** as a result of the YES determination in S**101** in FIG. **20**.

[0236] Then, referring to FIG. **23**, the controller **2** permits the YMC clutch **140**A and the K clutch **140**K to turn ON at the timing t**0**. Hence, the respective cams **150** rotate to render the separation sensors **4**C and **4**K OFF at a timing t**31**. Then, the controller **2** turns OFF the YMC clutch **140**A at a timing t**32** upon elapse of the first time period TC**1***s* from the turning OFF timing (t**31**) of the separation sensor **4**C for the color of cyan to stop rotations of the cams **150**Y, **150**M and **150**C. The first time period TC**1***s* for the low speed mode (where the rotation speed of each cam **150** is lowered) is set longer than the first time period TC**1***n* for the normal mode.

[0237] Then, the controller **2** controls the YMC clutch **140**A to turn ON at a timing t**33** to restart rotations of the cams **150**Y, **150**M and **150**C upon elapse of the second time period TC**2***s* from the timing t**1** at which the front sensor **28**B turns ON.

[0238] Further, the controller **2** permits the K clutch **140**K to turn OFF at a timing t**42** upon elapse of the first time period TK**1***s* from the turning OFF timing (t**31**) of the separation sensor **4**K for the color of black to stop the rotation of the K cam **150**K. The first time period TK**1***s* for the low speed mode is set longer than the first time period TK**1***n* for the normal mode.

[0239] Then, the controller **2** permits the K clutch **140**K to turn ON at a timing t**43** to start rotating the K cam **150**K upon elapse of the second time period TK**2***s* from the timing t**2** at which the back sensor **28**C turns ON.

[0240] Then, the controller **2** turns OFF the YMC clutch **140**A at a timing t**34** upon elapse of the third time period TC**3***s* from the turning ON timing (t**33**) of the YMC clutch **140**A to stop rotations of the cams **150**Y, **150**M and **150**C. The third time period TC**3***s* for the low speed mode (where the moving speed of the developing roller from the separated position to the contact position is lowered) is set longer than the third time period TC**3***n* for the normal mode.

[0241] Then, the controller **2** permits the K clutch **140**K to turn OFF at a timing t**44** to stop the rotation of the K cam **150**K upon elapse of the third time period TK**3***s* from the timing t**43** at which the K clutch **140**K is turned ON. The third time period TK**3***s* in the low speed mode is longer than the third time period TK**3***n* in the normal mode.

[0242] In the low speed mode, the Y developing roller **61**Y and the M developing roller **61**M are brought to the respective contact positions prior to the start of the exposure to the Y photosensitive drum **50**Y; the C developing roller **61**C is brought to the contact position approximately concurrently with the start of the exposure to the M photosensitive drum **50**M; and the K developing roller **61**K is brought to the contact position approximately concurrently with the start of the exposure to the C photosensitive drum **50**M.

[0243] Then, upon elapse of the fourth time period TC**4***n* from the timing t**4** at which the back sensor **28**C is turned OFF, the controller **2** turns ON the YMC clutch **140**A at a timing t**35** to rotate the cams **150**Y, **150**M and **150**C to thus successively start separation of the Y developing roller **61**Y, the M developing roller **61**M and the C developing roller **61**C from the corresponding photosensitive drums **50**. Then, the controller **2** permits the YMC clutch **140**A to turn OFF at a timing t**36** to stop the rotations of the cams **150**Y, **150**M and **150**C upon turning ON of the separation sensor **4**C for the color of cyan.

[0244] Further, upon elapse of the fourth time period TK**4** from the timing t**4** at which the back sensor **28**C is turned OFF, the controller **2** permits the K clutch **140**K to turn ON at a timing t**45** to rotate the K cam **150**K to thus start separation of the K developing roller **61**K from the photosensitive drum **50**K. The controller **2** turns OFF the K clutch **140**K at a timing t**46** to stop the rotation of the K cam **150**K upon turning ON of the separation sensor **4**K for the color of black.

[0245] In the low speed mode, the Y developing roller **61**Y starts moving toward the separated position approximately concurrently with the termination of the exposure to the Y photosensitive drum **50**Y; the M developing roller **61**M starts moving toward the separated position after the termi-

nation of the exposure to the M photosensitive drum **50**M; the C developing roller **61**C starts moving toward the separated position after the termination of the exposure to the C photosensitive drum **50**C; and the K developing roller **61**K starts moving toward the separated position approximately concurrently with the termination of the exposure to the K photosensitive drum **50**K.

[0246] Color Printing in the High Speed Mode

[0247] Next, color printing process under the high speed mode (the steps S**11**, S**12**: YES, and S**21** in FIG. **19**) will be described with reference to a timing chart illustrated in FIG. **24**.

[0248] As described above, in the case of the high speed mode, in the parameter setting step in S**11** of FIG. **19**, the parameters (TC**1**, TK**1**, TC**2**, TK**2**, TC**3**, TK**3** and TC**4**) are set to those for the highspeed mode (TC**1***f*, TK**1***f*, TC**2***f*, TK**2***f*, TC**3***f*, TK**3***f* and TC**4***f*) in S**105**, as the routine process to S**105** as a result of the NO determination in S**101** and the YES determination in S**102** in FIG. **20**.

[0249] Thereafter, referring to FIG. **24**, the controller **2** permits the YMC clutch **140**A and the K clutch **140**K to turn ON at the timing t**0**. Hence, the respective cams **150** rotate to render the separation sensors **4**C and **4**K OFF at a timing t**51**. Then, the controller **2** permits the YMC clutch **140**A to turn OFF at a timing t**52** upon elapse of the first time period TC**1***f* from the turning OFF timing (t**51**) of the separation sensor **4**C for the color of cyan to stop rotation of the cams **150**Y, **150**M and **150**C. The first time period TC**1***f* for the high speed mode (where the rotation speed of the cam **150** is higher) is set shorter than the first time period TC**1***n* in the normal mode.

[0250] Further, the controller **2** permits the K clutch **140**K to turn OFF at a timing t**62** upon elapse of the first time period TK**1***f* from the turning OFF timing (t**51**) of the separation sensor **4**K for the color of black to stop the rotation of the K cam **150**K. The first time period TK**1***f* in the high speed mode is set shorter than the first time period TK**1***n* in the normal mode.

[0251] Then, the controller **2** permits the YMC clutch **140**A to turn ON at a timing t**53** to restart rotations of the cams **150**Y, **150**M and **150**C upon elapse of the second time period TC**2***f* from the timing t**1** at which the front sensor **28**B turns ON. Then, the controller **2** permits the YMC clutch **140**A to turn OFF (t**54**) to stop rotation of the cams **150**Y, **150**M, **150**C upon elapse of the third time period TC**3***f* from the turning ON timing (t**53**) of the YMC clutch **140**A. The third time period TC**3***f* in the high speed mode (where the moving speed of the developing roller **61** from the separated position to the contact position is higher) is set shorter than the third time period TC**3***n* in the normal mode.

[0252] Then, the controller **2** permits the K clutch **140**K to turn ON at a timing t**63** to start rotation of the K cam **150**K upon elapse of the second time period TK**2***f* from the timing t**2** at which the back sensor **28**C turns ON. Then, the controller **2** permits the K clutch **140**K to turn OFF at a timing t**64** to stop rotation of the K cam **150**K upon elapse of the third time period TK**3***f* from the turning ON timing (t**63**) of the K clutch **140**K. The third time period TK**3***f* in the high speed mode is set shorter than the third time period TK**3***n* in the normal mode.

[0253] In the high speed mode, the Y developing roller **61**Y and the M developing roller **61**M are brought to the respective contact positions approximately concurrently with the start of the exposure to the Y photosensitive drum **50**Y; the C developing roller **61**C is brought to the contact position prior to the start of the exposure to the M photosensitive drum **50**M; and the K developing roller **61**K is brought to the contact position approximately concurrently with the start of the exposure to the C photosensitive drum **50**C.

[0254] Then, the controller **2** permits the YMC clutch **140**A to turn ON at a timing t**55** to rotate the cams **150**Y, **150**M and **150**C to thus successively start separation of the Y developing roller **61**Y, the M developing roller **61**M and the C developing roller **61**C from the corresponding photosensitive drums **50** upon elapse of the fourth time period TC**4***f* from the timing t**4** at which the back sensor **28**C is turned OFF. Then, the controller **2** permits the YMC clutch **140**A to turn OFF at a timing t**56** to stop the rotations of the cams **150**Y, **150**M and **150**C upon turning ON of the separation sensor **4**C for the color of cyan.

[0255] The controller **2** further permits the K clutch **140**K to turn ON at a timing t**65** to rotate the K cam **150**K to start separation of the K developing roller **61**K from the K photosensitive drum **50**K upon elapse of the fourth time period TK**4** from the timing t**4** at which the back sensor **28**C is turned OFF. Then, the controller **2** permits the K clutch **140**K to turn OFF at a timing t**66** to stop the rotation of the K cam **150**K upon turning ON of the separation sensor **4**K for the color of black.

[0256] In the high speed mode, the Y developing roller **61**Y starts moving to the separated position after the termination of the exposure to the Y photosensitive drum **50**Y; the M developing roller **61**M starts moving to the separated position after the termination of the exposure to the M photosensitive drum **50**M; the C developing roller **61**C starts moving to the separated position approximately concurrently with the termination of the exposure to the C photosensitive drum **50**C; and the K developing roller **61**K starts moving to the separated position approximately concurrently with the termination of the exposure to the K photosensitive drum **50**K.

[0257] Incidentally, the monochromatic printing process (to be performed in S**22** as a result of the NO determination in S**12** in FIG. **19**) is the same as the color printing process (in S**21** in FIG. **19**) except that the YMC clutch **140**A is never operated to keep the developing rollers **61**Y, **61**M and **61**C respectively in the separated positions (that is, the processing illustrated in FIG. **21**A is not performed). Hence, description for the monochromatic printing process will be omitted here.

Operational and Technical Advantages of the Embodiment

[0258] Advantageous functions and effects attained in the image-forming apparatus **1** of the depicted embodiment will be described.

[0259] In the image-forming apparatus **1**, as illustrated in FIG. **6**, the components for performing conveyance of the sheet S such as the photosensitive drums **50** are configured to be driven by the process motor **3**P, whereas the developing rollers **61** and the cams **150** are configured to be driven by the developing motor **3**D. Hence, in a structure capable of performing contact and separation between a developing roller and a photosensitive drum, the image-forming apparatus **1** according to the above-described embodiment can alter a rotation speed ratio between the photosensitive drums **50** and the developing rollers **61** with a reduced number of

motors, in comparison with a structure in which each motor is exclusively used for each of the photosensitive drums, the developing rollers, and the cams.

[0260] Further, FIGS. **25**A-**25**C are timing charts in the normal mode, low speed mode and high speed mode, respectively, to compare various timings for moving the developing roller **61** from the separated position to the contact position in the image-forming apparatus **1** according to the above-described embodiment. In the low speed mode depicted in FIG. **25**B, the YMC clutch **140**A is turned ON at the timing t**33** which is earlier than the timing t**13** at which the YMC clutch **140**A is turned ON in the normal mode to start rotating the cams **150**Y, **150**M and **150**C in order to move the developing rollers **61**Y, **61**M and **61**C toward the respective contact positions. This timing differential is set so that the timing at which the C developing roller **61**C is brought to the contact position in the low speed mode (as illustrated in FIG. **25**B) can be on or before the timing at which the C developing roller **61**C is brought to the contact position in the normal mode (as illustrated in FIG. **25**A). Hence, irrespective of the modes for image formation, the developing rollers **61**Y, **61**M and **61**C can be brought into contact with the corresponding photosensitive drums **50**Y, **50**M and **50**C in time for development on the photosensitive drums **50**Y, **50**M and **50**C in timed relation to the conveyance of the sheet S.

[0261] In this way, the image-forming apparatus **1** can establish not only the alteration of the rotation speed ratio between the photosensitive drum **50** and the developing roller **61**, but also the contact of the developing roller **61** with the photosensitive drum **50** just in time for development of a toner image on the photosensitive drum **50** in synchronism with the conveyance of the sheet S.

[0262] Further, in the image-forming apparatus **1** according to the above-described embodiment, the timing at which the C developing roller **61**C is brought to the contact position in the low speed mode (illustrated in FIG. **25**B) is coincident with the timing in the normal mode (illustrated in FIG. **25**A). Therefore, in the low speed mode, prolongation in contacting time period between the C developing roller **61**C and the C photosensitive drum **50**C can be obviated, and prolongation in contacting time period between the developing rollers **61**Y and **61**M and the corresponding photosensitive drums **50**Y and **50**M can be minimized. This is in high contrast to a configuration where the timing at which the C developing roller **61**C is brought to the contact position in the low speed mode is earlier than the timing at which the C developing roller **61**C is brought to the contact position in the normal mode.

[0263] Further, in the image-forming apparatus **1** according to the above-described embodiment, the timing at which the Y developing roller **61**Y starts separation from the photosensitive drum **50**Y in the low speed mode illustrated in FIG. **25**B is coincident with the timing in the normal mode illustrated in FIG. **25**A. Therefore, in the low speed mode, prolongation in contacting time period between the Y developing roller **61**Y and the Y photosensitive drum **50**Y can be obviated, and prolongation in contacting time period between the developing rollers **61**M and **61**C and the corresponding photosensitive drums **50**M and **50**C can be minimized. This is in high contrast to a configuration where the timing at which the Y developing roller **61**Y starts separation from the Y photosensitive drum **50**Y in the low speed mode is later than the timing in the normal mode.

[0264] Further, in the image-forming apparatus **1** according to the above-described embodiment, in a case of moving the developing roller **61** from the separated position to the contact position, the timing at which the YMC clutch **140**A is turned ON in the high speed mode (timing t**53**) is later than the timing at which the YMC clutch **140**A is turned ON in the normal mode (timing t**13**) to start rotating the cams **150**Y, **150**M and **150**C to move the developing rollers **61**Y, **61**M and **61**C toward the respective contact positions. This timing differential is set in order to make the timing at which the Y developing roller **61**Y is brought to the contact position in the high speed mode (see FIG. **25**C) on or before the timing at which the Y developing roller **61**Y is brought to the contact position in the normal mode (see FIG. **25**A). Hence, irrespective of the modes for image formation, the developing rollers **61**Y, **61**M and **61**C can be brought into contact with the corresponding photosensitive drums **50**Y, **50**M and **50**C in time for development on the photosensitive drums **50**Y, **50**M and **50**C in timed relation to the conveyance of the sheet S.

[0265] Further, the above-described configuration in the high speed mode can restrain prolongation of the contacting time period between the developing roller **61** and the photosensitive drum **50**, in comparison with a configuration where the timing to turn on the YMC clutch **140**A in the high speed mode for rotating the cams **150**Y, **150**M and **150**C is set earlier than the turning ON timing of the YMC clutch **140**A in the normal mode.

[0266] Further, in the image-forming apparatus **1** according to the above-described embodiment, the timing at which the Y developing roller **61**Y is brought to the contact position in the normal mode (FIG. **25**A) is coincident with the timing in the high speed mode (FIG. **25**C). Therefore, in the high speed mode, prolongation in contacting time period between the Y developing roller **61**Y and the Y photosensitive drum **50**Y can be obviated, and prolongation in contacting time period between the developing rollers **61**M and **61**C and the corresponding photosensitive drums **50**M and **50**C can be minimized. This is in high contrast to a configuration where the timing at which the Y developing roller **61**Y is brought to the contact position in the high speed mode is earlier than the timing at which the Y developing roller **61**Y is brought to the contact position in the normal mode.

[0267] Further, in the image-forming apparatus **1** according to the above-described embodiment, the timing at which the YMC clutch **140**A is turned ON in the high speed mode (timing t**55**) is later than the timing at which the YMC clutch **140**A is turned ON in the normal mode (timing t**15**) in order to start rotating the cams **150**Y, **150**M and **150**C to start moving the developing rollers **61**Y, **61**M and **61**C toward the respective separated positions. This timing differential is set in order to set the timing at which the C developing roller **61**C starts moving toward the separated position in the high speed mode to be on or after the timing at which the C developing roller **61**C starts moving toward the separated position in the normal mode. Hence, separation of the C developing roller **61**C from the C photosensitive drum **50**C during development on the C photosensitive drum **50**C can be avoided in the high speed mode.

[0268] Further, in the image-forming apparatus **1** according to the above-described embodiment, the timing at which the C developing roller **61**Y starts moving toward the separated position in the high speed mode is coincident with

the timing in the normal mode. Therefore, in the high speed mode, prolongation in contacting time period between the C developing roller **61**C and the C photosensitive drum **50**C can be obviated, and prolongation in contacting time period between the developing rollers **61**Y, **61**M and the corresponding photosensitive drums **50**Y, **50**M can be minimized. This is in high contrast to a configuration where the timing at which the C developing roller **61**C starts moving toward the separated position in the high speed mode is later than the timing at which the C developing roller **61**C starts moving toward the separated position in the normal mode.

[0269] Further, in the image-forming apparatus **1** according to the above-described embodiment, the developing cartridges **60**M, **60**C and **60**K are at locations overlapping with the paths of light beams to be irradiated on the photosensitive drums **50**Y, **50**M and **50**C positioned immediately upstream of the respective cartridges **60**M, **60**C and **60**K in the sheet conveying direction, when the developing rollers **61**M, **61**C and **61**K are respectively at the separated positions. Here, since the developing cartridges **60**M, **60**C and **60**K are moved for moving the developing rollers **61**M, **61**C and **61**K to the contact positions prior to exposure to the photosensitive drums **50**Y, **50**M and **50**C, size of each developing cartridge **60** can be increased to increase a toner accommodating capacity thereof, in comparison with a configuration where developing cartridges are arranged not to interfere with paths of light beams regardless of the positions of the respective developing cartridges.

[0270] Various modifications are conceivable.

[0271] For example, in the above-described embodiment, the timing at which the C developing roller **61**C is brought to the contact position is the same between the normal mode and the low speed mode (see FIGS. **25**A and **25**B). However, the timing at which the C developing roller **61**C is brought to the contact position in the low speed mode may be earlier than the timing in the normal mode.

[0272] Further, in the above-described embodiment, the timing at which the Y developing roller **61**Y starts moving toward the separated position is the same between the normal mode and the low speed mode (see FIGS. **25**A and **25**B). However, the timing at which the Y developing roller **61**Y starts moving toward the separated position in the low speed mode may be later than the timing in the normal mode.

[0273] Further, in the above-described embodiment, the timing at which the Y developing roller **61**Y is brought to the contact position is the same between the normal mode and the high speed mode (see FIGS. **25**A and **25**C). However, the timing at which the Y developing roller **61**Y is brought to the contact position in the high speed mode may be earlier than the timing in the normal mode.

[0274] Further, in the above-described embodiment, the timing at which the C developing roller **61**C starts moving toward the separated position is the same between the normal mode and the high speed mode (see FIGS. **25**A and **25**C). However, the timing at which the C developing roller **61**C starts moving toward the separated position in the high speed mode may be later than the timing in the normal mode.

[0275] Further, in the above-described embodiment, the normal mode, the low speed mode and the high speed mode are performable in the image-forming apparatus **1**. However, only the normal mode and the low speed mode may be performable, and, alternatively, only the normal mode and the high speed mode may be performable. Further, conditions for performing the low speed mode and the high speed mode may not be limited to the conditions described above.

[0276] Further, in the above-described embodiment, the developing cartridges **60**M, **60**C and **60**K are positioned to overlap with the paths of light beams to be irradiated to the photosensitive drums **50**Y, **50**M and **50**C those positioned immediately upstream of the developing cartridges **60**M, **60**C and **60**K when the developing rollers **61**M, **61**C and **61**K are respectively positioned at the separated positions. However, the developing cartridges **60**M, **60**C and **60**K may be configured not to overlap with the paths of light beams regardless of the positions of the developing rollers **61**M, **61**C and **61**K.

[0277] Further, the image-forming apparatus **1** according to the above-described embodiment is a color printer using toners of four colors. However, the image-forming apparatus of the disclosure may be exemplified as a color printer employing toners of three colors or five colors for forming color images. Still alternatively, a multifunction device and a copying machine are also available as the image-forming apparatus of the disclosure.

[0278] The elements described in the depicted embodiment and variations may be combined with one another as appropriate.

[0279] While the description has been made in detail with reference to the embodiments, it would be apparent to those skilled in the art that many modifications and variations may be made thereto.

REMARKS

[0280] The image-forming apparatus **1** is an example of an image-forming apparatus. The process motor **3**P is an example of a process motor. The developing motor **3**D is an example of a developing motor. The sheet feed mechanism **22** is an example of a sheet conveying device. The Y photosensitive drum **50**Y is an example of a first photosensitive drum. The Y developing roller **61**Y is an example of a first developing roller. The cam **150**Y is an example of a first cam. The C photosensitive drum **50**C is an example of a second photosensitive drum. The C developing roller **61**C is an example of a second developing roller. The cam **150**C is an example of a second cam. The M photosensitive drum **50**M is an example of a third photosensitive drum. The M developing roller **61**M is an example of a third developing roller. The cam **150**M is an example of a third cam. The YMC clutch **140**A is an example of a switching mechanism. The controller **2** is an example of a controller. The Y developing cartridge **60**Y is an example of a first developing cartridge. The C developing cartridge **60**C is an example of a second developing cartridge. The C developing cartridge **60**C is an example of a second developing cartridge. The M developing cartridge **60**M is an example of a third developing cartridge. The exposure device **40** is an example of an exposure device. The temperature sensor **6** is an example of a temperature sensor.

What is claimed is:

1. An image-forming apparatus comprising:

a process motor;

a sheet conveying device configured to convey a sheet in a sheet conveying direction upon receipt of a driving force from the process motor;

a first photosensitive drum rotatable upon receipt of the driving force from the process motor;

a second photosensitive drum rotatable upon receipt of the driving force from the process motor and positioned downstream of the first photosensitive drum in the sheet conveying direction;

a developing motor;

a first developing roller rotatable upon receipt of a driving force from the developing motor, the first developing roller being movable between a contact position in contact with the first photosensitive drum and a separated position away from the first photosensitive drum;

a second developing roller rotatable upon receipt of the driving force from the developing motor, the second developing roller being movable between a contact position in contact with the second photosensitive drum and a separated position away from the second photosensitive drum;

a first cam rotatable in a prescribed rotational direction upon receipt of the driving force from the developing motor, rotations of the first cam causing the first developing roller to move between the contact position and the separated position relative to the first photosensitive drum;

a second cam rotatable in the prescribed rotational direction upon receipt of the driving force from the developing motor, rotations of the second cam causing the second developing roller to move:

from the contact position to the separated position after movement of the first developing roller from the contact position to the separated position; and

from the separated position to the contact position after movement of the first developing roller from the separated position to the contact position;

a switching mechanism switchable between a transmission state and a cut-off state to control transmission of the driving force from the developing motor to the first cam and the second cam, the transmission state allowing the transmission of the driving force from the developing motor to the first cam and the second cam, the cut-off state interrupting the transmission of the driving force from the developing motor to the first cam and the second cam; and

a controller configured to provide control to the developing motor, the process motor and the switching mechanism to execute a normal mode and a low speed mode, the controller being configured to rotate the developing motor at a first rotation speed and rotate the process motor at a second rotation speed in the normal mode, and the controller being configured to rotate the developing motor at a rotation speed slower than the first rotation speed and rotate the process motor at the second rotation speed in the low speed mode,

the controller being configured to control the switching mechanism to be at the transmission state, for moving each of the first developing roller and the second developing roller from the separated position to the contact position, such that a timing at which the second developing roller comes in contact with the second photosensitive drum in the low speed mode is coincident with or earlier than a timing at which the second developing roller comes in contact with the second photosensitive drum in the normal mode.

2. The image-forming apparatus according to claim **1**, wherein, for moving each of the first developing roller and the second developing roller from the separated position to the contact position,

the controller is configured to control the switching mechanism to be in the transmission state such that the timing at which the second developing roller comes in contact with the second photosensitive drum in the low speed mode is coincident with the timing at which the second developing roller comes in contact with the second photosensitive drum in the normal mode.

3. The image-forming apparatus according to claim **1**, wherein, for moving each of the first developing roller and the second developing roller from the contact position to the separated position,

the controller is configured to control the switching mechanism to be in the transmission state such that a timing at which the first developing roller starts separating from the first photosensitive drum in the low speed mode is coincident with or later than a timing at which the first developing roller starts separating from the first photosensitive drum in the normal mode.

4. The image-forming apparatus according to claim **1**, wherein the controller is further configured to execute a high speed mode in which the controller rotates the developing motor at a rotation speed higher than the first rotation speed and rotate the process motor at the second rotation speed, and

wherein, for moving each of the first developing roller and the second developing roller from the separated position to the contact position, the controller is configured to control the switching mechanism to be in the transmission state such that a timing at which the first developing roller comes in contact with the first photosensitive drum in the high speed mode is coincident with or earlier than a timing at which the first developing roller comes in contact with the first photosensitive drum in the normal mode.

5. The image-forming apparatus according to claim **4**, wherein,

for moving each of the first developing roller and the second developing roller from the contact position to the separated position,

the controller is configured to control the switching mechanism to be in the transmission state such that a timing at which the second developing roller starts separating from the second photosensitive drum in the high speed mode is coincident with or later than a timing at which the second developing roller starts separating from the second photosensitive drum in the normal mode.

6. The image-forming apparatus according to claim **1**, further comprising:

a third photosensitive drum rotatable upon receipt of the driving force from the process motor and positioned between the first photosensitive drum and the second photosensitive drum in the sheet conveying direction;

a third developing roller rotatable upon receipt of the driving force from the developing motor, the third developing roller being movable between a contact position in contact with the third photosensitive drum and a separated position away from the third photosensitive drum; and

a third cam rotatable in the prescribed rotational direction upon receipt of the driving force from the developing motor, rotation of the third cam causing the third developing roller to move:

from the separated position to the contact position at a timing after movement of the first developing roller from the separated position to the contact position and before movement of the second developing roller from the separated position to the contact position; and

from the contact position to the separated position at a timing after movement of the first developing roller from the contact position to the separated position and before movement of the second developing roller from the contact position to the separated position,

wherein, in the transmission state, the switching mechanism is configured to transmit the driving force from the developing motor to the first cam, the second cam and the third cam, and

wherein, in the cut-off state, the switching mechanism is configured to interrupt transmission of the driving force from the developing motor to the first cam, the second cam and the third cam.

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

an exposure device configured to emit laser beams toward the first photosensitive drum, the second photosensitive drum and the third photosensitive drum for exposure;

a first developing cartridge including the first developing roller;

a second developing cartridge including the second developing roller, the second developing cartridge being positioned to overlap with the laser beam toward the third photosensitive drum while the second developing roller is at the separated position; and

a third developing cartridge including the third developing roller, the third developing cartridge being positioned to overlap with the laser beam toward the first photosensitive drum while the third developing roller is at the separated position,

wherein the controller is configured to:

move the third developing roller to the contact position before starting exposure to the first photosensitive drum; and

move the second developing roller to the contact position before starting exposure to the third photosensitive drum.

8. The image-forming apparatus according to claim **1**, further comprising:

a housing; and

a temperature sensor configured to detect a temperature of the housing,

wherein the controller is configured to execute the low speed mode in a case where the temperature of the housing detected by the temperature sensor is equal to or lower than a predetermined temperature.

9. The image-forming apparatus according to claim **1**, wherein the controller is configured to execute the low speed mode in a case where an amount of toner to be supplied from the first developing roller to the first photosensitive drum and from the second developing roller to the second photosensitive drum is to be smaller than in the normal mode.

10. An image-forming apparatus comprising:

a process motor;

a sheet conveying device configured to convey a sheet in a sheet conveying direction;

a first photosensitive drum rotatable upon receipt of a driving force from the process motor;

a second photosensitive drum rotatable upon receipt of the driving force from the process motor and positioned downstream of the first photosensitive drum in the sheet conveying direction;

a developing motor;

a first developing roller rotatable upon receipt of a driving force from the developing motor, the first developing roller being movable between a contact position in contact with the first photosensitive drum and a separated position away from the first photosensitive drum;

a second developing roller rotatable upon receipt of the driving force from the developing motor, the second developing roller being movable between a contact position in contact with the second photosensitive drum and a separated position away from the second photosensitive drum;

a first cam rotatable in a prescribed rotational direction upon receipt of the driving force from the developing motor, rotations of the first cam causing the first developing roller to move between the contact position and the separated position;

a second cam rotatable in the prescribed rotational direction upon receipt of the driving force from the developing motor, rotations of the second cam causing the second developing roller to move:

from the separated position to the contact position after movement of the first developing roller from the separated position to the contact position; and

from the contact position to the separated position after movement of the first developing roller from the contact position to the separated position;

a switching mechanism switchable between a transmission state and a cut-off state to control transmission of the driving force from the developing motor to the first cam and the second cam, the transmission state allowing the transmission of the driving force from the developing motor to the first cam and the second cam, the cut-off state preventing the transmission of the driving force from the developing motor to the first cam and the second cam; and

a controller configured to control rotations of the developing motor and the process motor to execute a first mode and a second mode, the controller being configured to rotate the developing motor at a first rotation speed and rotate the process motor at a second rotation speed in the first mode, and the controller being configured to rotate the developing motor at a third rotation speed different from the first rotation speed and rotate the process motor at the second rotation speed in the second mode.

11. The image-forming apparatus according to claim **10**, wherein the third rotation speed is slower than the first rotation speed.

12. The image-forming apparatus according to claim **11**, wherein the sheet conveying device is configured to convey the sheet upon receipt of the driving force from the process motor, and

wherein,

for moving each of the first developing roller and the second developing roller from the separated position to the contact position,

the controller is configured to control the switching mechanism to be in the transmission state such that a timing at which the second developing roller comes in contact with the second photosensitive drum in the second mode is coincident with or earlier than a timing at which the second developing roller comes in contact with the second photosensitive drum in the first mode.

13. The image-forming apparatus according to claim **10**, wherein the third rotation speed is higher than the first rotation speed.

14. The image-forming apparatus according to claim **13**, wherein the sheet conveying device is configured to convey the sheet upon receipt of the driving force from the process motor, and

wherein, for moving each of the first developing roller and the second developing roller from the separated position to the contact position,

the controller is configured to control the switching mechanism to be in the transmission state such that a timing at which the first developing roller comes in contact with the first photosensitive drum in the second mode is coincident with or earlier than a timing at which the first developing roller comes in contact with the first photosensitive drum in the first mode.

15. An image-forming apparatus comprising:

a first photosensitive drum;

a first developing roller movable between a first contact position where the first developing roller is in contact with the first photosensitive drum and a first separated position where the first developing roller is separated from the first photosensitive drum;

a first cam for moving the first developing roller between the first contact position and the first separated position;

a second photosensitive drum;

a second developing roller movable between a second contact position where the second developing roller is in contact with the second photosensitive drum and a second separated position where the second developing roller is separated from the second photosensitive drum;

a second cam for moving the second developing roller between the second contact position and the second separated position;

a process motor for driving the first photosensitive drum and the second photosensitive drum;

a developing motor for driving the first developing roller, the first cam, the second developing roller, and the second cam; and

a controller configured to control the developing motor, the process motor, the first cam and the second cam, the controller being configured to control the developing motor and the process motor in:

a first mode in which the process motor rotates at a first process speed and the developing motor rotates at a first developing speed; and

a second mode in which the process motor rotates at a second process speed and the developing motor rotates at a second developing speed slower than the first developing speed, a ratio of the first process speed to the first developing speed in the first mode being different from a ratio of the second process speed to the second developing speed in the second mode.

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