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(54) **MEDIUM CONVEYING DEVICE, MEDIUM FEEDING METHOD, AND CONTROL PROGRAM**

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(57) **ABSTRACT**

A medium conveying apparatus includes a feed roller to feed a medium, a separation roller located to face the feed roller, a regulating guide provided to be movable between a first position where contact of the medium with the feed roller and the separation roller is regulated and a second position where contact of the medium with the feed roller and the separation roller is not regulated, and a processor to control the feed roller, the separation roller, and the regulating guide. When feeding of a medium is started, the processor controls the feed roller, the separation roller, and the regulating guide such that the feed roller feeds the medium after the regulating guide moves from the first position toward the second position and the separation roller contacts the medium.

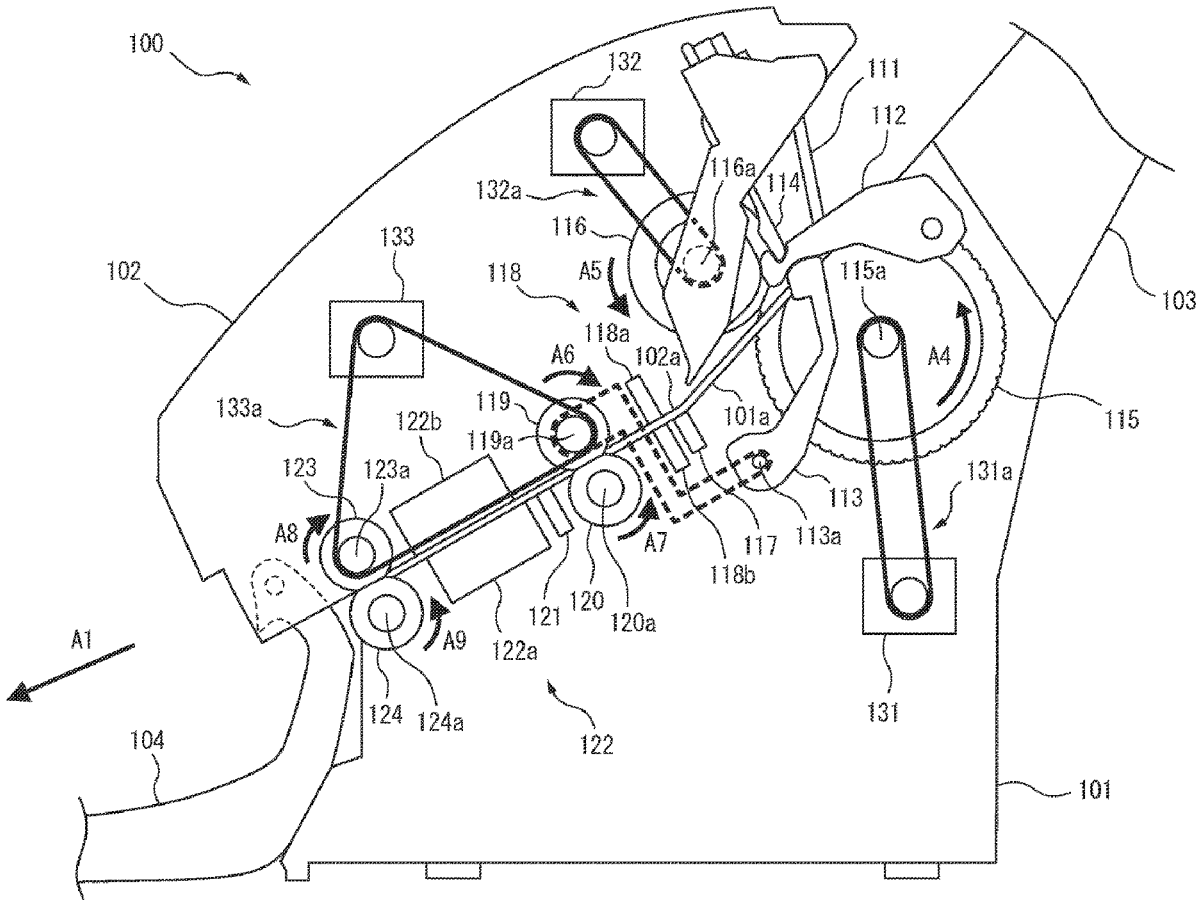
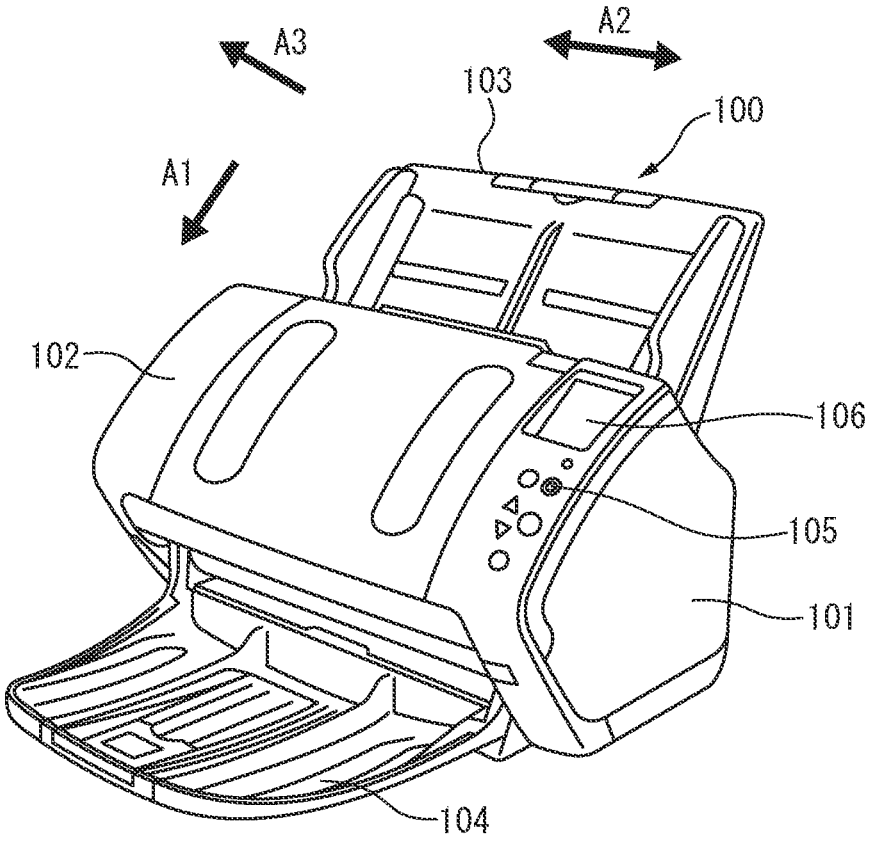


FIG. 1



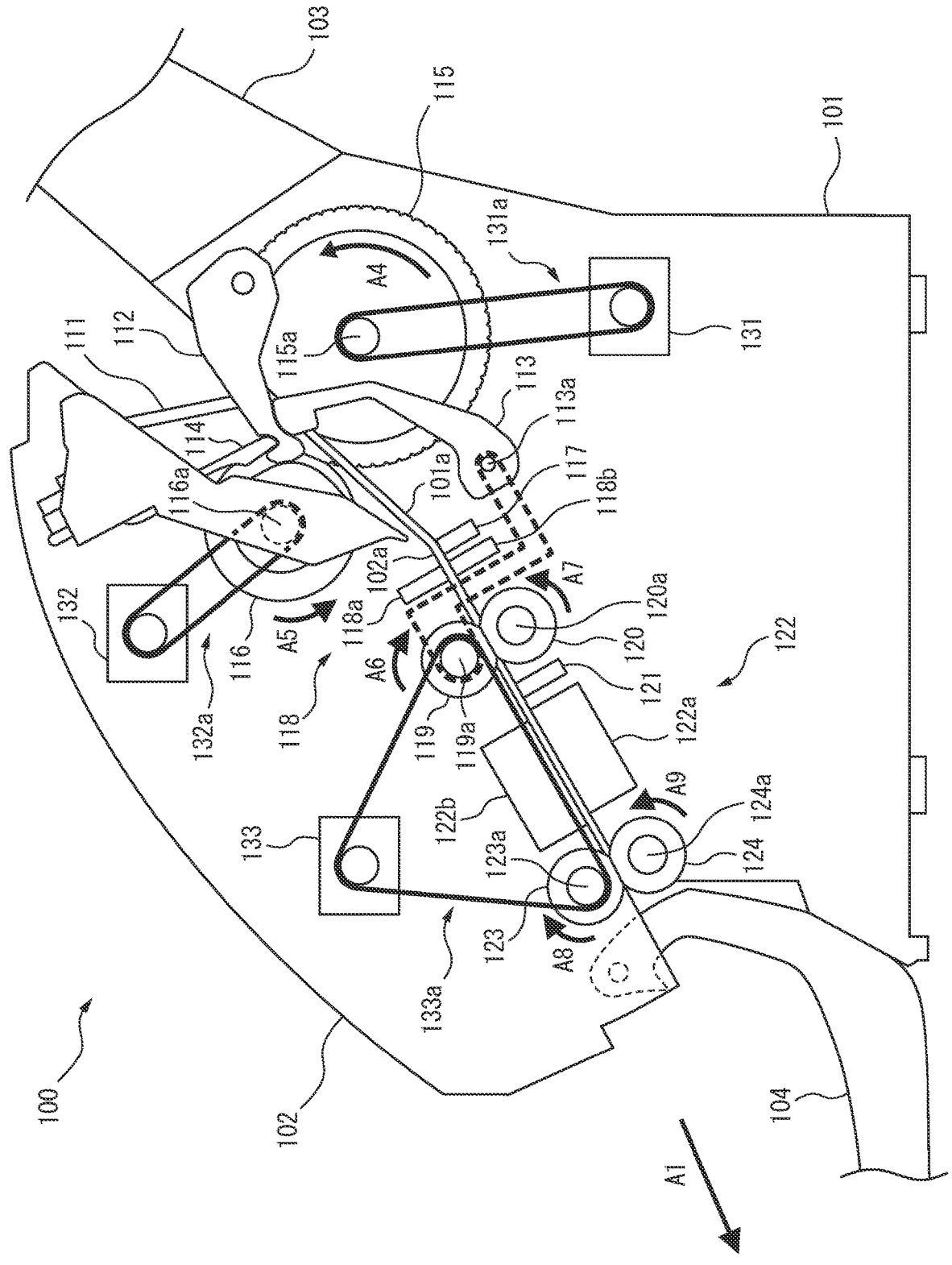

100
101
101a
102
102a
103
104
111
112
113
113a
114
115
115a
116
116a
117
118
118a
118b
119
119a
120
120a
121
122
122a
122b
123
123a
124
124a
131
131a
132
132a
133
133a
A1
A4
A5
A6
A7
A8
A9

FIG. 2

FIG. 3

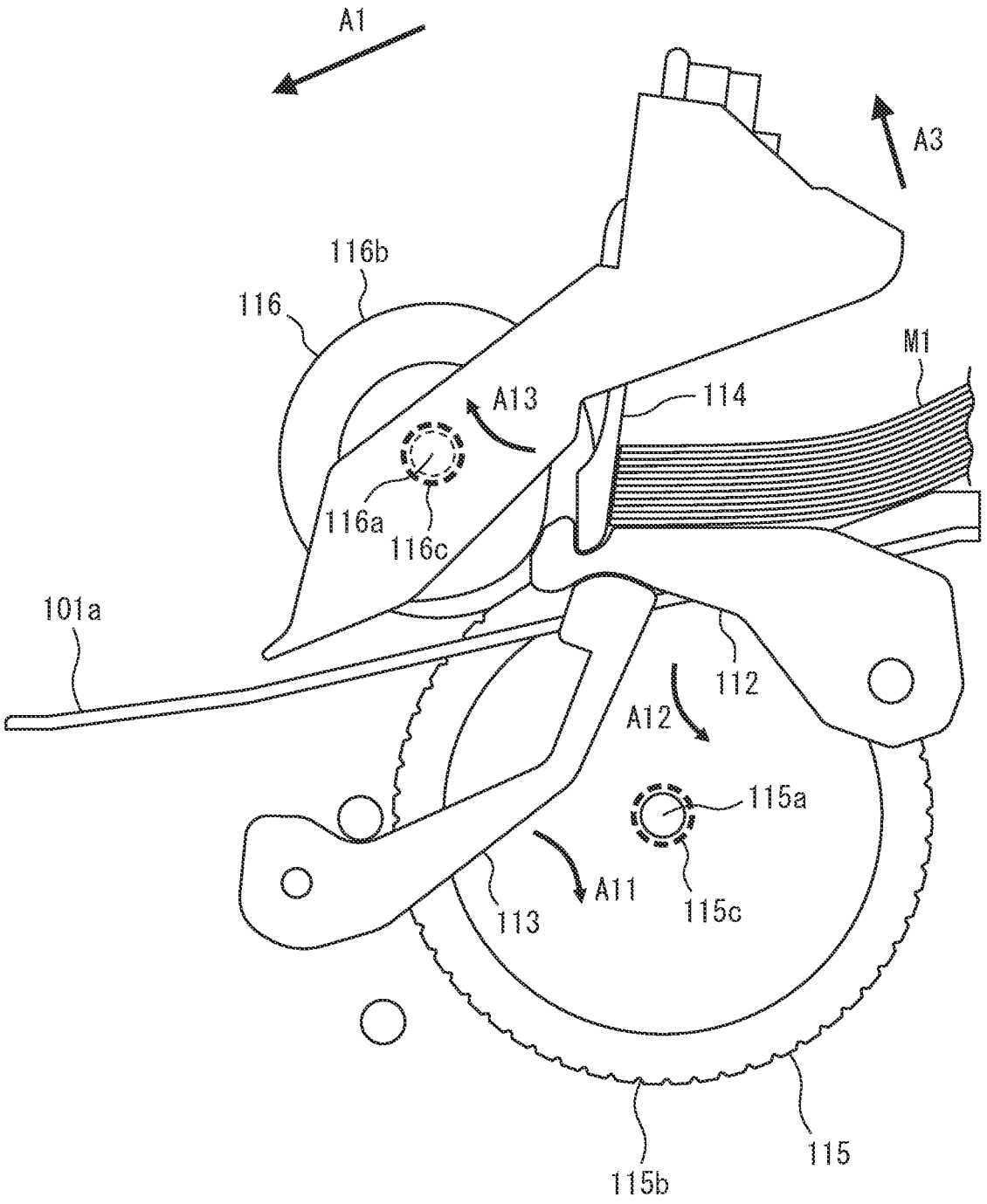

A1
A3
116b
116
M1
A13
114
116a
116c
101a
112
A12
115a
A11
113
115c
115
115b

FIG. 4

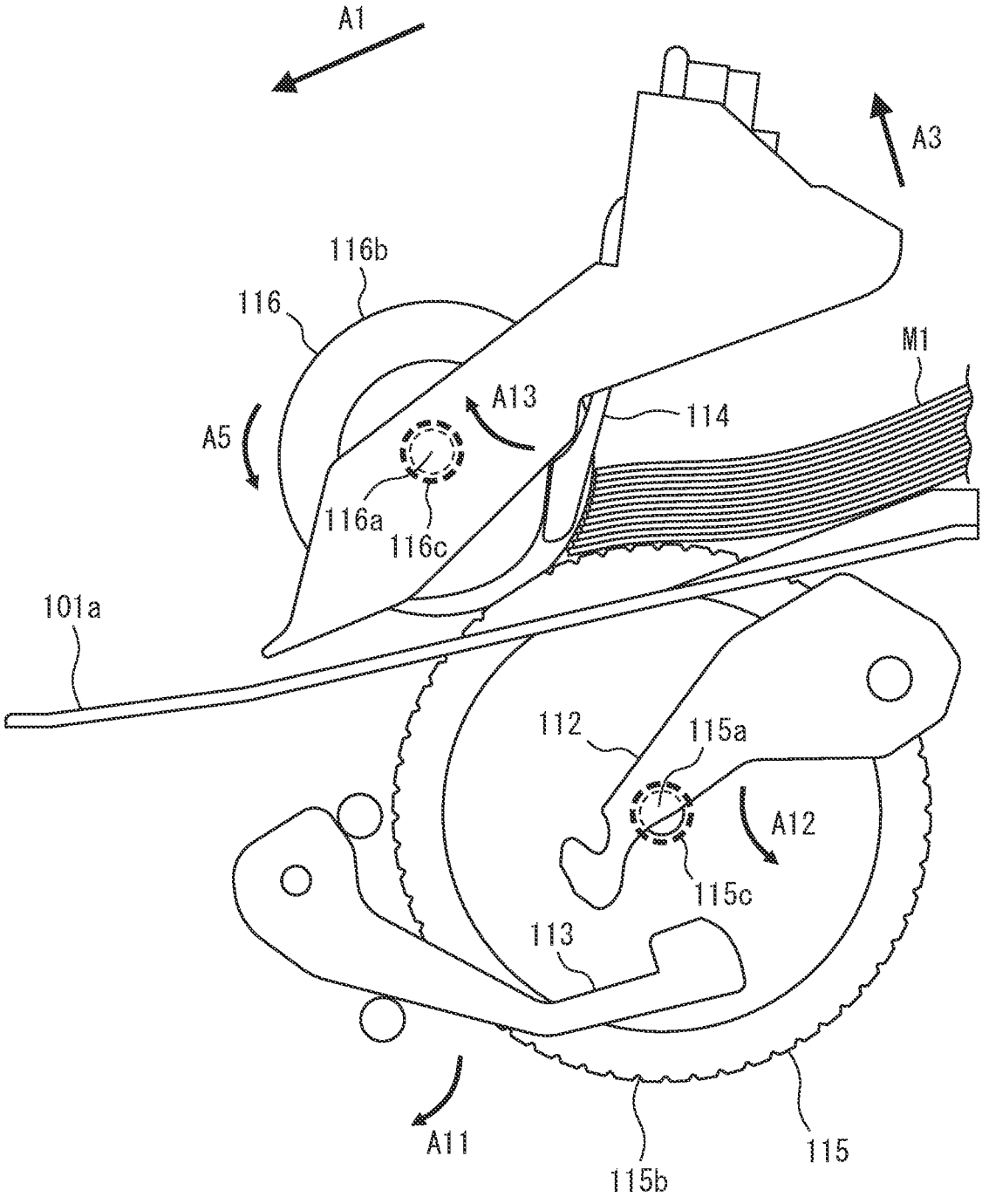

A1
A3
116b
116
M1
A13
A5
114
116a
116c
101a
112
115a
A12
115c
113
A11
115b
115

FIG. 5

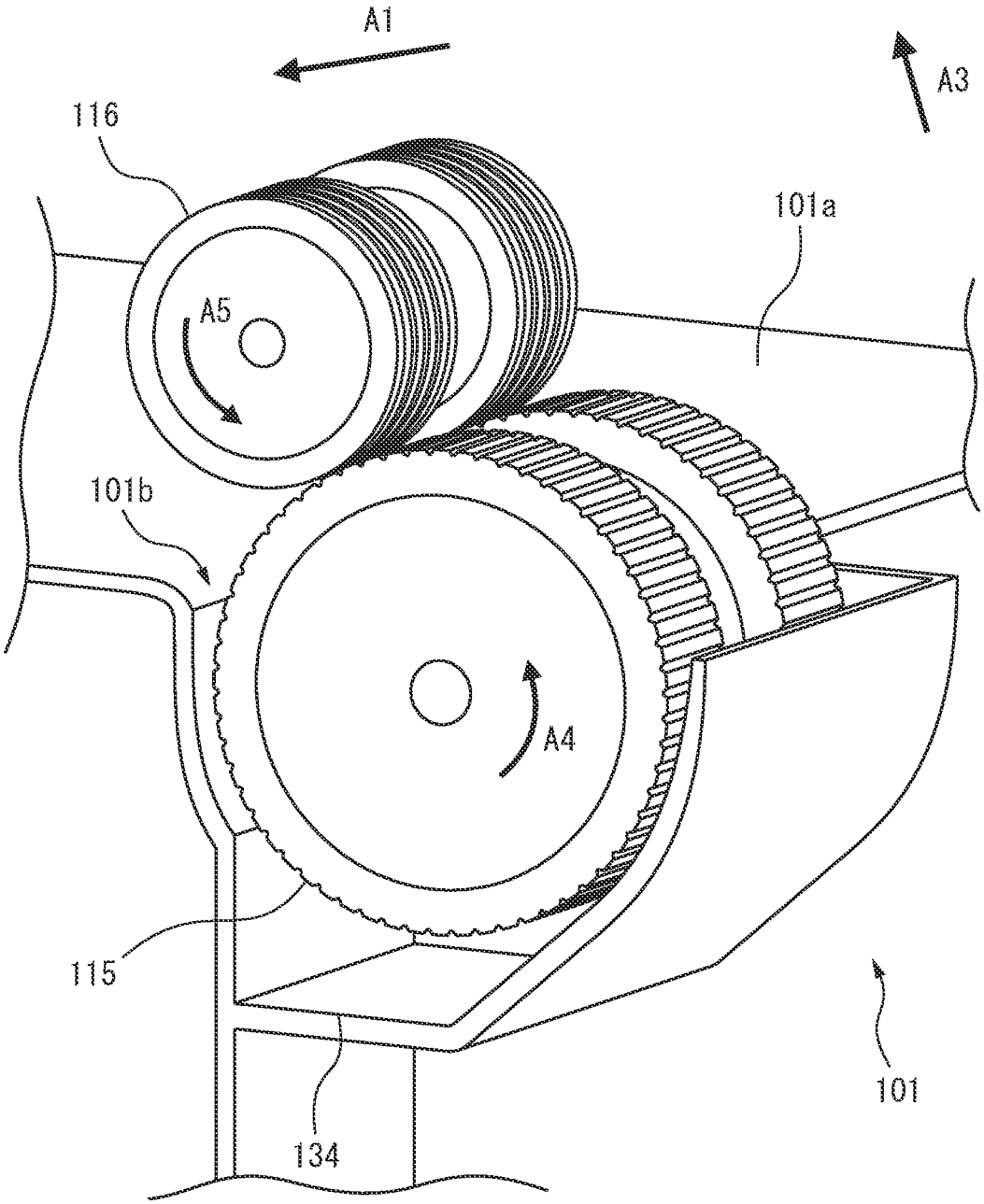


FIG. 6

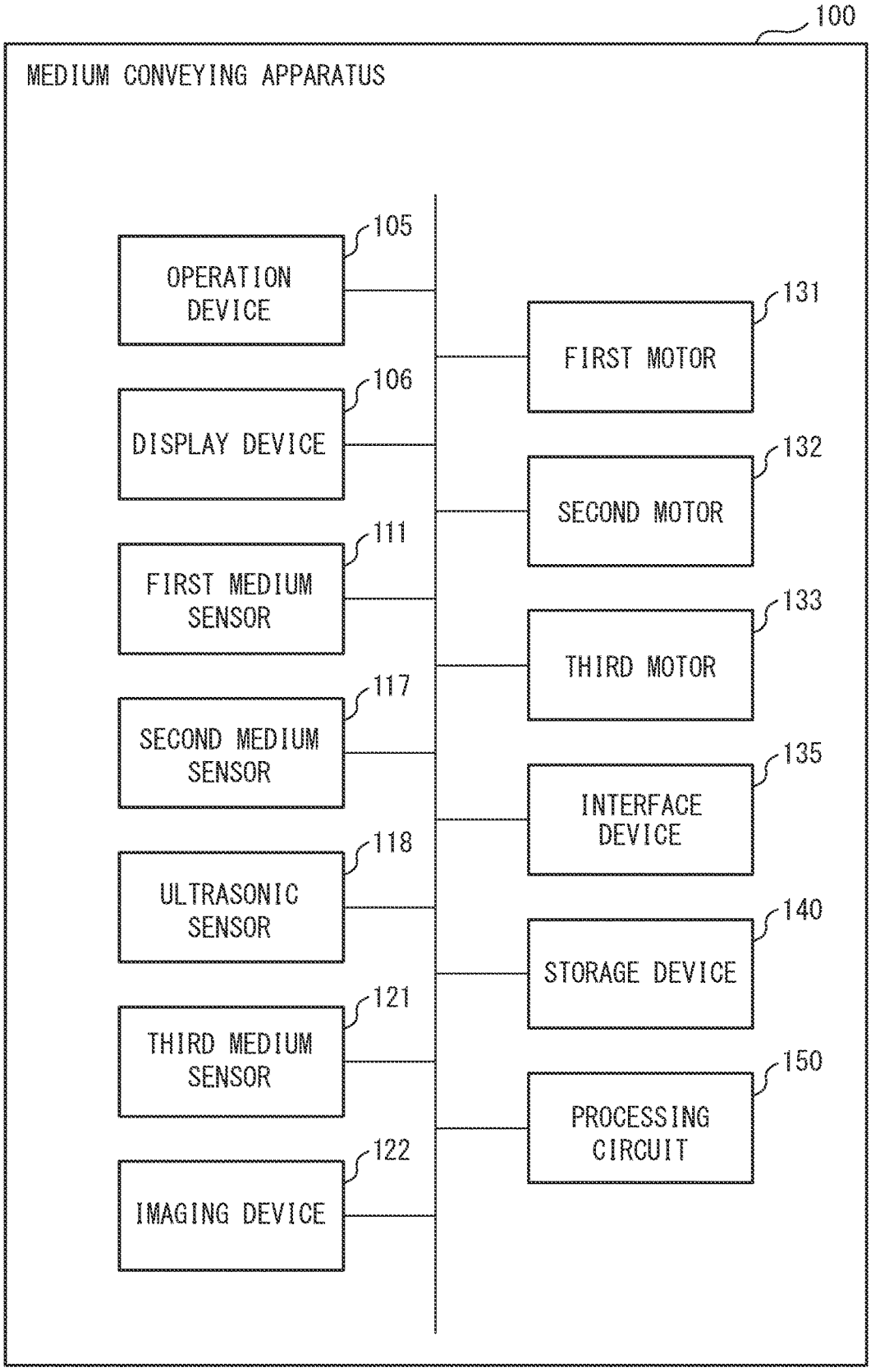

100
MEDIUM CONVEYING APPARATUS
105
OPERATION DEVICE
106
DISPLAY DEVICE
111
FIRST MEDIUM SENSOR
117
SECOND MEDIUM SENSOR
118
ULTRASONIC SENSOR
121
THIRD MEDIUM SENSOR
122
IMAGING DEVICE
131
FIRST MOTOR
132
SECOND MOTOR
133
THIRD MOTOR
135
INTERFACE DEVICE
140
STORAGE DEVICE
150
PROCESSING CIRCUIT

FIG. 7

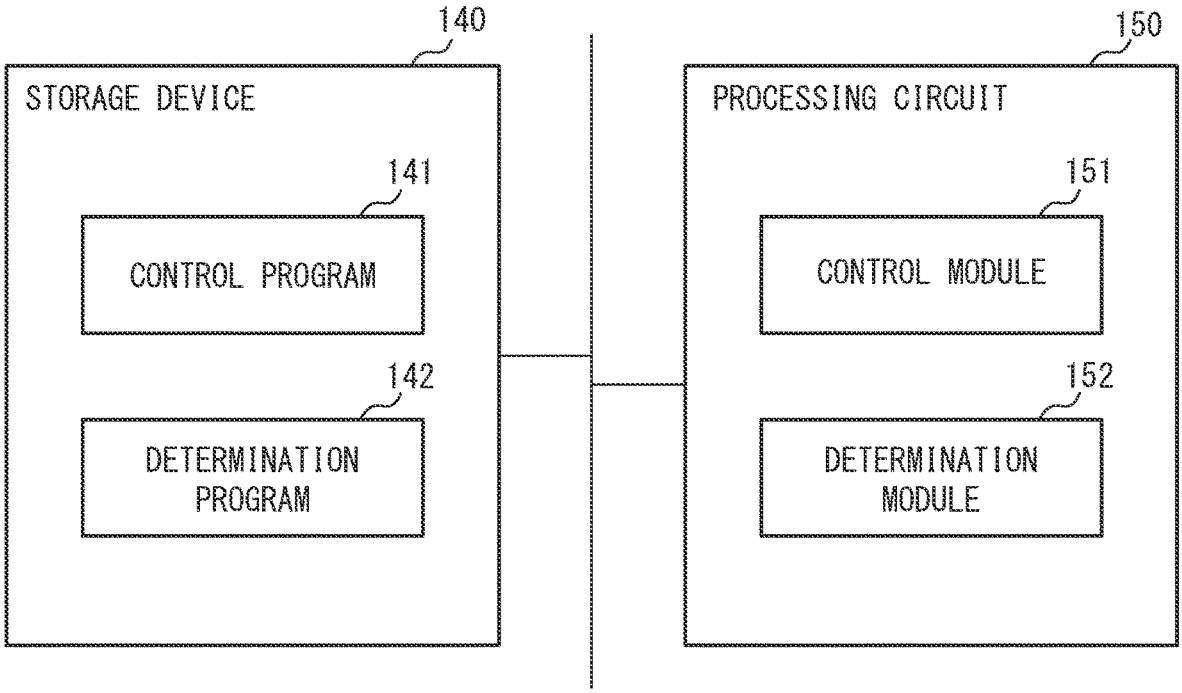

140
STORAGE DEVICE
141
CONTROL PROGRAM
142
DETERMINATION PROGRAM
150
PROCESSING CIRCUIT
151
CONTROL MODULE
152
DETERMINATION MODULE

FIG. 8

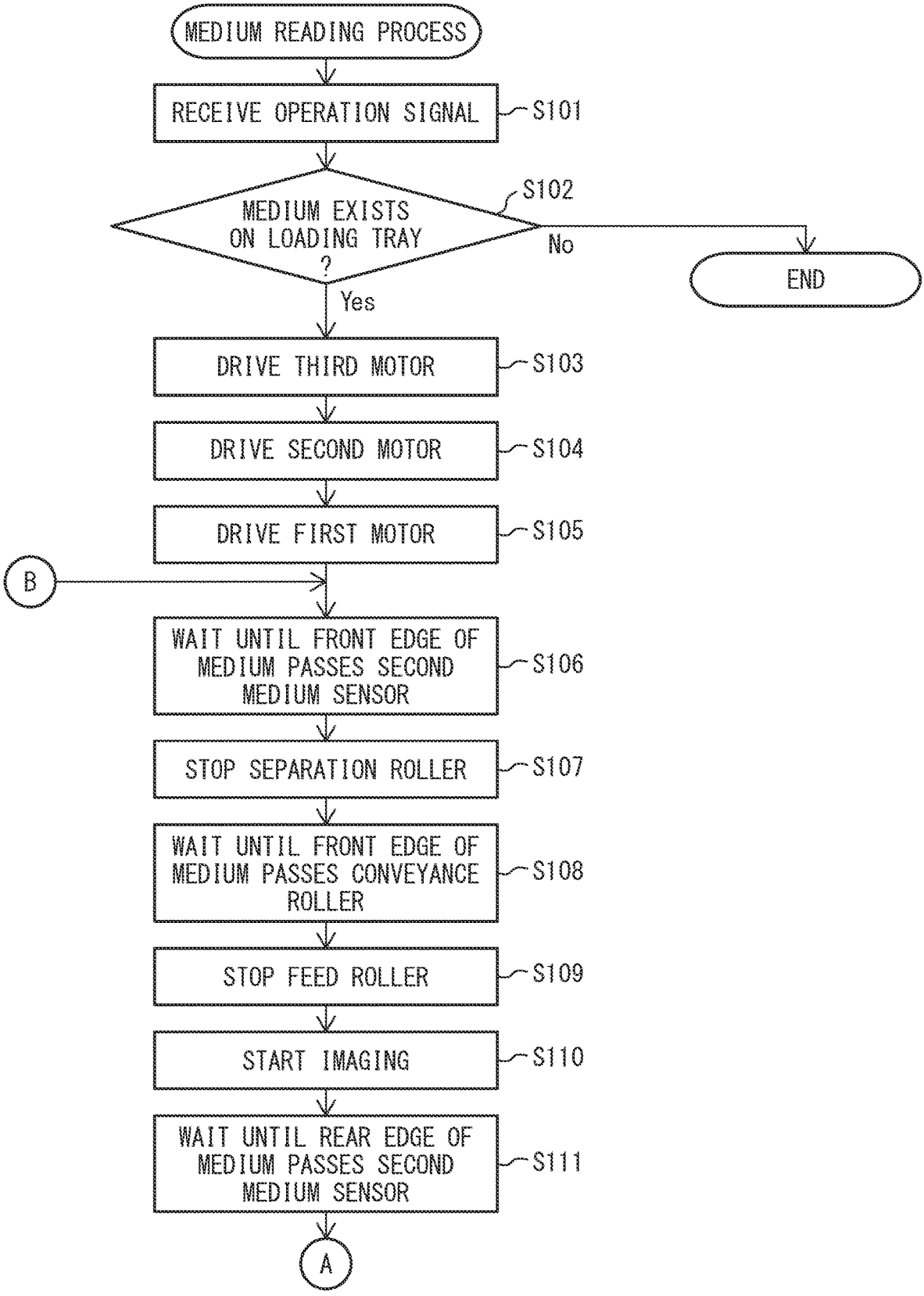

MEDIUM READING PROCESS
RECEIVE OPERATION SIGNAL
S101
MEDIUM EXISTS ON LOADING TRAY ?
S102
No
END
Yes
DRIVE THIRD MOTOR
S103
DRIVE SECOND MOTOR
S104
DRIVE FIRST MOTOR
S105
B
WAIT UNTIL FRONT EDGE OF MEDIUM PASSES SECOND MEDIUM SENSOR
S106
STOP SEPARATION ROLLER
S107
WAIT UNTIL FRONT EDGE OF MEDIUM PASSES CONVEYANCE ROLLER
S108
STOP FEED ROLLER
S109
START IMAGING
S110
WAIT UNTIL REAR EDGE OF MEDIUM PASSES SECOND MEDIUM SENSOR
S111
A

FIG. 9

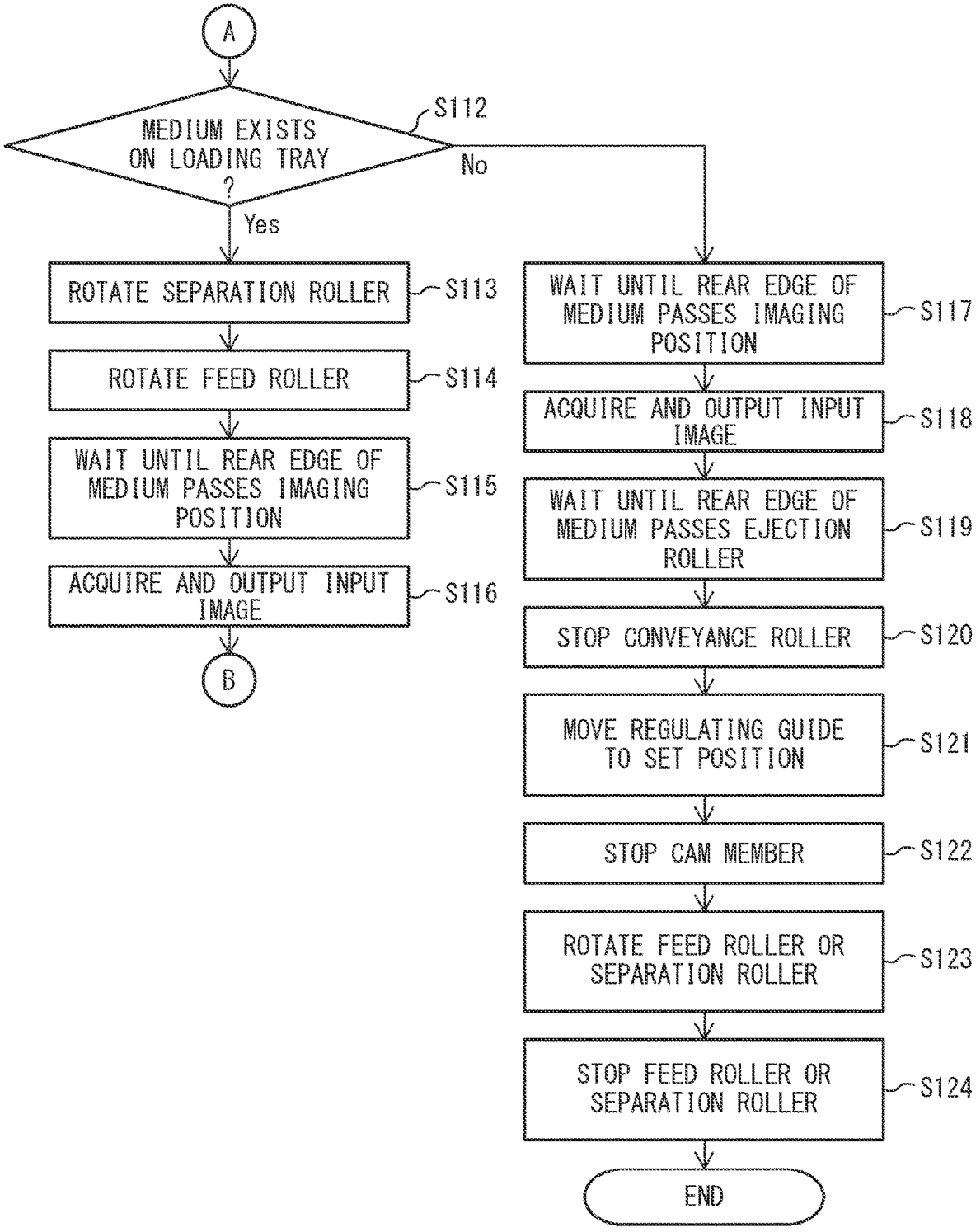

A
MEDIUM EXISTS ON LOADING TRAY ?
S112
No
Yes
ROTATE SEPARATION ROLLER
S113
ROTATE FEED ROLLER
S114
WAIT UNTIL REAR EDGE OF MEDIUM PASSES IMAGING POSITION
S115
ACQUIRE AND OUTPUT INPUT IMAGE
S116
B
WAIT UNTIL REAR EDGE OF MEDIUM PASSES IMAGING POSITION
S117
ACQUIRE AND OUTPUT INPUT IMAGE
S118
WAIT UNTIL REAR EDGE OF MEDIUM PASSES EJECTION ROLLER
S119
STOP CONVEYANCE ROLLER
S120
MOVE REGULATING GUIDE TO SET POSITION
S121
STOP CAM MEMBER
S122
ROTATE FEED ROLLER OR SEPARATION ROLLER
S123
STOP FEED ROLLER OR SEPARATION ROLLER
S124
END

FIG. 10

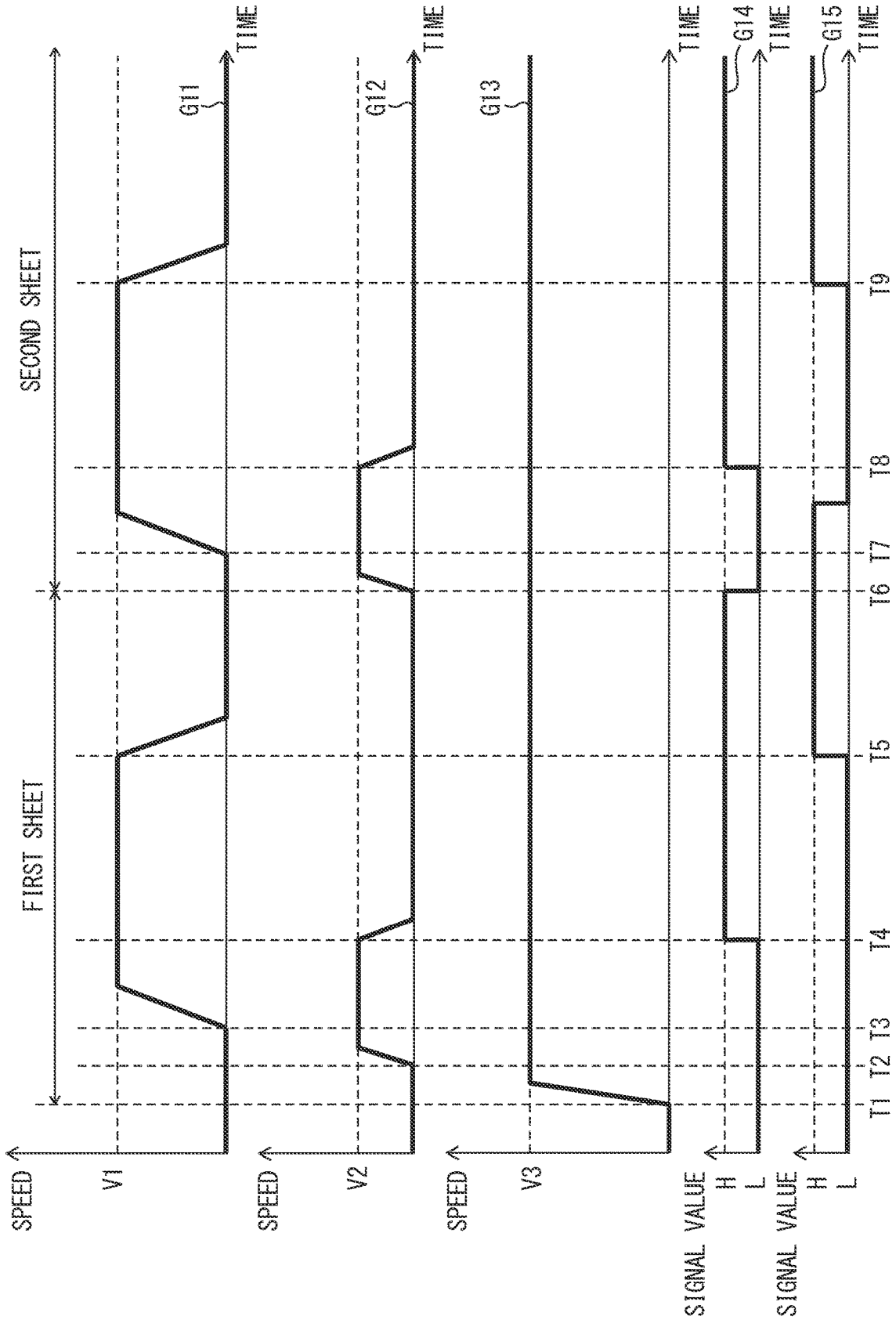

SECOND SHEET
FIRST SHEET
SPEED
V1
G11
TIME
SPEED
V2
G12
TIME
SPEED
V3
G13
TIME
SIGNAL VALUE
H
L
G14
TIME
SIGNAL VALUE
H
L
G15
TIME
T1 T2 T3 T4 T5 T6 T7 T8 T9

FIG. 11

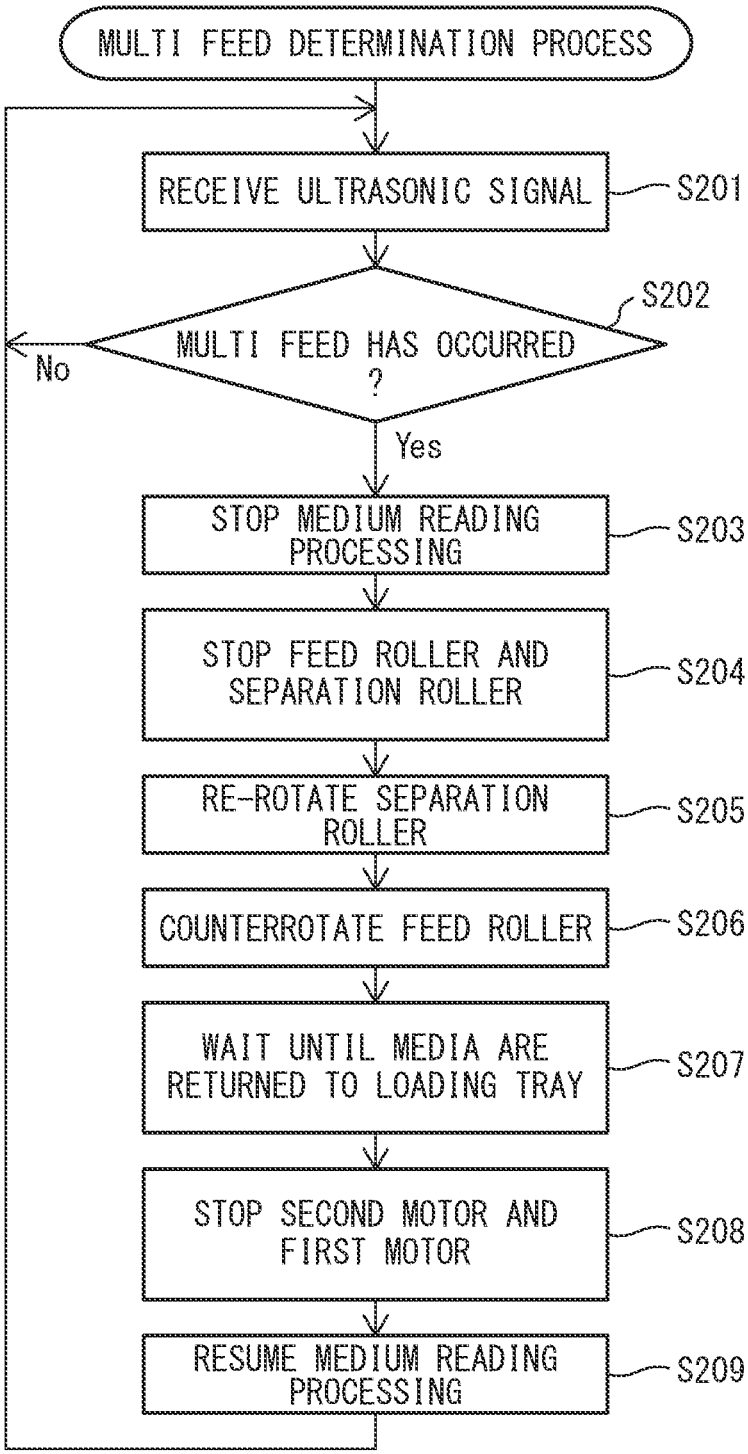
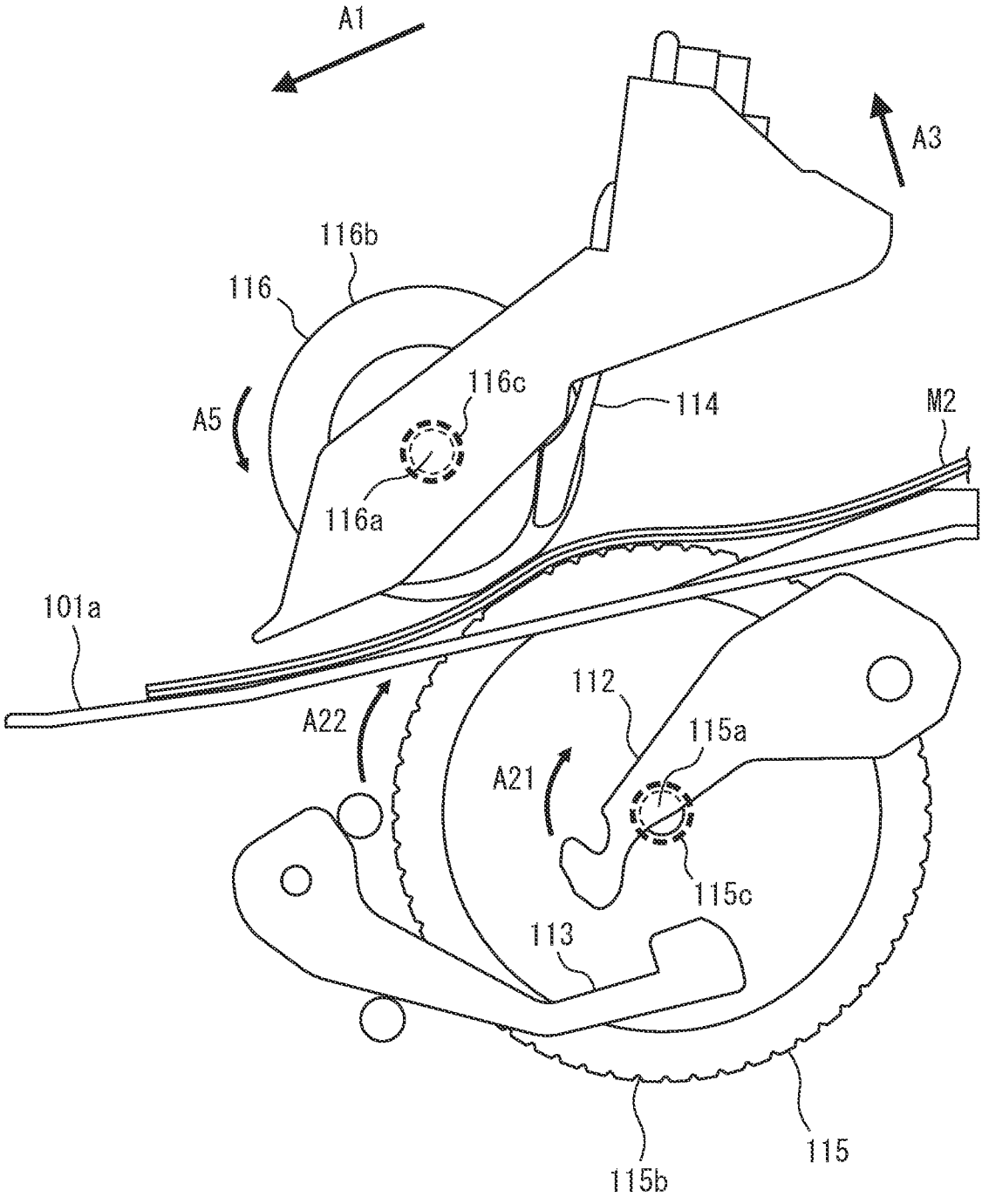

MULTI FEED DETERMINATION PROCESS
RECEIVE ULTRASONIC SIGNAL
S201
S202
MULTI FEED HAS OCCURRED ?
No
Yes
STOP MEDIUM READING PROCESSING
S203
STOP FEED ROLLER AND SEPARATION ROLLER
S204
RE-ROTATE SEPARATION ROLLER
S205
COUNTERROTATE FEED ROLLER
S206
WAIT UNTIL MEDIA ARE RETURNED TO LOADING TRAY
S207
STOP SECOND MOTOR AND FIRST MOTOR
S208
RESUME MEDIUM READING PROCESSING
S209

FIG. 12


A1
A3
116b
116
116c
A5
114
M2
116a
101a
112
A22
115a
A21
115c
113
115
115b

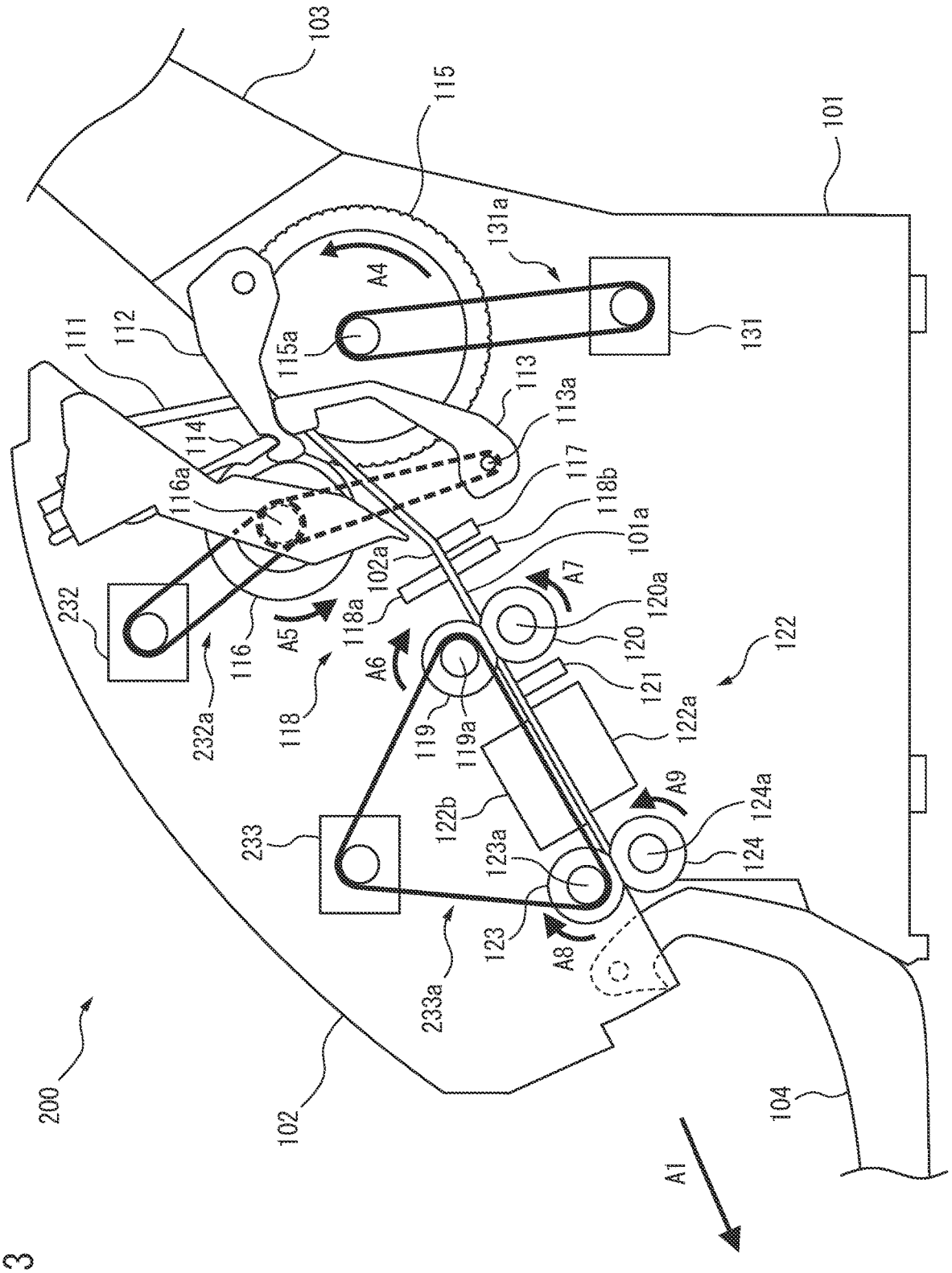
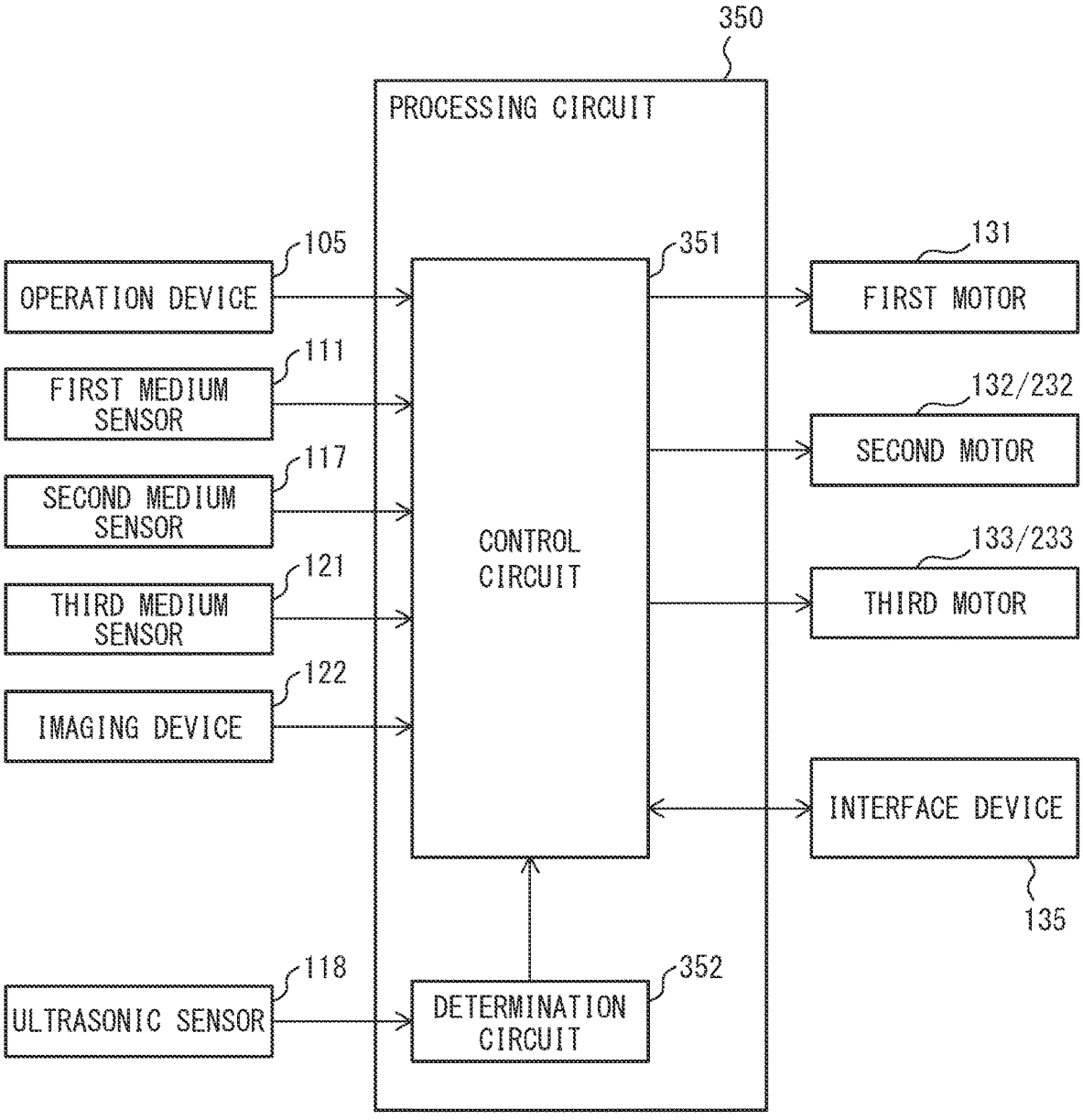

103
115
101
131a
A4
111
112
115a
131
113
113a
114
116a
117
118b
101a
102a
A7
232
118a
120a
A5
120
116
A6
122
121
232a
118
119
119a
122a
A9
122b
124a
233
123a
124
123
A8
233a
200
102
104
A1

FIG. 13

FIG. 14


350
PROCESSING CIRCUIT
105
OPERATION DEVICE
111
FIRST MEDIUM SENSOR
117
SECOND MEDIUM SENSOR
121
THIRD MEDIUM SENSOR
122
IMAGING DEVICE
118
ULTRASONIC SENSOR
351
CONTROL CIRCUIT
352
DETERMINATION CIRCUIT
131
FIRST MOTOR
132/232
SECOND MOTOR
133/233
THIRD MOTOR
INTERFACE DEVICE
135

MEDIUM CONVEYING DEVICE, MEDIUM FEEDING METHOD, AND CONTROL PROGRAM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation application of International Application No. PCT/JP2022/003421, filed on Jan. 28, 2022, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a medium conveying apparatus, a medium feeding method, and a control program.

BACKGROUND

[0003] In a medium conveying apparatus such as a scanner that sequentially feed and image a plurality of media while separating the media, it is preferable to more satisfactorily separate media in order not to cause multi feed of media.

[0004] A document separation apparatus including a feed roller, a reverse roller, a lever to detect a document on a document table, and a reading motor to rotate the reverse roller, based on detection information of the lever, is known. In the document separation apparatus, when the reading motor detects a document on the document table by the lever, the document separation apparatus rotates the reverse roller without rotating the feed roller.

[0005] A feeding apparatus including a supporting part that supports a medium set on a setting part and, when feeding a medium by a feed roller, moves such that the medium comes into contact with the feed roller is known. In the document feeding apparatus, when feeding the medium by the feed roller, the feeding apparatus drives the feed roller before movement of the supporting part.

SUMMARY

[0006] A medium conveying apparatus according to an embodiment includes a feed roller to feed a medium, a separation roller located to face the feed roller, a regulating guide provided to be movable between a first position where contact of the medium with the feed roller and the separation roller is regulated and a second position where contact of the medium with the feed roller and the separation roller is not regulated, and a processor to control the feed roller, the separation roller, and the regulating guide. When feeding of a medium is started, processor controls the feed roller, the separation roller, and the regulating guide such that the feed roller feeds the medium after the regulating guide moves from the first position toward the second position and the separation roller contacts the medium.

[0007] A method for feeding a medium according to an embodiment includes, when feeding of a medium is started, controlling a feed roller for feeding a medium, a separation roller located to face the feed roller, and a regulating guide provided to be movable between a first position where contact of the medium with the feed roller and the separation roller is regulated and a second position where contact of the medium with the feed roller and the separation roller is not regulated such that the feed roller feeds the medium after the regulating guide moves from the first position toward the second position and the separation roller contacts the medium

[0008] A computer-readable, non-transitory medium storing executable instructions for feeding a medium according to an embodiment includes, when feeding of a medium is started, controlling a feed roller for feeding a medium, a separation roller located to face the feed roller, and a regulating guide provided to be movable between a first position where contact of the medium with the feed roller and the separation roller is regulated and a second position where contact of the medium with the feed roller and the separation roller is not regulated such that the feed roller feeds the medium after the regulating guide moves from the first position toward the second position and the separation roller contacts the medium.

BRIEF DESCRIPTION OF DRAWINGS

[0009] FIG. **1** is a perspective view illustrating a medium conveying apparatus according to an embodiment.

[0010] FIG. **2** is a diagram for illustrating a conveyance path inside the medium conveying apparatus.

[0011] FIG. **3** is a schematic diagram for illustrating a regulating guide, etc.

[0012] FIG. **4** is a schematic diagram for illustrating operation of the regulating guide.

[0013] FIG. **5** is a schematic diagram for illustrating a holding part.

[0014] FIG. **6** is a block diagram illustrating a schematic configuration of the medium conveying apparatus.

[0015] FIG. **7** is a diagram illustrating a schematic configuration of a storage device and a processing circuit.

[0016] FIG. **8** is a flowchart illustrating an operation example of medium reading process.

[0017] FIG. **9** is a flowchart illustrating the operation example of the medium reading process.

[0018] FIG. **10** is a graph for illustrating changes in the speeds of a feed roller, etc.

[0019] FIG. **11** is a flowchart illustrating an operation example of multi feed determination process.

[0020] FIG. **12** is a schematic diagram for illustrating an operation of returning a medium to a loading tray.

[0021] FIG. **13** is a diagram for illustrating a conveyance path inside another medium conveying apparatus.

[0022] FIG. **14** is a diagram illustrating a schematic configuration of another processing circuit.

DESCRIPTION OF EMBODIMENTS

[0023] The object and advantages of the invention will be realized and attained by means of the elements and combinations, in particular, described in the claims. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory, and are not restrictive of the invention as claimed.

[0024] Hereinafter, a medium conveying apparatus, a method for feeding a medium, and a computer-readable, non-transitory medium storing executable instructions according to an embodiment, will be described with reference to the drawings. However, it should be noted that the technical scope of the invention is not limited to these embodiments, and extends to the inventions described in the claims and their equivalents.

[0025] FIG. **1** is a perspective view illustrating an example of a medium conveying apparatus configured as an image scanner. The medium conveying apparatus **100** conveys and images a medium being a document. Examples of a medium include paper, thin paper, thick paper, a card, a booklet, and a passport. The medium conveying apparatus **100** may be a facsimile, a copying machine, a multifunctional peripheral (MFP), etc. A conveyed medium may be an object being printed on, etc., instead of a document, and the medium conveying apparatus **100** may be a printer, etc.

[0026] The medium conveying apparatus **100** includes a lower housing **101**, an upper housing **102**, a loading tray **103**, an ejection tray **104**, an operation device **105**, a display device **106**, etc. In FIG. **1**, an arrow A**1** indicates a medium conveying direction, an arrow A**2** indicates a width direction perpendicular to the medium conveying direction, and an arrow A**3** indicates a high direction perpendicular to the medium conveying direction A**1** and the width direction. Hereinafter, upstream refers to upstream in the medium conveying direction A**1**, and downstream refers to downstream in the medium conveying direction A**1**.

[0027] The upper housing **102** is located at a position covering the top surface of the medium conveying apparatus **100** and is engaged with the lower housing **101** to be rotatable by a hinge to be openable when, for example, a medium is stuck or cleaning of the inside of the medium conveying apparatus **100** is performed.

[0028] The loading tray **103** is engaged with the lower housing **101** and places a medium to be fed and conveyed. The ejection tray **104** is engaged with the upper housing **102** and places an ejected medium. The ejection tray **104** may be engaged with the lower housing **101**.

[0029] The operation device **105** includes an input device such as a button, and an interface circuit acquiring a signal from the input device, accepts an input operation by a user, and outputs an operation signal based on the input operation by the user. The display device **106** includes a display including a liquid crystal, an organic electro-luminescence (EL), etc., and an interface circuit outputting image data to the display, and displays the image data on the display.

[0030] FIG. **2** is a diagram illustrating a conveyance path inside the medium conveying apparatus.

[0031] The conveyance path inside the medium conveying apparatus **100** includes a first medium sensor **111**, a regulating guide **112**, a cam member **113**, a flap **114**, a feed roller **115**, a separation roller **116**, a second medium sensor **117**, an ultrasonic sensor **118**, a conveyance roller **119**, a first facing roller **120**, a third medium sensor **121**, an imaging device **122**, an ejection roller **123**, and a second facing roller **124**, etc.

[0032] Each of the numbers of the feed roller **115**, the separation roller **116**, the conveyance roller **119**, the first facing roller **120**, the ejection roller **123**, and/or the second facing roller **124** is not limited to one and may be more than one. In that case, a plurality of feed rollers **115**, separation rollers **116**, conveyance rollers **119**, first facing rollers **120**, ejection rollers **123**, and/or second facing rollers **124** are respectively spaced in the width direction A**2** perpendicular to the medium conveying direction.

[0033] The top surface of the lower housing **101** forms a lower guide **101***a* of the conveyance path of a medium, and the bottom surface of the upper housing **102** forms an upper guide **102***a* of the conveyance path of a medium.

[0034] The first medium sensor **111** is located on the upstream side of the feed roller **115** and the separation roller **116**. The first medium sensor **111** includes a contact detection sensor and detects whether a medium is placed on the loading tray **103**. The first medium sensor **111** generates and outputs a medium signal the signal value of which varies between a state in which a medium is placed on the loading tray **103** and a state in which a medium is not placed. The first medium sensor **111** is not limited to a contact detection sensor and any other sensor that can detect the presence of a medium, such as a light detection sensor, may be used as the first medium sensor **111**.

[0035] The feed roller **115** is provided in the lower housing **101**, sequentially feeds media placed on the loading tray **103** from the lower side. The separation roller **116** is a so-called brake roller or retard roller, is provided in the upper housing **102**, is located to face the feed roller **115**. The separation roller **113** is provided to be rotatable in a direction opposite to the medium feeding direction, or stoppable. The feed roller **115** may be provided in the upper housing **102**, and the separation roller **116** may be provided in the lower housing **101**.

[0036] The second medium sensor **117** is located on the downstream side of the feed roller **115** and on the upstream side of the conveyance roller **119**, and detects a medium conveyed to the position of the sensor. The second medium sensor **117** includes a light emitter and a light receiver that are provided on one side of the medium conveyance path and a light guide, provided at a position facing the light emitter and the light receiver with the medium conveyance path in between. The light emitter is a light emitting diode (LED), etc., and emits light toward the medium conveyance path. The light receiver is a photodiode, etc., and receives light emitted by the light emitter and guided by the light guide. When a medium is present at a position facing the second medium sensor **117**, light emitted from the light emitter is blocked by the medium, and therefore the light receiver does not detect the light emitted from the light emitter. The second medium sensor **117** generates and outputs a second medium signal, the signal value of which varies between a state in which a medium is present at the position of the second medium sensor **117** and a state in which a medium is not present, based on the intensity of light received by the light receiver.

[0037] A reflection member such as a mirror may be used in place of the light guide. Further, the light emitter and the light receiver may be provided to face each other with the medium conveyance path in between. Further, the second medium sensor **117** may detect existence of a medium by, for example, a contact detection sensor to pass predetermined current when a medium is in contact or when a medium is not in contact.

[0038] The ultrasonic sensor **118** is located on the downstream side of the feed roller **115** and in particular, on the downstream side of the second medium sensor **117** and on the upstream side of the conveyance roller **119**. The ultrasonic sensor **118** includes an ultrasonic transmitter **118***a* and an ultrasonic receiver **118***b*. The ultrasonic transmitter **118***a* and the ultrasonic receiver **118***b* are located close to the conveyance path of a medium to face each other with the conveyance path in between. The ultrasonic transmitter **118***a* transmits an ultrasonic wave. The ultrasonic receiver **118***b* receives an ultrasonic wave transmitted by the ultrasonic transmitter **118***a* and passing through a medium and gener-

ates and outputs an ultrasonic signal being an electric signal based on the received ultrasonic wave. When a plurality of media are conveyed in a stacked manner, an ultrasonic wave passing through the media is attenuated by an air layer between the media conveyed in a stacked manner. Accordingly, the medium conveying apparatus **100** can detect multi feed of media, based on the ultrasonic signal.

[0039] The conveyance roller **119** and the first facing roller **120** are located on the downstream side of the feed roller **112** in the medium conveying direction A**1** to face each other. The conveyance roller **119** is provided in the upper housing **102** and conveys a medium fed by the feed roller **115** and the separation roller **116** to the imaging device **122**. The conveyance roller **119** may be provided in the lower housing **101**, and the first facing roller **120** may be provided in the upper housing **102**.

[0040] The third medium sensor **121** is located on the downstream side of the conveyance roller **119** and on the upstream side of the imaging device **122**, and detects a medium conveyed to the position of the sensor. The third medium sensor **121** includes a light emitter and a light receiver that are provided on one side of the medium conveyance path and a light guide, provided at a position facing the light emitter and the light receiver with the medium conveyance path in between. The light emitter is an LED, etc., and emits light toward the medium conveyance path. The light receiver is a photodiode, etc., and receives light emitted by the light emitter and guided by the light guide. When a medium is present at a position facing the third medium sensor **121**, light emitted from the light emitter is blocked by the medium, and therefore the light receiver does not detect the light emitted from the light emitter. The third medium sensor **121** generates and outputs a third medium signal, the signal value of which varies between a state in which a medium is present at the position of the third medium sensor **121** and a state in which a medium is not present, based on the intensity of light received by the light receiver.

[0041] A reflection member such as a mirror may be used in place of the light guide. Further, the light emitter and the light receiver may be provided to face each other with the medium conveyance path in between. Further, the third medium sensor **121** may detect existence of a medium by, for example, a contact detection sensor to pass predetermined current when a medium is in contact or when a medium is not in contact.

[0042] The imaging device **122** is an example of an imaging module, is located on the downstream side of the conveyance roller **119** and the first facing roller **120** in the medium conveying direction A**1**, and images a medium conveyed by the conveyance roller **119** and the first facing roller **120**. The imaging device **122** includes a first imaging device **122***a* and a second imaging device **122***b* that are located to face each other with the medium conveyance path in between.

[0043] The first imaging device **122***a* includes a line sensor based on a unity-magnification optical system type contact image sensor (CIS) including complementary metal oxide semiconductor- (CMOS-) based imaging elements linearly arranged in a main scanning direction. The first imaging device **122***a* further includes lenses each forming an image on an imaging element, and an A/D converter amplifying and analog-digital (A/D) converting an electric signal output from the imaging element. The first imaging device **122***a* generates an input image by imaging the front side of a conveyed medium in accordance with control from a processing circuit described later and outputs the generated image.

[0044] The second imaging device **122***b* includes a line sensor based on a unity-magnification optical system type CIS including CMOS-based imaging elements linearly arranged in the main scanning direction. The second imaging device **122***b* further includes lenses each forming an image on an imaging element, and an A/D converter amplifying and analog-digital (A/D) converting an electric signal output from the imaging element. The second imaging device **122***b* generates an input image by imaging the back side of a conveyed medium in accordance with control from the processing circuit described later and outputs the generated image.

[0045] Only one of the first imaging device **122***a* and the second imaging device **122***b* may be located and only one side of a medium may be read in the medium conveying apparatus **100**.

[0046] Further, a line sensor based on a unity-magnification optical system type CIS including charge coupled device- (CCD-) based imaging elements may be used in place of the line sensor based on a unity-magnification optical system type CIS including CMOS-based imaging elements. Further, a reduction optical system type line sensor including CMOS-based or CCD-based imaging elements may be used. The image sensors may be located to face each other, or may not be located to face each other.

[0047] The ejection roller **123** and the second facing roller **124** are located on the downstream side of the imaging device **122**, i.e., on the downstream side of the conveyance roller **119** and the first facing roller **120** in the medium conveying direction A**1**, to face each other. The ejection roller **123** is provided in the upper housing **102**, conveys a medium conveyed by the conveyance roller **119** and the first facing roller **120** toward the further downstream side, and ejects it into the ejection tray **104**. The ejection roller **123** may be provided in the lower housing **101**, and the second facing roller **124** is provided in the upper housing **102**.

[0048] A medium placed on the loading tray **103** is conveyed between the lower guide **101***a* and the upper guide **102***a* toward the medium conveying direction A**1** by the feed roller **115** rotating in a direction of an arrow A**4**, i.e., the medium feeding direction. The medium conveying apparatus **100** includes a separation mode of separating and feeding a medium and a non-separation mode of feeding a medium without separation as feed modes. The feed mode is set by a user by using the operation device **105** or an information processing apparatus connected to the medium conveying apparatus **100** by communication. When the feed mode is set to the separation mode, the separation roller **116** rotates in a direction of an arrow A**5**, i.e., a direction opposite to the medium feeding direction or stops. When a plurality of media are placed on the loading tray **103**, only a medium in contact with the feed roller **115** of the medium placed on the loading tray **103** is separated by working of the feed roller **115** and the separation roller **116**. Consequently, conveyance of a medium other than the separated medium is restricted (prevention of multi feed). On the other hand, when the feed mode is set to the non-separation mode, the separation roller **116** rotates in a direction opposite to the arrow A**5**, i.e., the medium feeding direction.

[0049] A medium is fed between the conveyance roller **119** and the first facing roller **120** while being guided by the lower guide **101***a* and the upper guide **102***a*. The medium is fed between the first imaging device **122***a* and the second imaging device **122***b* by the conveyance roller **119** and the first facing roller **120** rotating in directions of an arrow A**6** and an arrow A**7**, respectively. The medium read by the imaging device **122** is ejected into the ejection tray **104** by the ejection roller **123** and the second facing roller **124** rotating in directions of an arrow A**8** and an arrow A**9**, respectively.

[0050] As illustrated in FIG. **2**, the medium conveying apparatus **100** includes a first motor **131**, a second motor **132**, and a third motor **133** as driving sources of the rollers.

[0051] The first motor **131** is provided in the lower housing **101**, is connected to the feed roller **115** through a first transmission mechanism **131***a*, and drives the feed roller **115**. The first motor **131** generates a driving force for driving the feed roller **115** in accordance with a control signal from a processing circuit. The first transmission mechanism **131***a* includes one or a plurality of pulleys, belts, gears, etc., provided between the first motor **131** and a shaft **115***a*being the rotation axis of the feed roller **115** and transmits the driving force generated by the first motor **131** to the feed roller **115**. The first motor **131** feeds a medium by rotating the feed roller **115**. The first motor **131** may be located in the upper housing **102**.

[0052] The second motor **132** is provided in the upper housing **102** separately from the first motor **131**, is connected to the separation roller **116** through a second transmission mechanism **132***a*, and drives the separation roller **116**. The second motor **132** generates a driving force for driving the separation roller **116** in accordance with a control signal from the processing circuit. The second transmission mechanism **132***a* includes one or a plurality of pulleys, belts, gears, etc., provided between the second motor **132** and a shaft **116***a* being the rotation axis of the separation roller **116**. The second transmission mechanism **132***a* transmits the driving force generated by the second motor **132** to the separation roller **116**. The second motor **132** separates, feeds, and conveys a medium by rotating the separation roller **116**. The second motor **132** may be located in the lower housing **101**.

[0053] The third motor **133** is provided in the upper housing **102** separately from the first motor **131** and the second motor **132**. The third motor **133** is connected to the conveyance roller **119**, the ejection roller **123**, and the cam member **113** through a third transmission mechanism **133***a* and drives the conveyance roller **119**, the ejection roller **123**, and the cam member **113**. The third motor **133** generates a driving force for driving the conveyance roller **119**, the ejection roller **123**, and the cam member **113** in accordance with a control signal from the processing circuit. The third transmission mechanism **133***a* includes one or a plurality of pulleys, belts, gears, etc., provided between the third motor **133**, and a shaft **119***a* being the rotation axis of the conveyance roller **119**, a shaft **123***a* being the rotation axis of the ejection roller **123** and the rotation axis **113***a* of the cam member **113**. The third transmission mechanism **133***a* transmits the driving force generated by the third motor **133** to the conveyance roller **119**, the ejection roller **123**, and the cam member **113**. The third motor **133** conveys and ejects a medium by rotating the conveyance roller **119** and the ejection roller **123**. In other words, the conveyance roller **119** and the ejection roller **123** are provided to be driven by the third motor **133**. Further, the third motor **133** moves the regulating guide **112** in contact with the cam member **113** by rotating the cam member **113**. The third motor **133** may be located in the lower housing **101**.

[0054] Thus, in the medium conveying apparatus **100**, a motor for driving the conveyance roller **119** and the ejection roller **123** and a motor for moving the regulating guide **112** may be common. Consequently, the medium conveying apparatus **100** can reduce the cost and weight of the apparatus by reducing the number of motors.

[0055] The first facing roller **120** is a driven roller driven to rotate by the conveyance roller **119**, and the second facing roller **124** is a driven roller driven to rotate by the ejection roller **123**.

[0056] The first facing roller **120** and/or the second facing roller **124** may be provided to be driven by the driving force from the third motor **133**. In that case, one or a plurality of gears are further provided between the shaft **119***a* of the conveyance roller **119** and a shaft **120***a* being the rotation axis of the first facing roller **120** and/or between the shaft **123***a* of the ejection roller **123** and a shaft **124***a* being the rotation axis of the second facing roller **124**. The third transmission mechanism **133***a* further transmits the driving force generated by the third motor **133** to the first facing roller **120** and/or the second facing roller **124**.

[0057] FIG. **3** is a schematic diagram for illustrating the regulating guide, the cam member, and the flap. FIG. **3** is a schematic diagram of the regulating guide, the cam member, and the flap viewed from the side before medium feeding.

[0058] As illustrated in FIG. **3**, the regulating guide **112** is a guide for setting a medium (group) M**1** placed on the loading tray **103**. The regulating guide **112** is located at a position facing the feed roller **115** and the separation roller **116** in the medium conveying direction A**1**. The regulating guide **112** is rotatably (swingably) supported by the lower housing **101** and, when feeding of the medium M**1** is not executed, supports the bottom surface of the medium M**1** placed on the loading tray **103**. The position where the regulating guide **112** supports the bottom surface of the medium M**1** placed on the loading tray **103** as illustrated in FIG. **3** maybe hereinafter referred to as a set position.

[0059] The cam member **113** is a moving member for moving the regulating guide **112**. The cam member **113** is located on the downstream side of the regulating guide **112** in the medium conveying direction A**1**. The cam member **113** is provided to be rotatable (swingable) by the third motor **133**. The cam member **113** is supported by the lower housing **101** to be rotatable according to the driving force from the third motor **133** and, when medium feeding is not executed, comes into contact with the downstream edge of the regulating guide **112** and holds the regulating guide **112** at the set position.

[0060] The flap **114** is a stopper for preventing the medium M**1** from entering a nip part of the feed roller **115** and the separation roller **116** before medium feeding. The flap **114** is located at a position facing the regulating guide **112** in the medium conveying direction A**1**. The flap **114** is swingably provided in the upper housing **102** and, when feeding of the medium M**1** is not executed, the flap **114** is engaged with the regulating guide **112** located at the set position and prevents entry of the medium M**1** into the nip part of the feed roller **115** and the separation roller **116**.

[0061] In other words, the regulating guide **112** at the set position regulates contact of the medium M**1** with the feed roller **115** and the separation roller **116**. The set position is an example of a first position.

[0062] FIG. **4** is a schematic diagram for illustrating operation of the regulating guide, the cam member, and the flap. FIG. **4** is a schematic diagram of the regulating guide, the cam member, and the flap viewed from the side at medium feeding.

[0063] As illustrated in FIG. **4**, when feeding of the medium M**1** is executed, the cam member **113** swings (rotates) downward (in a direction of an arrow A**11**) according to the driving force from the third motor **133** and separates from the downstream edge of the regulating guide **112**. By the downstream edge of the regulating guide separating from the cam member **113** and not being held by the cam member **113**, the regulating guide **112** swings below a medium conveyance surface (in a direction of an arrow A**12**) and separates from the bottom surface of the medium M**1** placed on the loading tray **103**. The position where the regulating guide **112** is separated from the bottom surface of the medium M**1** placed on the loading tray **103** as illustrated in FIG. **4** maybe hereinafter referred to as a release position. By the regulating guide **112** being located at the release position, the engagement between the flap **114** and the regulating guide **112** is released. Consequently, the flap **114** is pushed by the front edge of the medium M**1** placed on the loading tray **103** and swings to the downstream side (in a direction of an arrow A**13**), and the medium M**1** can enter the nip part of the feed roller **115** and the separation roller **116**. Thus, when the regulating guide **112** is located at the release position, the flap **114** allows entry of the medium M**1** into the nip part of the feed roller **115** and the separation roller **116**.

[0064] In other words, the regulating guide **112** at the release position does not regulate contact of the medium M**1** with the feed roller **115** and the separation roller **116**. The release position is an example of a second position. The regulating guide **112** is provided to be movable between the set position and the release position. The regulating guide **112** is provided to move by rotation of the cam member **113**.

[0065] As illustrated in FIG. **3** and FIG. **4**, the feed roller **115** is provided with an outer peripheral surface **115***b*, a one-way clutch **115***c*, etc. The one-way clutch **115***c* is located on the shaft **115***a* being the rotation axis of the feed roller **115**. The one-way clutch **115***c* prevents (the outer peripheral surface **115***b* of) the feed roller **115** from rotating in a direction opposite to the medium feeding direction A**4** relative to the shaft **115***a*. Consequently, the feed roller **115** is prevented from rotating in the direction opposite to the medium feeding direction A**4** due to being dragged by the separation roller **116** rotating in the direction A**5** opposite to the medium feeding direction.

[0066] The conveyance roller **119** conveys a medium at a conveyance speed greater than the feeding speed of the feed roller **115**. Accordingly, when a medium arrives at the position of the conveyance roller **119**, the medium is pulled by the conveyance roller **119** while being clamped by the feed roller **115** and the separation roller **116**. At this time, the outer peripheral surface **115***b* of the feed roller **115** rotates according to the clamped medium by the working of the one-way clutch **115***c* and does not hamper conveyance of the medium. The conveyance roller **119** may convey a medium at a conveyance speed being the same as the feeding speed of the feed roller **115**.

[0067] The separation roller **116** is provided with an outer peripheral surface **116***b*, a torque limiter **116***c*, etc. The torque limiter **116***c* is located on the shaft **116***a* being the rotation axis of the separation roller **116**. The torque limiter **116***c* defines a maximum torque exerted on the separation roller **116**. The limit value of the torque limiter **116***c* is set to a value at which a turning force through the torque limiter **116***c* is cut off when there is one medium and the turning force is transmitted through the torque limiter **116***c* when there are a plurality of media. Consequently, when only one medium is conveyed, the separation roller **116** is driven by the feed roller **115** instead of rotating according to the driving force from the second motor **132**. On the other hand, when a plurality of media are conveyed, the separation roller **116** rotates in the direction A**5** opposite to the medium feeding direction and prevents occurrence of multi feed by separating a medium in contact with the feed roller **115** from the remaining media. At this time, the outer peripheral surface **116***b* of the separation roller **116** may apply a force in the direction A**5** opposite to the medium feeding direction to the medium by stopping instead of rotating in the direction A**5** opposite to the medium feeding direction.

[0068] FIG. **5** is a schematic diagram for illustrating the holding part.

[0069] As illustrated in FIG. **5**, a holding part **134** is provided in the lower housing **101**. The holding part **134** holds substances adhered to a conveyed medium, such as paper dust or dirt, or substances adhered to the feed roller **115** or the separation roller **116** from a conveyed medium.

[0070] The lower guide **101***a* being a medium guide surface in the lower housing **101** includes an opening **101***b* for locating the feed roller **115**. The holding part **134** is located below the feed roller **115** to face the opening **101***b* and holds substances falling from a conveyed medium, the feed roller **115**, or the separation roller **116**, and substances entering from a gap between the feed roller **115** and the opening **101***b*. Further, the holding part **134** is provided to be attachable to and detachable from the lower housing **101**, i.e., the medium conveying apparatus **100**. The holding part **134** allows the medium conveying apparatus **100** to suitably collect paper dust or dirt and suppress accumulation of paper dust or dirt in the medium conveyance path.

[0071] FIG. **6** is a block diagram illustrating a schematic configuration of an example of a medium conveying apparatus.

[0072] In addition to the configuration described above, the medium conveying apparatus **100** further includes an interface device **135**, a storage device **140**, a processing circuit **150**, etc.

[0073] For example, the interface device **135** includes an interface circuit conforming to a serial bus such as USB and transmits and receives an input image and various types of information by being electrically connected to an unillustrated information processing apparatus (such as a personal computer or a mobile information terminal). A communication device including an antenna transmitting and receiving wireless signals and a wireless communication interface circuit for transmitting and receiving signals through a wireless communication line in accordance with a predetermined communication protocol may be used in place of the interface device **135**. For example, the predetermined com-

munication protocol is a wireless local area network (LAN). The communication device may include a wired communication interface circuit for transmitting and receiving signals through a wired communication line in accordance with a communication protocol such as a wired LAN.

[0074] The storage device **140** includes a memory device such as a random-access memory (RAM) or a read-only memory (ROM), a fixed disk device such as a hard disk, a portable storage device such as a flexible disk or an optical disk, etc. Further, a computer program, a database, a table, etc., that are used for various types of processing in the medium conveying apparatus **100** are stored in the storage device **140**. The computer programs may be installed on the storage device **140** from a computer-readable, non-transitory portable storage medium by using a well-known set-up program, etc. The portable storage medium is, for example, a compact disc read-only memory (CD-ROM) or a digital versatile disc read-only memory (DVD-ROM).

[0075] The processing circuit **150** operates in accordance with a program previously stored in the storage device **140**. For example, the processing circuit is a central processing unit (CPU). Examples of the processing circuit **150** that may also be used include a digital signal processor (DSP), a large scale integration (LSI), an application specific integrated circuit (ASIC), and a field-programmable gate array (FPGA).

[0076] The processing circuit **150** is connected to the operation device **105**, the display device **106**, the first medium sensor **111**, the second medium sensor **117**, the ultrasonic sensor **118**, the third medium sensor **121**, the imaging device **122**, the first motor **131**, the second motor **132**, the third motor **133**, the interface device **135**, the storage device **140**, etc., and controls the components. The processing circuit **150** performs drive control of each motor, imaging control of the imaging device **122**, etc., based on each medium signal received from each medium sensor.

[0077] The processing circuit **150** acquires an input image from the imaging device **122** and transmits the acquired image to the information processing apparatus through the interface device **135**. Further, the processing circuit **150** determines whether multi feed of media has occurred, based on an ultrasonic signal received from the ultrasonic sensor **118**, and when multi feed of media has occurred, controls each motor to return the media to the loading tray **103**.

[0078] FIG. **7** is a diagram illustrating a schematic configuration of an example of a storage device and a processing circuit.

[0079] As illustrated in FIG. **7**, a control program **141**, a determination program **142**, etc., are stored in the storage device **140**. Each program is a functional module implemented by software operating on the processor. The processing circuit **150** reads each program stored in the storage device **140** and operates in accordance with the read program. Consequently, the processing circuit **150** functions as a control module **151**, and a determination module **152**.

[0080] FIG. **8** and FIG. **9** are flowcharts illustrating an operation example of medium reading processing in a medium conveying apparatus.

[0081] The operation example of the medium reading process in the medium conveying apparatus **100** will be described below referring to the flowchart illustrated in FIG. **8** and FIG. **9**.

[0082] The operation flow described below is executed mainly by the processing circuit **150** in accordance with a program previously stored in the storage device **140** in cooperation with the components in the medium conveying apparatus **100**.

[0083] First, the control module **151** waits until an instruction to read a medium is input by a user by using the operation device **105** or the information processing apparatus and an operation signal providing an instruction to read a medium is received from the operation device **105** or the interface device **132** (step S**101**).

[0084] Next, the control module **151** acquires the medium signal from the first medium sensor **111** and determines whether a medium exist on the loading tray **103**, based on the acquired medium signal (step S**102**). When a medium does not exist on the loading tray **103**, the control module **151** ends the series of steps.

[0085] On the other hand, when a medium exists on the loading tray **103**, the control module **151** first drives the third motor **133** (step S**103**). By driving the third motor **133**, the control module **151** rotates the cam member **113** in the direction of the arrow A**11** in FIG. **3** and moves the regulating guide **112** in the direction of the arrow A**12** in FIG. **3**, i.e., from the set position to the release position. Further, by driving the third motor **133**, the control module **151** rotates the conveyance roller **119**, the first facing roller **120**, the ejection roller **123**, and/or the second facing roller **124** in the directions of the arrows A**6**, A**7**, A**8**, and/or A**9** in FIG. **2**, respectively.

[0086] Next, the control module **151** rotates the separation roller **116** in a direction opposite to the medium feeding direction (in the direction of the arrow A**5** in FIG. **2**) by driving the second motor **132** (step S**104**).

[0087] Next, the control module **151** rotates the feed roller **115** in the medium feeding direction (in the direction of the arrow A**4** in FIG. **2**) to feed the medium by driving the first motor **131** (step S**105**).

[0088] FIG. **10** is a graph for illustrating changes in the speeds of the feed roller, the separation roller, and the conveyance roller.

[0089] In FIG. **10**, a graph G**11** illustrates changes in the speed of the feed roller **115**, a graph G**12** illustrates changes in the speed of the separation roller **116**, and a graph G**13** illustrates changes in the speed of the conveyance roller **119**. Since the speeds of the first facing roller **120**, the ejection roller **123**, and the second facing roller **124** change similarly to the speed of the conveyance roller **119**, changes in the speed of the conveyance roller **119** will be described below as a representative. The horizontal axis of each of the graphs G**11** to G**13** indicates time, and the vertical axis of each of the graphs G**11** to G**13** indicates speed.

[0090] On the other hand, a graph G**14** illustrates changes in the signal value of the second medium sensor **117**, and a graph G**15** illustrates changes in the signal value of the third medium sensor **121**. The horizontal axis of each of the graphs G**14** and G**15** indicates time, and the vertical axis indicates the signal value of each of the graphs G**14** and G**15**. According to the present embodiment, when a medium does not exist at the position of each sensor, the signal value of a related signal takes on L, and when a medium exists at the position of each sensor, the signal value of a related signal takes on H.

[0091] In FIG. **10**, a time T**1** denotes the time when medium feeding is started. As described above, the control module **151** starts driving the third motor **133**, the second motor **132**, and the first motor **131** in this order, and

therefore, the conveyance roller **119**, the separation roller **116**, and the feed roller **115** sequentially start rotation at times T**1**, T**2**, and T**3**, respectively. The speed (the surface moving speed) V**2** of the separation roller **116** is set to a speed less than the speed (surface moving speed) V**1** of the feed roller **115**. The speed (the surface moving speed)

[0092] V**3** of the conveyance roller **119** is set to a speed greater than the speed (the surface moving speed) V**1** of the feed roller **115**.

[0093] The control module **151** starts driving the third motor **133**, the second motor **132**, and the first motor **131** in this order. Therefore, when the regulating guide **112** moves from the set position and regulation of a medium by the flap **114** is released, i.e., when the front edge of a medium placed on the loading tray **103** comes into contact with the separation roller **116** and the feed roller **115**, the feed roller **115** and the separation roller **116** are at a standstill. Then, the separation roller **116** starts rotation before the feed roller **115** starts rotation. Accordingly, as illustrated in FIG. **4**, the medium group M**1** placed on the loading tray **103** comes into contact with the separation roller **116** before entering the nip part of the feed roller **115** and the separation roller **116**. The front edge of the medium group M**1** is arranged such that a medium closer to the top is placed further on the upstream side by the separation roller **116** rotating in the direction opposite to the medium feeding direction. Consequently, a plurality of media entering the nip part of the feed roller **115** and the separation roller **116** together when rotation of the feed roller **115** starts is suppressed, and occurrence of multi feed of media is suppressed.

[0094] By the separation roller **116** starting rotation before the feed roller **115** starts rotation, the separation roller **116** being driven by the feed roller **115** before the start of rotation is suppressed, and the separation roller **116** can satisfactorily separate media.

[0095] The control module **151** may execute the processing in step S**104** before the processing in step S**103** and operate the third motor **133** after operating the second motor **132** when feeding of a medium is started. In that case, the separation roller **116** rotates and the feed roller **115** is at a standstill when the regulating guide **112** moves from the set position and the front edge of the medium comes into contact with the separation roller **116** and the feed roller **115**. Accordingly, in that case, the medium conveying apparatus **100** also controls the first motor **131**, the second motor **132**, and the third motor **133** such that the feed roller **115** rotates after the separation roller **116** in a rotating state contacts the medium. The front edge of the medium group M**1** is arranged such that a medium closer to the top is placed further on the upstream side by the separation roller **116** rotating in the direction opposite to the medium feeding direction. Consequently, occurrence of multi feed of media due to a plurality of media entering the nip part of the feed roller **115** and the separation roller **116** together when rotation of the feed roller **115** starts is suppressed.

[0096] By the separation roller **116** starting rotation before the feed roller **115** starts rotation, the separation roller **116** being driven by the feed roller **115** before the start of rotation is suppressed, and the separation roller **116** can satisfactorily separate media.

[0097] Thus, the control module **151** controls the first motor **131**, the second motor **132**, and the third motor **133**, i.e., the feed roller **115**, the separation roller **116**, and the regulating guide **112** such that, when feeding of a medium is started, the feed roller **115** rotates, i.e., feeds the medium, after the separation roller **116** in a rotating state comes in contact with the medium. In particular, when feeding of a medium is started, the control module **151** operates the first motor **131** after operating the second motor **132** and the third motor **133**. Consequently, the control module **151** can suppress occurrence of multi feed of media when feeding of the media is started.

[0098] As described above, the regulating guide **112** is provided to move by rotation of the cam member **113**, and the regulating guide **112** and the flap **114** regulate contact of a medium with the feed roller **115** and the separation roller **116** by engaging each other. Accordingly, it takes a certain time after the third motor **133** is driven until the regulating guide **112** and the flap **114** move and the medium comes into contact with the feed roller **115** and the separation roller **116**. The control module **151** can shorten the time required for feeding of a medium by starting movement of the regulating guide **112** and the flap **114** by driving the third motor **133** before starting rotation of the feed roller **115** by driving the first motor **131**.

[0099] The control module **151** may wait for a first predetermined time after driving the third motor **133** in step S**103** before driving the first motor **131** in step S**105**. The first predetermined time is set to the time required for the front edge of a medium regulated by the flap **114** to come into contact with the separation roller **116** rotating in the direction opposite to the medium feeding direction after the third motor **133** is driven. Consequently, the control module **151** can reliably apply a separating force exerted by the separation roller **116** to a medium group before a feeding force exerted by the feed roller **115** is applied and medium conveying apparatus can reliably suppress occurrence of multi feed of media.

[0100] As described above, the shaft **116***a* of the separation roller **116** is provided with the torque limiter **116***c*. Depending on the placement position of the torque limiter **116***c*, a gap (a backlash component) to which a driving force is not transmitted may exist between the shaft **116***a* and (the outer peripheral surface **116***b* of) the separation roller **116**. Therefore, depending on the placement position of the torque limiter **116***c*, it may take a certain time until the driving force from the second motor **132** is transmitted to the separation roller **116**. By starting rotation of the separation roller **116** by driving the second motor **132** before starting rotation of the feed roller **115** by driving the first motor **131**, the control module **151** can eliminate the gap (backlash component) between the shaft **116***a* and the separation roller **116**. Consequently, the control module **151** can reliably apply a separating force exerted by the separation roller **116** to a medium group before a feeding force exerted by the feed roller **115** is applied and can suppress occurrence of multi feed of media.

[0101] The control module **151** may wait for a second predetermined time after driving the second motor **132** in step S**104** before driving the first motor **131** in step S**105**. The second predetermined time is set to the time required for the separation roller **116** to reliably rotate after the second motor **132** is driven. Consequently, the control module **151** can reliably suppress occurrence of multi feed of media.

[0102] Next, the control module **151** waits until the front edge of the conveyed medium passes the position of the second medium sensor **117** (step S**106**). The control module **151** periodically acquires the second medium signal from

the second medium sensor **117**, and determines that the front edge of the medium has passed the position of the second medium sensor **117** when the signal value of the second medium signal changes from a value indicating that a medium does not exist to a value indicating that a medium exists.

[0103] Next, the control module **151** controls the second motor **132** to stop the separation roller **116** (step S**107**).

[0104] In FIG. **10**, a time T**4** denotes the time when the signal value of the second medium signal changes from L to H, i.e., when the front edge of the medium has passed the position of the second medium sensor **117**. As illustrated in FIG. **10**, rotation of the separation roller **116** is stopped when the front edge of the medium passes the position of the second medium sensor **117**. When passing the position of the second medium sensor **117**, the front edge of the medium has already passed the nip part of the feed roller **115** and the separation roller **116**, and separation of media is completed. Therefore, by the control module **151** stopping the separation roller **116**, the medium conveying apparatus **100** can reduce the amount of power consumption and the apparatus temperature while suitably separating media.

[0105] Next, the control module **151** waits until the front edge of the conveyed medium passes the position of the conveyance roller **119** (step S**108**). The control module **151** periodically acquires the third medium signal from the third medium sensor **121**, and determines that the front edge of the medium has passed the position of the third medium sensor **121** when the signal value of the third medium signal changes from a value indicating that a medium does not exist to a value indicating that a medium exists. The control module **151** determines that the front edge of the medium has passed the position of the conveyance roller **119** when the front edge of the medium passes the position of the third medium sensor **121**.

[0106] Next, the control module **151** controls the first motor **131** to stop the feed roller **115** (step S**108**).

[0107] In FIG. **10**, a time T**5** denotes the time when the signal value of the third medium signal changes from L to H, i.e., when the front edge of the medium has passed the position of the third medium sensor **121**. As illustrated in FIG. **10**, after the front edge of the medium passes the position of the third medium sensor **121**, the control module **151** stops the feed roller **115**. Consequently, from this point, the medium is conveyed by the conveyance roller **119**, and the feed roller **115** is rotated by the medium being conveyed. By the control module **151** stopping the feed roller **115**, the medium conveying apparatus **100** can suppress occurrence of jamming of the medium due to the medium being pushed by the feed roller **115** and being bent between the feed roller **115** and the conveyance roller **119**.

[0108] Next, the control module **151** causes the imaging device **122** to start imaging of the medium (step S**110**).

[0109] Next, the control module **151** waits until the rear edge of the conveyed medium passes the position of the second medium sensor **117** (step S**111**). The control module **151** periodically acquires the second medium signal from the second medium sensor **117**, and determines that the rear edge of the medium has passed the position of the second medium sensor **117** when the signal value of the second medium signal changes from a value indicating that a medium exists to a value indicating that a medium does not exist.

[0110] Next, the control module **151** determines whether a medium remains on the loading tray **103**, based on the medium signal received from the first medium sensor **111** (step S**112**).

[0111] When a medium remains on the loading tray **103**, the control module **151** controls the second motor **132** to re-rotate the separation roller **116** in the direction opposite to the medium feeding direction (in the direction of the arrow A**5** in FIG. **2**) (step S**113**).

[0112] Next, the control module **151** controls the first motor **131** to re-rotate the feed roller **115** in the medium feeding direction (in the direction of the arrow A**4** in FIG. **2**) to feed a succeeding medium (step S**114**).

[0113] In FIG. **10**, a time T**6** denotes the time when the signal value of the second medium signal changes from H to L, i.e., when the rear edge of the medium has passed the position of the second medium sensor **117**. As described above, the control module **151** starts driving of the second motor **132** and the first motor **131** in this order, and therefore, the separation roller **116** and the feed roller **115** sequentially start rotation at times T**6** and T**7**, respectively.

[0114] Consequently, the control module **151** can apply a separating force exerted by the separation roller **116** on the medium group remaining on the loading tray **103** before a feeding force exerted by the feed roller **115** is applied. Accordingly, before entering the nip part of the feed roller **115** and the separation roller **116**, the front edge of the medium group remaining on the loading tray **103** is arranged such that a medium closer to the top is placed further on the upstream side by the separation roller **116** rotating in the direction opposite to the medium feeding direction. Therefore, occurrence of multi feed of media due to a plurality of media entering the nip part of the feed roller **115** and the separation roller **116** together when rotation of the feed roller **115** starts is suppressed.

[0115] By the separation roller **116** starting rotation before the feed roller **115** starts rotation, the separation roller **116** being driven by the feed roller **115** before the start of rotation is suppressed, and the separation roller **116** can satisfactorily separate media.

[0116] Thus, when feeding of a second or subsequent medium out of media set on the regulating guide **112** is started, the control module **151** controls the first motor **131** and the second motor **132** such that the feed roller **115** rotates after the separation roller **116** rotates. Consequently, the control module **151** can suppress occurrence of multi feed of media when feeding of a second or subsequent medium is started.

[0117] Next, the control module **151** waits until the rear edge of the preceding medium passes an imaging position of the imaging device **122** (step S**115**). The control module **151** periodically acquires the third medium signal from the third medium sensor **121** and determines that the rear edge of the preceding medium has passed the position of the third medium sensor **121** when the signal value of the third medium signal changes from a value indicating that a medium exists to a value indicating that a medium does not exist. The control module **151** determines that the rear edge of the preceding medium has passed the imaging position when a third predetermined time elapses after the rear edge of the preceding medium passes the position of the third medium sensor **121**. The third predetermined time is set to a value acquired by adding a margin to the time required for

a medium to move from the position of the third medium sensor **121** to the imaging position.

[0118] Next, the control module **151** acquires an input image from the imaging device **122** and outputs the acquired input image by transmitting the image to the information processing apparatus through the interface device **135** (step S**116**).

[0119] Next, the control module **151** returns the processing to step S**106** and repeats the processing in and after step S**106** on a succeeding medium. In this case, the control module **151** waits until the front edge of the succeeding medium passes the position of the second medium sensor **117** (a time T**8** in FIG. **10**) in step S**106** and controls the second motor **132** to stop the separation roller **116** in step S**107**. Furthermore, the control module **151** waits until the front edge of the succeeding medium passes the position of the conveyance roller **119** (a time T**9** in FIG. **10**) in step S**108** and controls the first motor **131** to stop the feed roller **115** in step S**109**.

[0120] On the other hand, when a medium does not remain on the loading tray **103** in step S**112**, the control module **151** waits until the rear edge of the conveyed medium passes the imaging position of the imaging device **122**, similarly to the processing in step S**115** (step S**117**).

[0121] Next, the control module **151** acquires an input image from the imaging device **122** and outputs the acquired input image by transmitting the image to the information processing apparatus through the interface device **135** (step S**118**).

[0122] Next, the control module **151** waits until the rear edge of the conveyed medium passes the position of the ejection roller **123** (step S**119**). The control module **151** determines that the rear edge of the medium has passed the position of the ejection roller **123** when a fourth predetermined time elapses after the rear edge of the medium passes the position of the third medium sensor **121**. The fourth predetermined time is set to a value acquired by adding a margin to the time required for a medium to move from the position of the third medium sensor **121** to the position of the ejection roller **123**.

[0123] Next, the control module **151** controls the third motor **133** to stop the conveyance roller **119**, the first facing roller **120**, the ejection roller **123**, and/or the second facing roller **124** (step S**120**).

[0124] Next, the control module **151** controls (counterrotates) the third motor **133** to move the regulating guide **112** in a direction opposite to the arrow A**12** in FIG. **3**, i.e., from the release position to the set position by rotating the cam member **113** in a direction opposite to the arrow A**11** in FIG. **3** (step S**121**). Consequently, the regulating guide **112** is located at the set position, and the flap **114** is engaged with the regulating guide **112** located at the set position and is located at a position where the medium is prevented from entering the nip part of the feed roller **115** and the separation roller **116** (the position illustrated in FIG. **3**). At this time, the conveyance roller **119**, the first facing roller **120**, the ejection roller **123**, and/or the second facing roller **124** rotate in directions opposite to the arrows A**6**, A**7**, A**8**, and A**9** in FIG. **2**, respectively; however, since no medium exists in the medium conveyance path, no issue occurs.

[0125] Next, the control module **151** controls the third motor **133** to stop the cam member **113** (step S**122**).

[0126] Next, the control module **151** controls the first motor **131** or the second motor **132** to rotate the feed roller **115** or the separation roller **116** (step S**123**). The control module **151** controls the first motor **131** or the second motor **132** to rotate either one or both of the feed roller **115** and the separation roller **116** in the medium feeding direction. By the control module **151** rotating either one of the feed roller **115** and the separation roller **116**, the other roller can be driven to rotate.

[0127] In other words, when not feeding a medium, the control module **151** controls the first motor **131** or the second motor **132** to rotate the feed roller **115** or the separation roller **116** while the regulating guide **112** is located at the set position. The control module **151** rotates the feed roller **115** or the separation roller **116** to move substances adhered to the feed roller **115** or the separation roller **116**. By rotating the feed roller **115** and the separation roller **116**, substances adhered from a fed medium to the feed roller **115** or the separation roller **116** falls from the feed roller **115** or the separation roller **116** and is held by the holding part **134**. Further, by rotating the feed roller **115** and the separation roller **116**, substances adhered to each roller or substances gathered around each roller area are spread. A contact area between the medium and a rubber part of each roller is secured, and the medium conveying apparatus **100** can suppress decline in a medium feeding force and a medium separating force.

[0128] Next, the control module **151** controls the first motor **131** or the second motor **132** to stop the feed roller **115** or the separation roller **116** (step S**124**) and ends the series of steps.

[0129] The processing in steps S**103**, S**104**, and S**105** may be executed in any order. The processing in steps S**113** and S**114** may be executed in any order. The processing in steps S**123** and S**124** may be executed at any timing when a medium is not fed. Alternatively, the processing in steps S**123** and S**124** may be omitted.

[0130] FIG. **11** is a flowchart illustrating an operation example of multi feed determination process in the medium conveying apparatus.

[0131] An operation example of the multi feed determination process in the medium conveying apparatus **100** will be described below referring to the flowchart illustrated in FIG. **11**. The operation flow described below is executed mainly by the processing circuit **150** in accordance with a program prestored in the storage device **140** in cooperation with each component in the medium conveying apparatus **100**. The operation flow illustrated in FIG. **11** is periodically executed during medium conveyance.

[0132] First, the determination module **152** acquires an ultrasonic signal from the ultrasonic sensor **118** (step S**201**).

[0133] Next, the determination module **152** determines whether multi feed of media has occurred, based on the acquired ultrasonic signal (step S**202**). The determination module **152** determines that multi feed of media has not occurred when the signal value of the ultrasonic signal is greater than or equal to a multi feed threshold value and determines that multi feed of media has occurred when the signal value of the ultrasonic signal is less than the multi feed threshold value. The multi feed threshold value is set to a value between a signal value of the ultrasonic signal when a sheet of paper is conveyed and a signal value of the ultrasonic signal when multi feed of papers occurs. When determining that multi feed of media has not occurred, the determination module **152** returns the processing to step S**201** and repeats the processing in steps S**201** and S**202**.

[0134] On the other hand, when the determination module **152** determines that multi feed of media has occurred, the control module **151** temporarily stops the medium reading process (step S**203**).

[0135] Next, the control module **151** controls the first motor **131** and the second motor **132** to stop the feed roller **115** and the separation roller **116** (step S**204**). The determination module **152** detects occurrence of multi feed of media when the front edge of multi-fed media passes the position of the ultrasonic sensor **118**. At this time, the front edge of the media has not arrived at the position of the conveyance roller **119**. Therefore, the control module **151** controls the third motor **133** to continuously rotate the conveyance roller **119**, the first facing roller **120**, the ejection roller **123**, and/or the second facing roller **124**. Consequently, the control module **151** can continue conveyance of a medium fed before the multi-fed media.

[0136] Next, the control module **151** controls the second motor **132** to re-rotate the separation roller **116** in the direction opposite to the medium feeding direction (in the direction of the arrow A**5** in FIG. **2**) (step S**205**).

[0137] Next, the control module **151** returns the multi-fed media to the loading tray **103** by controlling (counterrotating) the first motor **131** to rotate the feed roller **115** in a direction opposite to the medium feeding direction (in a direction opposite to the arrow A**4** in FIG. **2**) (step S**206**). The control module **151** controls the first motor **131** and the second motor **132** such that the circumferential speed of the shaft **115***a* being the rotation axis of the feed roller **115** is greater than the circumferential speed of the outer peripheral surface **115***b* of the feed roller **115** driven by the separation roller **116**.

[0138] Thus, when the determination module **152** determines that multi feed of media has occurred, the control module **151** controls the first motor **131** and the second motor **132** to return the media to the loading tray **103**. When returning the media to the loading tray **103**, the control module **151** controls the first motor **131** and the second motor **132** to rotate the feed roller **115** after rotating the separation roller **116**. When returning the media to the loading tray **103**, the control module **151** controls the first motor **131** and the second motor **132** such that the circumferential speed of the shaft **115***a* being the rotation axis of the feed roller **115** is greater than the circumferential speed of the outer peripheral surface **115***b* of the feed roller **115** driven by the separation roller **116**.

[0139] FIG. **12** is a schematic diagram for illustrating an operation of returning multi-fed media M**2** to the loading tray. FIG. **12** is a schematic diagram of the feed roller and the separation roller viewed from the side when multi feed occurs.

[0140] As described above, the limit value of the torque limiter **116***c* provided on the shaft **116***a* of the separation roller **116** is set to a value allowing transmission of a turning force through the torque limiter **116***c* when there are a plurality of media. When the shaft **115***a* being the rotation axis of the feed roller **115** is rotated in a direction A**21** opposite to the medium feeding direction, the outer peripheral surface **115***b* of the feed roller **115** does not rotate according to the driving force from the first motor **131** due to the working of the one-way clutch **115***c*. The outer peripheral surface **115***b* of the feed roller **115** is driven to rotate by the separation roller **116** in a direction A**22** opposite to the medium feeding direction.

[0141] The shaft **115***a* of the feed roller **115** is provided to rotate at a circumferential speed greater than the circumferential speed of the outer peripheral surface **115***b* of the feed roller **115** driven to rotate by the separation roller **116**. Consequently, the outer peripheral surface **115***b* of the feed roller **115** rotates according to rotation of the outer peripheral surface **116***b* of the separation roller **116** without being hampered by the one-way clutch **115***c*. Thus, the feed roller **115** is provided to be driven to rotate by the separation roller **116** in the direction A**22** opposite to the medium feeding direction. The separation roller **116** rotates in the direction A**5** opposite to the medium feeding direction without receiving a load by the feed roller **115**.

[0142] Accordingly, even when a plurality of media M**2** are multi fed between the separation roller **116** and the feed roller **115**, the medium conveying apparatus **100** can return all of the plurality of media M**2** to the loading tray **103** by counterrotating the first motor **131**.

[0143] As described above, the shaft **116***a* of the separation roller **116** is provided with the torque limiter **116***c*, and, depending on the placement position of the torque limiter **116***c*, a backlash component to which a driving force is not transmitted may exist between the shaft **116***a*and the separation roller **116**. Therefore, assuming that the shaft **115***a* of the feed roller **115** is rotated before the separation roller **116**, the shaft **115***a* of the feed roller **115** may start rotation in a state of the separation roller **116** not being locked. In this case, the media are not sufficiently fixed by the separation roller **116** and are in an unstable state; and a wrinkle may occur in a medium in contact with the feed roller **115** (a medium positioned at the bottom) when rotation of the shaft **115***a* of the feed roller **115** starts. Furthermore, the separation roller **116** starts rotation in a state of the outer peripheral surface **115***b* of the feed roller **115** not being locked. The media are not sufficiently fixed by the outer peripheral surface **115***b* of the feed roller **115** and are in an unstable state; and a wrinkle may occur in a medium in contact with the separation roller **116** (a medium positioned at the top) when rotation of the separation roller **116** starts.

[0144] The medium conveying apparatus **100** rotates the shaft **115***a* of the feed roller **115** after rotating the separation roller **116**. Consequently, when rotation of the separation roller **116** starts, the outer peripheral surface **115***b* of the feed roller **115** is supported by the shaft **115***a* of the feed roller **115**, and the media are in a stabilized state by the feed roller **115**. Accordingly, the medium conveying apparatus **100** can suppress occurrence of a wrinkle in a medium in contact with the separation roller **116** (a medium positioned at the top). Further, a backlash component does not exist between the separation roller **116** and the shaft **116***a* when rotation of the shaft **115***a* of the feed roller **115** starts, and the media are in a stabilized state by the separation roller **116**. Accordingly, the medium conveying apparatus **100** can suppress occurrence of a wrinkle in a medium in contact with the feed roller **115** (a medium positioned at the bottom).

[0145] The control module **151** may wait for a fifth predetermined time after re-rotating the separation roller **116** in step S**205** before counterrotating the feed roller **115** in step S**206**. The fifth predetermined time is set to the time required for the separation roller **116** to rotate by a backlash component between the separation roller **116** and the shaft **116***a*. Consequently, the control module **151** can start rotation of the shaft **115***a* of the feed roller **115** after the backlash component between the separation roller **116** and the shaft

116*a* reliably disappears and can more reliably suppress occurrence of a wrinkle in a medium.

[0146] Next, the control module **151** waits until the media are returned to the loading tray **103** (step S**207**). The control module **151** periodically acquires the second medium signal from the second medium sensor **117** and determines that the downstream edge of the media traveling in the opposite direction has passed the position of the second medium sensor **117** when the signal value of the second medium signal changes from a value indicating that a medium exists to a value indicating that a medium does not exist. The control module **151** determines that the media have returned to the loading tray **103** when a sixth predetermined time elapses after the downstream edge of the media passes the position of the second medium sensor **117**. The sixth predetermined time is set to a value acquired by adding a margin to the time required for media traveling in the opposite direction to move from the position of the second medium sensor **117** to the upstream edge of the nip part of the feed roller **115** and the separation roller **116**.

[0147] Next, the control module **151** controls the first motor **131** and the second motor **132** to stop the feed roller **115** and the separation roller **116** (step S**208**).

[0148] Next, the control module **151** resumes the medium reading process (step S**209**).

[0149] Since the conveyance roller **119**, the first facing roller **120**, the ejection roller **123**, and/or the second facing roller **124** are already rotating, the control module **151** resumes the medium reading process from the processing in step S**104** in FIG. **8**. Further, the control module **151** returns the processing to step S**201** and repeats the processing in steps S**201** to S**209**.

[0150] The feed roller **115** may not include the one-way clutch **115***c* and be provided such that the outer peripheral surface **115***b* rotates according to rotation of the shaft **115***a*. In that case as well, the control module **151** controls the second motor **132** to re-rotate the separation roller **116** in the direction opposite to the medium feeding direction in step S**205** and controls the first motor **131** to rotate the feed roller **115** in the direction opposite to the medium feeding direction in step S**206**. In other words, when returning the media to the loading tray **103**, the control module **151** controls the first motor **131** and the second motor **132** to rotate the feed roller **115** after rotating the separation roller **116**. When returning the media to the loading tray **103**, the control module **151** controls the first motor **131** and the second motor **132** such that the moving speed of the outer peripheral surface **115***b* of the feed roller **115** is greater than the moving speed of the outer peripheral surface **116***b* of the separation roller **116**.

[0151] In this case as well, when the plurality of media M**2** are multi fed between the separation roller **116** and the feed roller **115**, the medium conveying apparatus **100** can return all of the plurality of media M**2** to the loading tray **103** by counterrotating the first motor **131**.

[0152] When multi feed of media occurs, multi-fed media exist on a medium positioned at the bottom, and gravity of the multi-fed media is applied to the medium in contact with the feed roller **115**. Therefore, when the feed roller **115** is rotated before the separation roller **116** is rotated, a downward force exerted by the gravity of the multi-fed media and a force toward the upstream side exerted by the feed roller **115** are applied to the medium positioned at the bottom.

[0153] Therefore, a medium twisting force is applied to the medium positioned at the bottom, and a wrinkle may occur.

[0154] The medium conveying apparatus **100** rotates the feed roller **115** after rotating the separation roller **116**. No medium exists on a medium being in contact with the separation roller **116** and being positioned at the top. Therefore, when the separation roller **116** is rotated before the feed roller **115** is rotated, only a force toward the upstream side exerted by the separation roller **116** is applied to the medium in contact with the separation roller **116**, and therefore, the possibility of occurrence of a wrinkle is low. Accordingly, the medium conveying apparatus **100** can suppress occurrence of a wrinkle in a medium by rotating the feed roller **115** after rotating the separation roller **116**.

[0155] The control module **151** sets the moving speed of the outer peripheral surface **115***b* of the feed roller **115** to a speed greater than the moving speed of the outer peripheral surface **116***b* of the separation roller **116**. Consequently, the control module **151** can cause the medium being in contact with the feed roller **115** and being positioned at the bottom to catch up with the medium being in contact with the separation roller **116** and being positioned at the top. Accordingly, the control module **151** can synchronize timings for returning the respective multi-fed media to the loading tray **103** and therefore enables early completion of recovery of the media.

[0156] The control module **151** may control the first motor **131** and the second motor **132** such that the rotation amount of the separation roller **116** (the moving amount of the outer peripheral surface **116***b*) is greater than the rotation amount of the feed roller **115** (the moving amount of the outer peripheral surface **115***b*). By increasing the rotation amount of the separation roller **116**, the control module **151** can more reliably return an upper medium fed with a medium being a feed target to the loading tray **103**. Further, by decreasing the rotation amount of the feed roller **115**, the control module **151** can suppress occurrence of a wrinkle in a lower medium due to excessively returning the medium.

[0157] The medium conveying apparatus **100** may not execute the multi feed determination process.

[0158] As described in detail above, the first motor **131** for driving the feed roller **115**, the second motor **132** for driving the separation roller **116**, and the third motor **133** for driving the regulating guide **112** are separately provided in the medium conveying apparatus **100**. When feeding of a medium starts, the medium conveying apparatus **100** controls the first motor **131**, the second motor **132**, and the third motor **133** such that the feed roller **115** rotates after the separation roller **116** in a rotating state contacts the medium. Consequently, the medium conveying apparatus **100** can satisfactorily arrange the front edge of a medium group placed on the loading tray **103** by the separation roller **116** and can more satisfactorily separate media.

[0159] The first motor **131** for driving the feed roller **115** and the second motor **132** for driving the separation roller **116** are separately provided in the medium conveying apparatus **100**. When returning media to the loading tray **103** at occurrence of multi feed, the medium conveying apparatus **100** controls the first motor **131** and the second motor **132** to rotate the shaft **115***a* of the feed roller **115** after rotating the separation roller **116**. Consequently, the medium conveying apparatus **100** can stably return multi-fed media to

the loading tray **103** and can more suitably restore media when multi feed of the media occurs.

[0160] Further, the medium conveying apparatus **100** can stably separate media and can stably return multi-fed media to the loading tray **103** regardless of the number of media conveyed together or the type of conveyed medium. Further, when returning multi-fed media to the loading tray **103**, the medium conveying apparatus **100** can suppress occurrence of a jam of a medium.

[0161] FIG. **13** is a diagram for illustrating a conveyance path inside a medium conveying apparatus according to another embodiment.

[0162] The medium conveying apparatus **200** includes the components included in the medium conveying apparatus **100**. However, the medium conveying apparatus **200** includes a second motor **232**, a third motor **233**, a second transmission mechanism **232***a*, and a third transmission mechanism **233***a* in place of the second motor **132**, the third motor **133**, the second transmission mechanism **132***a*, and the third transmission mechanism **133***a*.

[0163] The second motor **232** and the second transmission mechanism **232***a* have structures similar to those of the second motor **132** and the second transmission mechanism **132***a*, respectively. However, the second motor **232** is connected to the separation roller **116** and the cam member **113** through the second transmission mechanism **232***a* and drives the separation roller **116** and the cam member **113**. The second motor **232** generates a driving force for driving the separation roller **116** and the cam member **113** in accordance with a control signal from the processing circuit **150**. The second transmission mechanism **232***a* includes one or a plurality of pulleys, belts, gears, etc., provided between the second motor **232**, and the shaft **116***a* being the rotation axis of the separation roller **116** and the rotation axis **113***a* of the cam member **113**. In particular, one or a plurality of gears for varying the rotation direction of the separation roller **116** and the rotation direction of the cam member **113** are provided between the shaft **116***a* of the separation roller **116** and the rotation axis **113***a* of the cam member **113**. The second transmission mechanism **232***a* transmits the driving force generated by the second motor **232** to the separation roller **116** and the cam member **113**. Consequently, the second motor **232** causes the separation roller **116** to separate, feed, and convey a medium by rotating the separation roller **116**. Further, the second motor **232** moves the regulating guide **112** in contact with the cam member **113** by rotating the cam member **113**. In other words, in the medium conveying apparatus **200**, the cam member **113** is provided to be rotatable by the second motor **232**, and the regulating guide **112** is provided to be movable by the second motor **232**.

[0164] The third motor **233** and the third transmission mechanism **233***a* have structures similar to those of the third motor **133** and the third transmission mechanism **133***a*, respectively.

[0165] However, the third motor **233** is connected to the conveyance roller **119** and the ejection roller **123** through the third transmission mechanism **233***a* but is not connected to the cam member **113**. The third motor **233** generates a driving force for driving the conveyance roller **119** and the ejection roller **123** in accordance with a control signal from the processing circuit **150**. The third transmission mechanism **233***a* includes one or a plurality of pulleys, belts, gears, etc., provided between the third motor **233**, and the shaft **119***a* being the rotation axis of the conveyance roller **119** and the shaft **123***a* being the rotation axis of the ejection roller **123**. The third transmission mechanism **133***a* transmits the driving force generated by the third motor **133** to the conveyance roller **119** and the ejection roller **123**. Consequently, the third motor **133** causes the conveyance roller **119** and the ejection roller **123** to convey and eject a medium by rotating the conveyance roller **119** and the ejection roller **123**.

[0166] The control module **151** and the determination module **152** in the medium conveying apparatus **200** execute the medium reading process illustrated in FIG. **8** and FIG. **9**, and the multi feed determination process illustrated in FIG. **11**.

[0167] In step S**103**, the control module **151** rotates the conveyance roller **119**, a first facing roller **120**, the ejection roller **123**, and/or a second facing roller **124** by driving the third motor **233**. In step S**104**, the control module **151** rotates the separation roller **116** and moves the regulating guide **112** from the set position to the release position by driving the second motor **232** to rotate the cam member **113**. In step S**105**, the control module **151** rotates a feed roller **115** by driving a first motor **131**. Consequently, when feeding of a medium starts, the control module **151** controls the first motor **131** and the second motor **232** such that the feed roller **115** rotates after the separation roller **116** in a rotating state contacts the medium. Further, when feeding of the medium starts, the control module **151** operates the first motor **131** after operating the second motor **232**.

[0168] In step S**107**, the control module **151** controls the second motor **232** to stop the separation roller **116**. In step S**113**, the control module **151** controls the second motor **232** to re-rotate the separation roller **116**. In the steps above, the regulating guide **112** does not move from the release position. In step S**114**, the control module **151** controls the first motor **131** to re-rotate the feed roller **115**. Consequently, when feeding of a second or subsequent medium out of media set on the regulating guide **112** is started, the control module **151** controls the first motor **131** and the second motor **232** such that the feed roller **115** rotates after the separation roller **116** rotates.

[0169] In step S**120**, the control module **151** controls the third motor **233** to stop the conveyance roller **119**, the first facing roller **120**, the ejection roller **123**, and/or the second facing roller **124**. In step S**121**, the control module **151** controls the second motor **232** to move the regulating guide **112** from the release position to the set position by rotating the cam member **113**. At this time, the separation roller **116** rotates in a medium feeding direction. However, since no medium exists on a loading tray **103**, no issue occurs.

[0170] In step S**123**, the control module **151** controls the first motor **131** to rotate the feed roller **115**. In other words, when not feeding a medium, the control module **151** controls the first motor **131** or the second motor **232** to rotate the feed roller **115** while the regulating guide **112** is located at the set position. The control module **151** rotates the feed roller **115** to move substances adhered to the feed roller **115** or the separation roller **116**. In step S**124**, the control module **151** controls the first motor **131** to stop the feed roller **115**.

[0171] In S**204**, S**205**, and S**208** of the multi feed determination process, the control module **151** controls the second motor **232** to stop or re-rotate the separation roller **116**. In the steps above, the regulating guide **112** does not move from the release position.

[0172] As described in detail above, the medium conveying apparatus **200** can more satisfactorily separate media when driving the separation roller **116** and the regulating guide **112** by the common second motor **232** as well. Further, the medium conveying apparatus **200** can more suitably restore media when multi feed of the media occurred by driving the separation roller **116** and the regulating guide **112** with the common second motor **232** as well.

[0173] FIG. **14** is a diagram illustrating a schematic configuration of a processing circuit in a medium conveying apparatus according to yet another embodiment. The processing circuit **350** is used in place of the processing circuit **150** in the medium conveying apparatuses **100** and **200** and executes, in place of the processing circuit **150**, the medium reading process, the multi feed determination process, etc. The processing circuit **350** includes a control circuit **351**, a determination circuit **352**, etc. Each component may be independently configured with an integrated circuit, a microprocessor, firmware, etc.

[0174] The control circuit **351** is an example of a control module and has a function similar to that of the control module **151**. The control circuit **351** receives the operation signal from the operation device **105** or the interface device **135**, the medium signal from the first medium sensor **111**, the second medium signal from the second medium sensor **117**, and the third medium signal from the third medium sensor **121**. Further, the control circuit **351** receives a determination result of multi feed of media from the determination circuit **352**. The control circuit **351** controls the first motor **131**, the second motor **132** or **232**, and the third motor **133** or **233**, based on the received information, acquires the input image from the imaging device **122**, and outputs the acquired image to the interface device **135**.

[0175] The determination circuit **352** is an example of a determination module and has a function similar to that of the determination module **152**. The determination circuit **352** receives the ultrasonic signal from the ultrasonic sensor **118**, determines whether multi feed of media has occurred, based on the received ultrasonic signal, and outputs the determination result to the control circuit **351**.

[0176] As described in detail above, the medium conveying apparatus can satisfactorily separate media when the processing circuit **350** is used as well. Further, the medium conveying apparatus can more suitably restore media at occurrence of multi feed of the media when the processing circuit **350** is used as well.

[0177] According to the embodiments, the medium conveying apparatus, the method for feeding a medium and the computer-readable, non-transitory medium storing executable instructions according to the present embodiment enables more satisfactory separation of media.

[0178] All examples and conditional language recited herein are intended for pedagogical purposes to aid the reader in understanding the invention and the concepts contributed by the inventor to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions, nor does the organization of such examples in the specification relate to a presentation of the superiority and inferiority of the invention. Although the embodiment(s) of the present inventions have been described in detail, it should be understood that the various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention.

What is claimed is:

1. A medium conveying apparatus comprising:
a feed roller to feed a medium;
a separation roller located to face the feed roller;
a regulating guide provided to be movable between a first position where contact of the medium with the feed roller and the separation roller is regulated and a second position where contact of the medium with the feed roller and the separation roller is not regulated; and
a processor to control the feed roller, the separation roller, and the regulating guide,
wherein, when feeding of a medium is started, the processor controls the feed roller, the separation roller, and the regulating guide such that the feed roller feeds the medium after the regulating guide moves from the first position toward the second position and the separation roller contacts the medium.

2. The medium conveying apparatus according to claim **1**, further comprising:
a first motor to drive the feed roller;
a second motor to drive the separation roller; and
a third motor to move the regulating guide, wherein
when feeding of a medium is started, the processor controls the first motor, the second motor, and the third motor such that the feed roller feeds the medium after the regulating guide moves from the first position toward the second position and the separation roller contacts the medium.

3. The medium conveying apparatus according to claim **2**, wherein the processor operates the first motor after operating the second motor and the third motor when feeding of a medium is started.

4. The medium conveying apparatus according to claim **3**, further comprising a torque limiter to define a maximum torque exerted on the separation roller.

5. The medium conveying apparatus according to claim **3**, further comprising a cam provided to be rotatable by the third motor, wherein
the regulating guide is provided to move by rotation of the cam.

6. The medium conveying apparatus according to claim **3**, further comprising a conveyance roller located on a downstream side of the feed roller and the separation roller in a medium conveying direction, wherein
the conveyance roller is provided to be driven by the third motor.

7. The medium conveying apparatus according to claim **3**, wherein, when feeding of a second or subsequent medium out of media set on the regulating guide is started, the processor controls the first motor and the second motor such that the feed roller rotates after the separation roller rotates.

8. The medium conveying apparatus according to claim **2**, wherein the processor controls the first motor or the second motor to rotate the feed roller or the separation roller while the regulating guide is located at the first position to move substances adhered to the feed roller or the separation roller when not feeding a medium.

9. The medium conveying apparatus according to claim **1**, further comprising:
a first motor to drive the feed roller; and
a second motor to drive the separation roller and move the regulating guide,
wherein, when feeding of a medium is started, the processor controls the first motor and the second motor such that the feed roller feeds the medium after the

regulating guide moves from the first position toward the second position and the separation roller contacts the medium.

10. The medium conveying apparatus according to claim **9**, wherein the processor operates the first motor after operating the second motor when feeding of a medium is started.

11. The medium conveying apparatus according to claim **10**, further comprising a torque limiter to define a maximum torque exerted on the separation roller.

12. The medium conveying apparatus according to claim **10**, further comprising a cam provided to be rotatable by the second motor, wherein

the regulating guide is provided to move by rotation of the cam.

13. The medium conveying apparatus according to claim **10**, wherein, when feeding of a second or subsequent medium out of media set on the regulating guide is started, the processor controls the first motor and the second motor such that the feed roller rotates after the separation roller rotates.

14. The medium conveying apparatus according to claim **9**, wherein the processor controls the first motor or the second motor to rotate the feed roller while the regulating guide is located at the first position to move substances adhered to the feed roller or the separation roller when not feeding a medium.

15. A method for feeding a medium, the method comprising:

when feeding of a medium is started, controlling the feed roller to feed a medium, a separation roller located to face the feed roller, and a regulating guide provided to be movable between a first position where contact of the medium with the feed roller and the separation roller is regulated and a second position where contact of the medium with the feed roller and the separation roller is not regulated such that the feed roller feeds the medium after the regulating guide moves from the first position toward the second position and the separation roller contacts the medium.

16. The method according to claim **15**, further comprising:

when feeding of a medium is started, controlling a first motor for driving the feed roller, a second motor for driving the separation roller, and a third motor for moving the regulating guide such that the feed roller feeds the medium after the regulating guide moves from the first position toward the second position and the separation roller contacts the medium.

17. The method according to claim **16**, wherein the first motor is operated after operating the second motor and the third motor when feeding of a medium is started.

18. A computer-readable, non-transitory medium storing executable instructions for feeding a medium, the executable instructions comprising:

when feeding of a medium is started, controlling the feed roller for feeding a medium, a separation roller located to face the feed roller, and a regulating guide provided to be movable between a first position where contact of the medium with the feed roller and the separation roller is regulated and a second position where contact of the medium with the feed roller and the separation roller is not regulated such that the feed roller feeds the medium after the regulating guide moves from the first position toward the second position and the separation roller contacts the medium.

19. The computer-readable, non-transitory medium according to claim **18**, wherein:

when executed, when feeding of a medium is started, a first motor for driving the feed roller, a second motor for driving the separation roller, and a third motor for moving the regulating guide are controlled such that the feed roller feeds the medium after the regulating guide moves from the first position toward the second position and the separation roller contacts a medium.

20. The computer-readable, non-transitory medium according to claim **19**, wherein when executed, the first motor is operated after operating the second motor and the third motor when feeding of a medium is started.

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