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(54) **SHEET FEEDER AND IMAGE FORMING APPARATUS HAVING SAID SHEET FEEDER**

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(57) **ABSTRACT**

Disclosed is a sheet feeder in which sheets are fed by a feeding member from a tray on which the sheets have been loaded. When the tray is driven by a drive unit to lift up the tray from a sheet replenishment position to a position at which sheets can be fed, a first sensor senses that the top sheet on the tray is situated at a prescribed position. Response to this sensing of the first sensor the drive unit performs a predetermined intermittent driving for lifting the tray. It is determined based upon outputs from the first and second sensors whether or not a sheet is present on the tray.

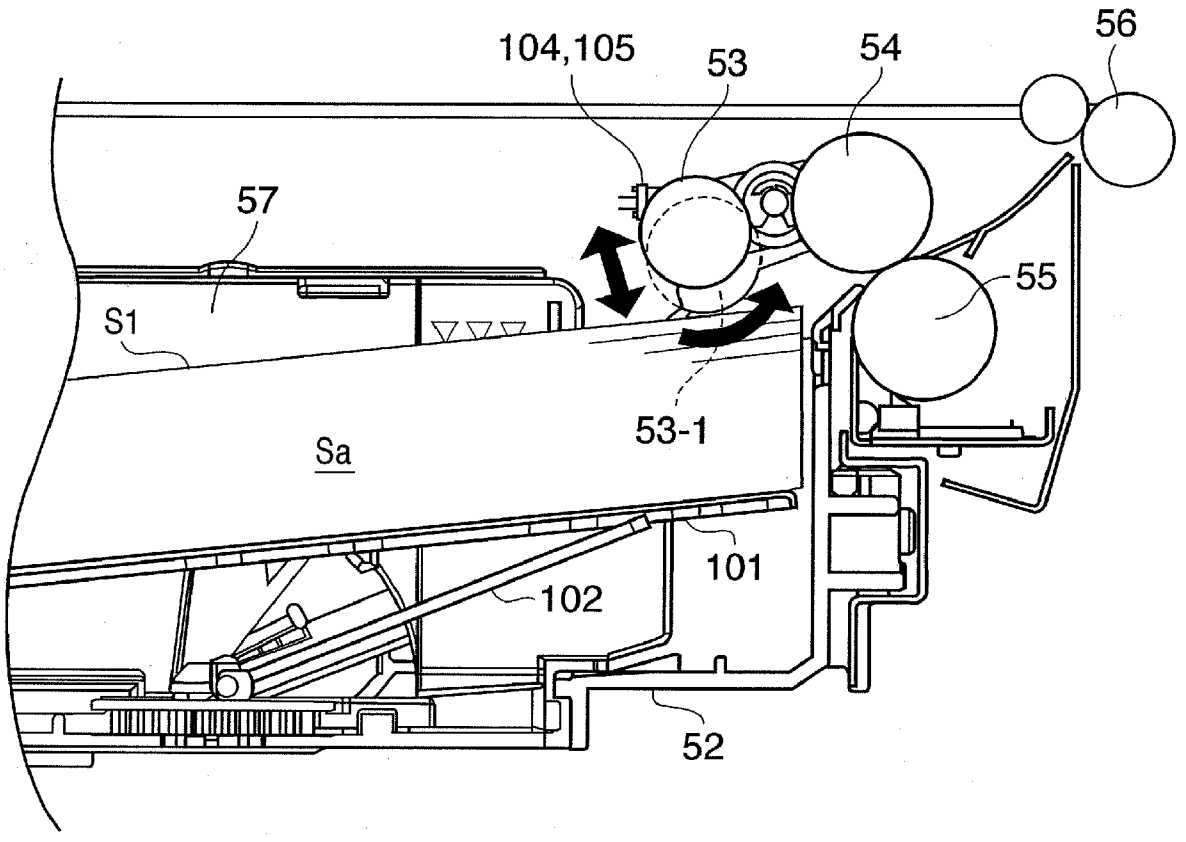


FIG. 1

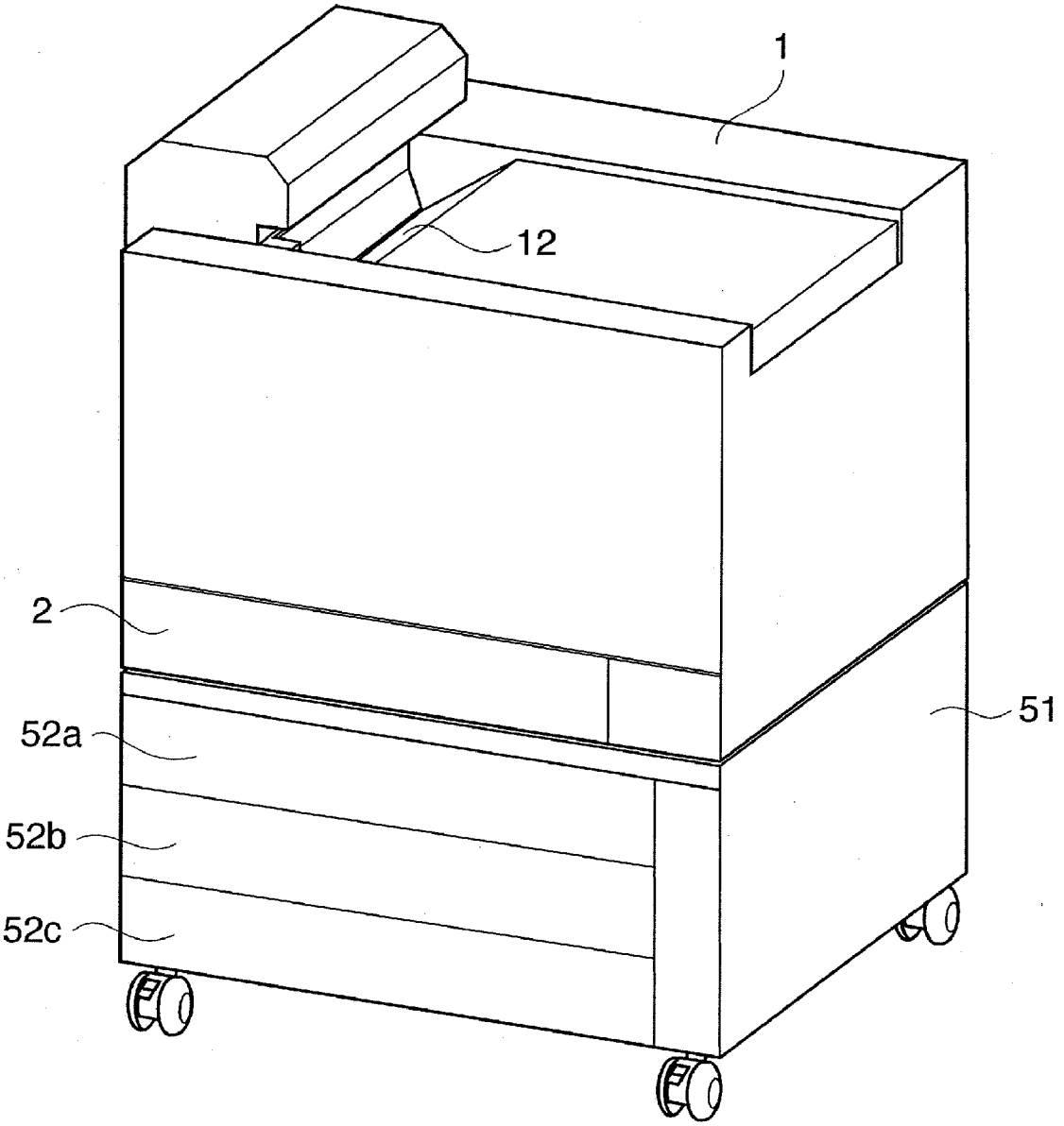


FIG. 2

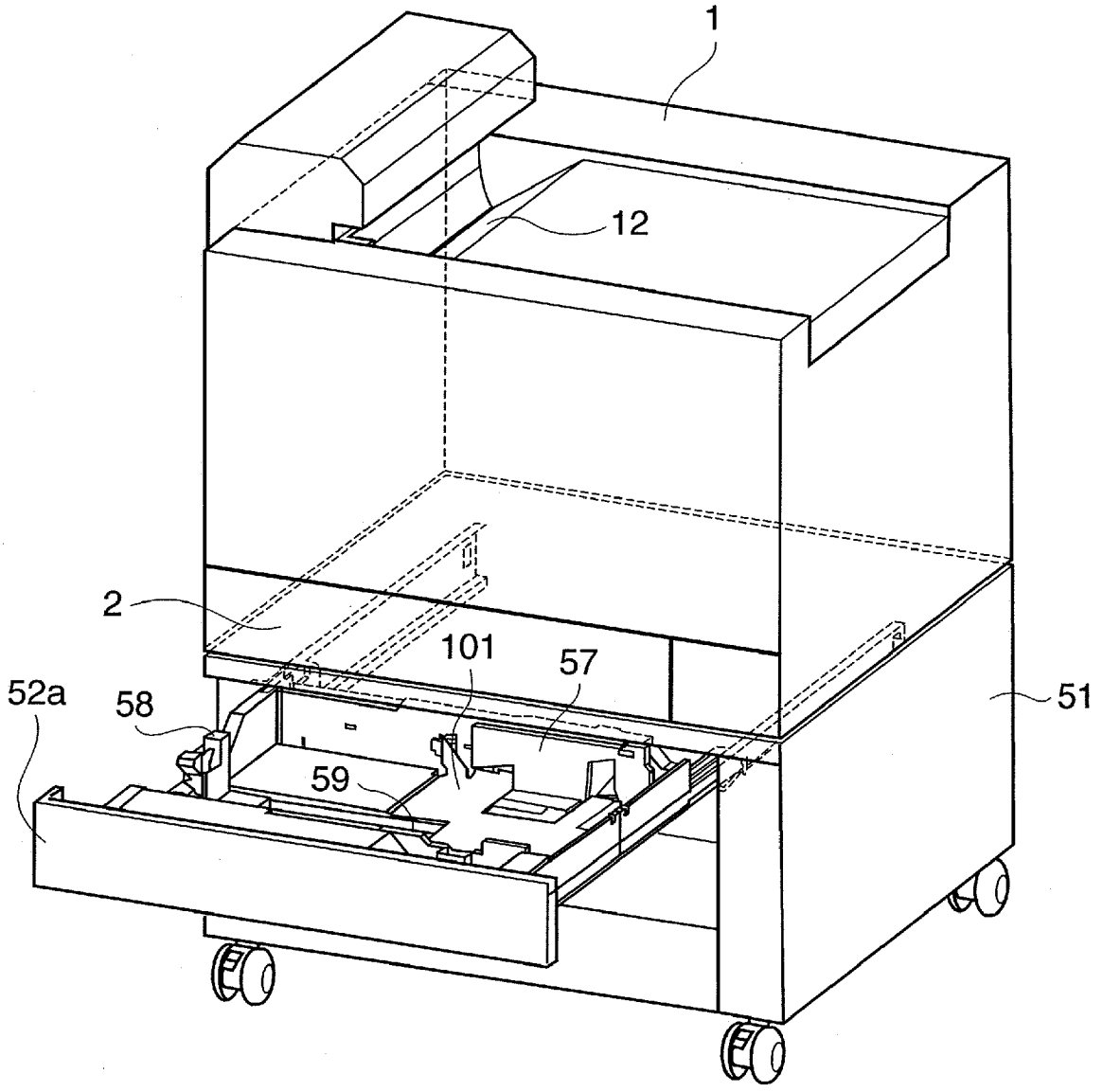


FIG. 3

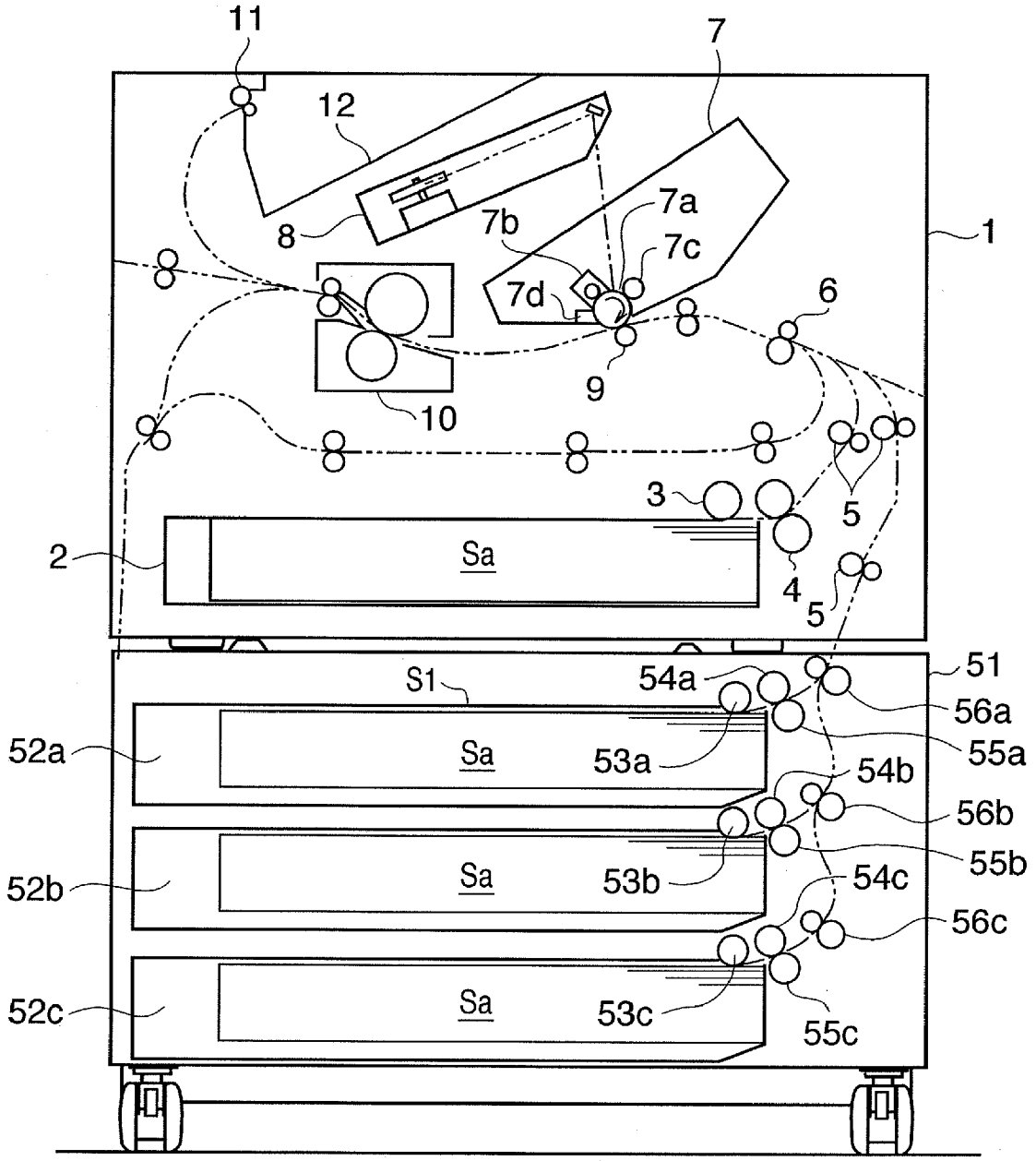

11
12
7
8
7b
7a
7c
7d
1
6
9
10
3
5
2
Sa
4
5
S1
54a
51
56a
52a
Sa
53a
55a
54b
56b
52b
Sa
53b
55b
54c
56c
52c
Sa
53c
55c

FIG. 4

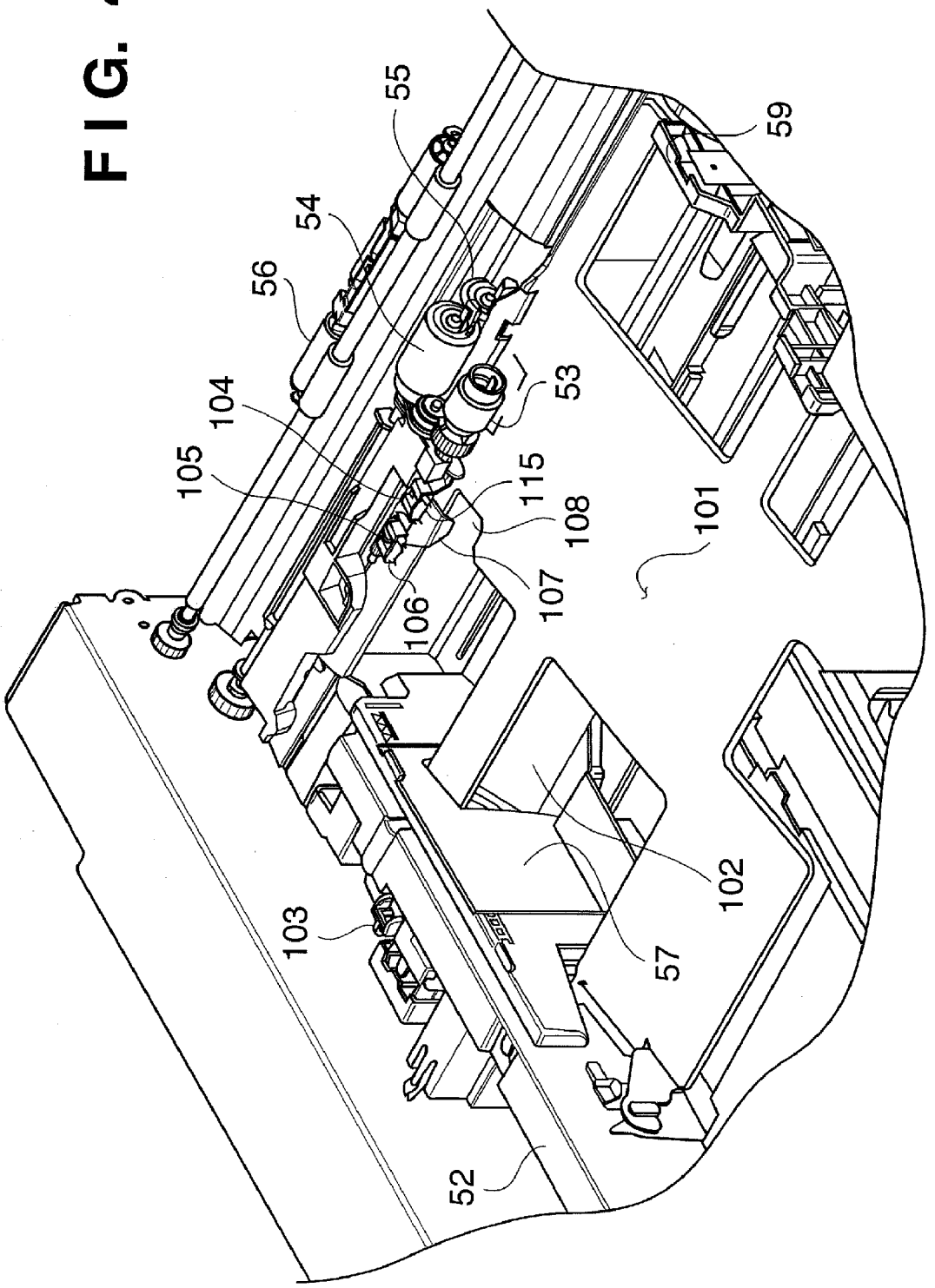


FIG. 5

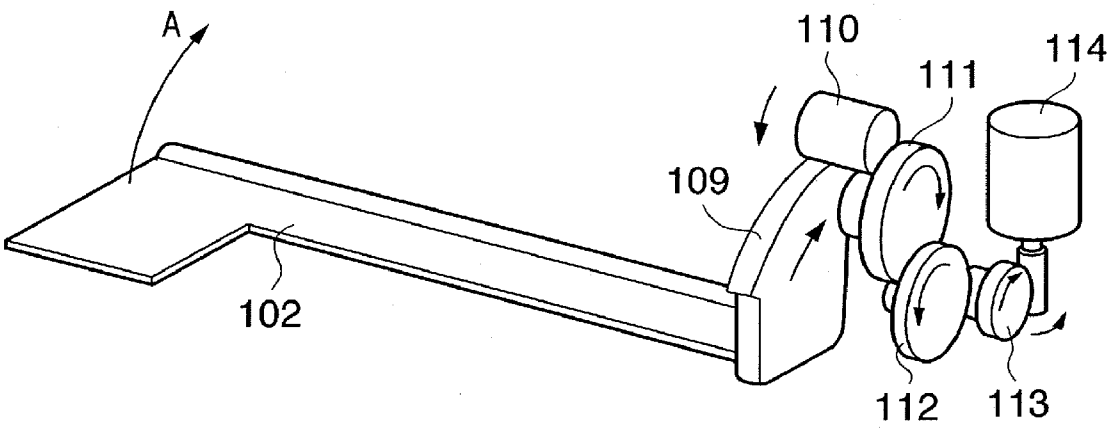


FIG. 6

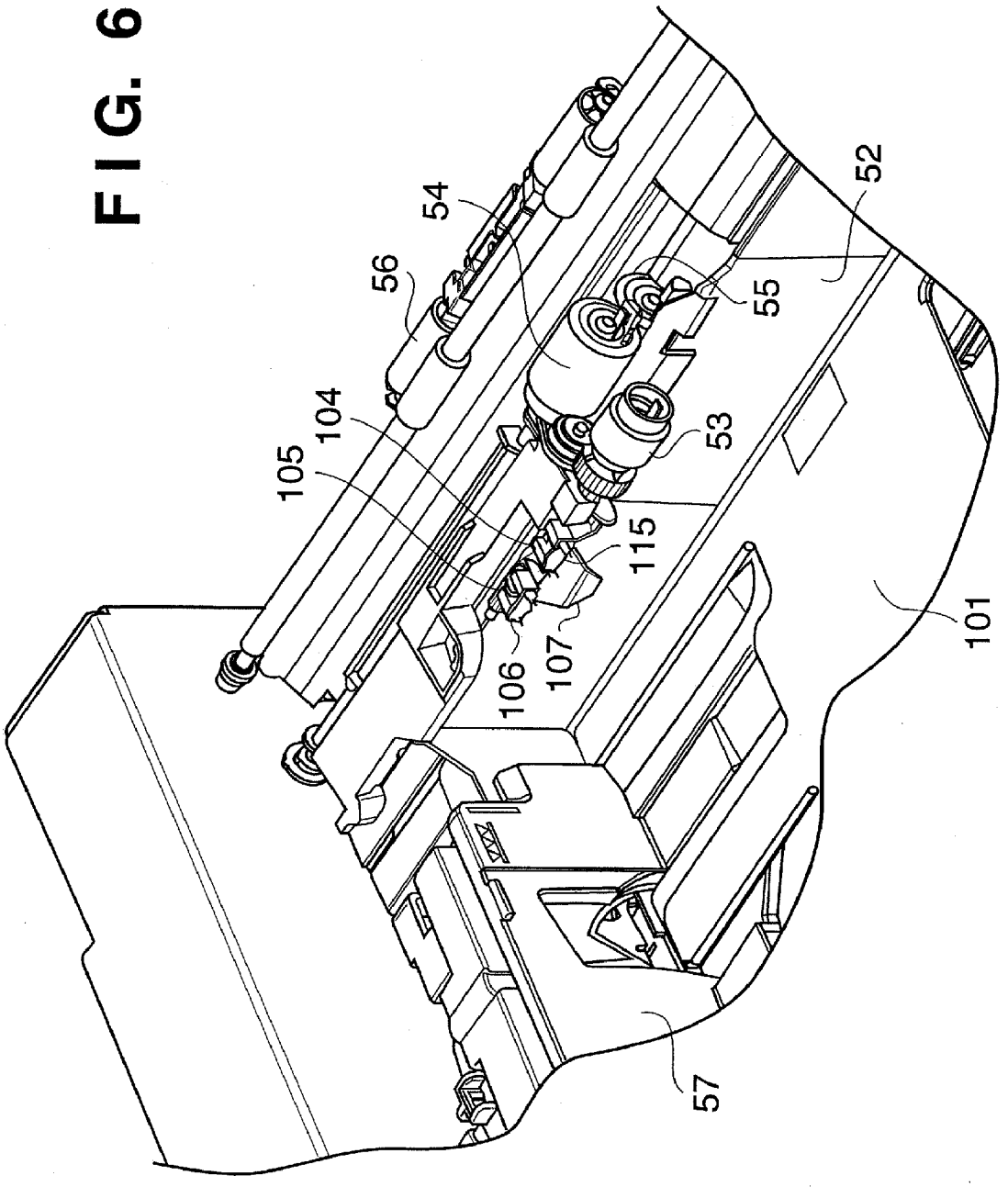


FIG. 7

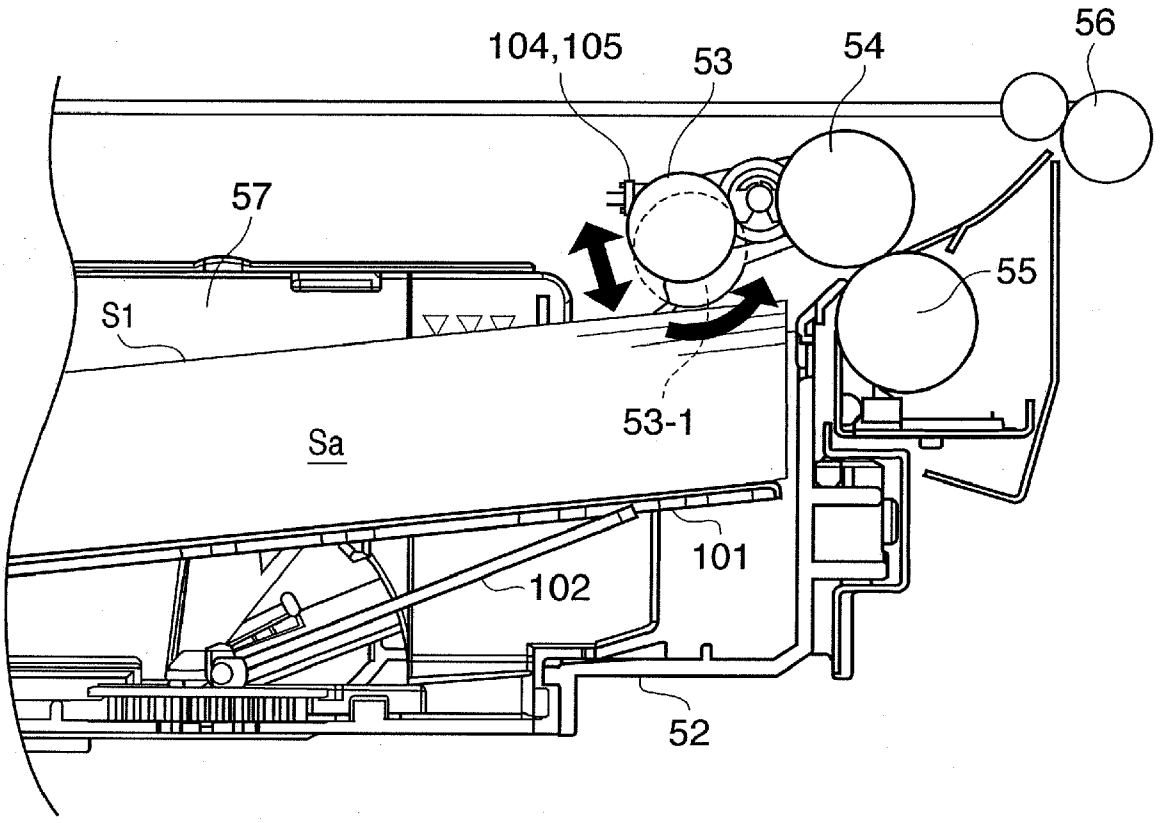


FIG. 8A

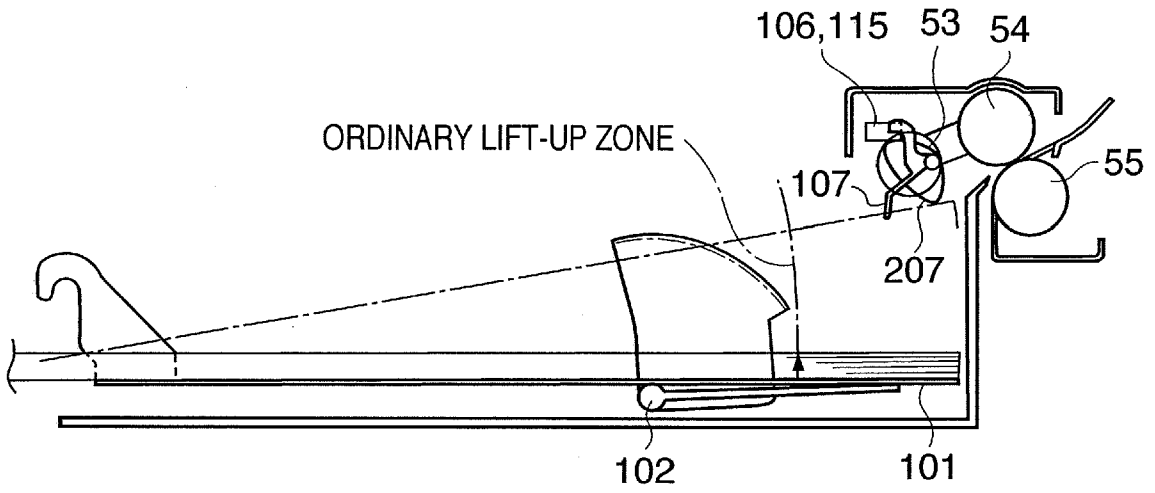

106,115
53
54
ORDINARY LIFT-UP ZONE
55
107
207
102
101

FIG. 8B

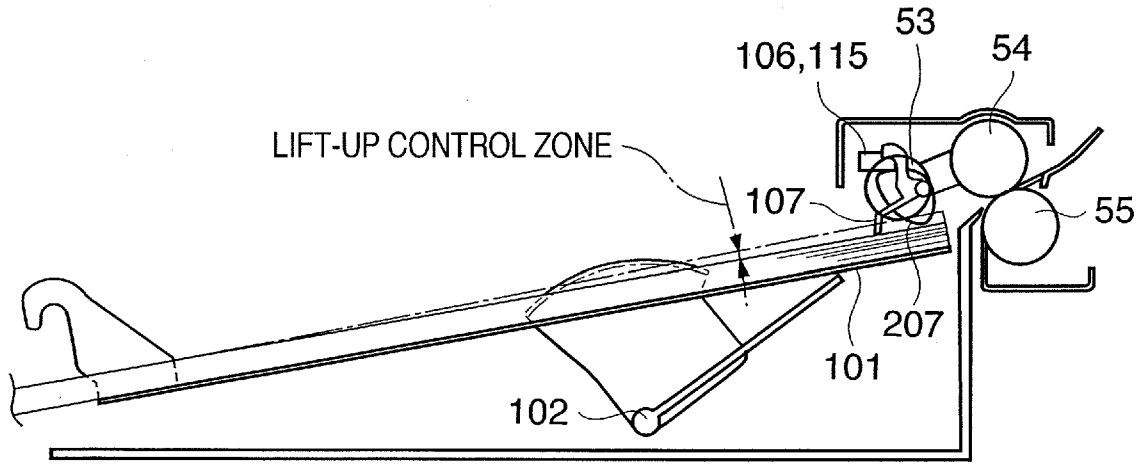

53
106,115
54
LIFT-UP CONTROL ZONE
107
55
207
101
102

FIG. 9A

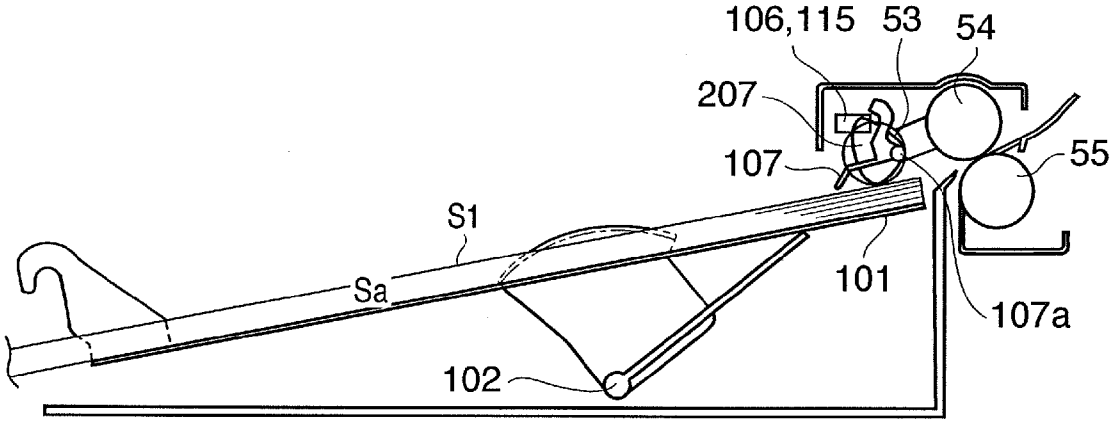

106,115
53
54
207
107
55
S1
Sa
101
107a
102

FIG. 9B

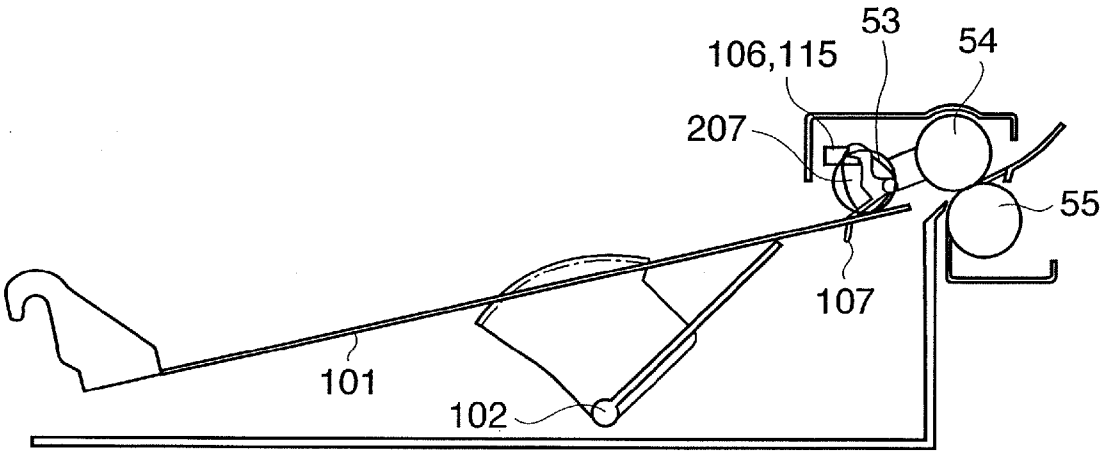

53
106,115
54
207
55
107
101
102

FIG. 10

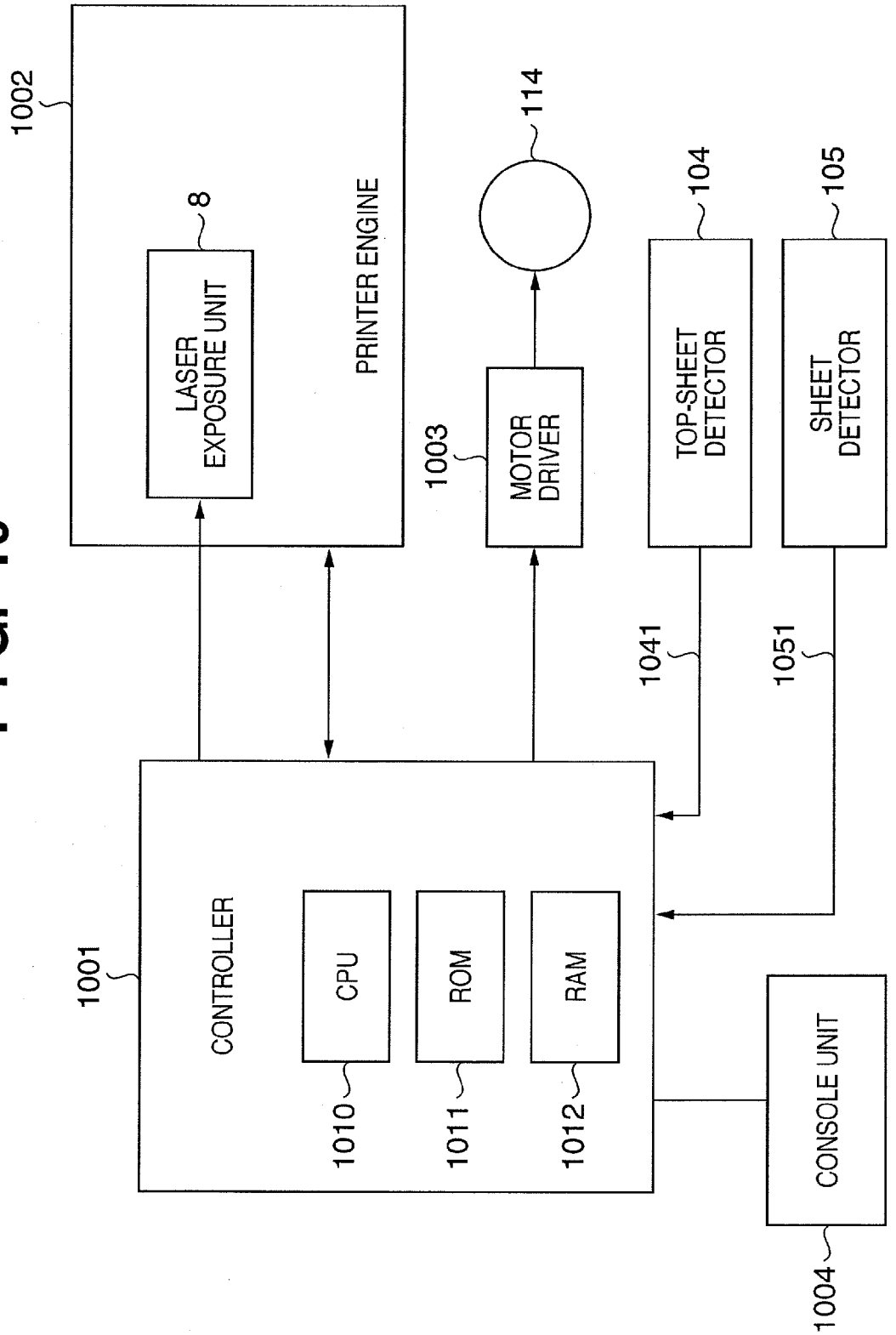

1002
PRINTER ENGINE
8
LASER EXPOSURE UNIT
114
1003
MOTOR DRIVER
104
TOP-SHEET DETECTOR
105
SHEET DETECTOR
1041
1051
1001
CONTROLLER
CPU
ROM
RAM
1010
1011
1012
CONSOLE UNIT
1004

FIG. 11

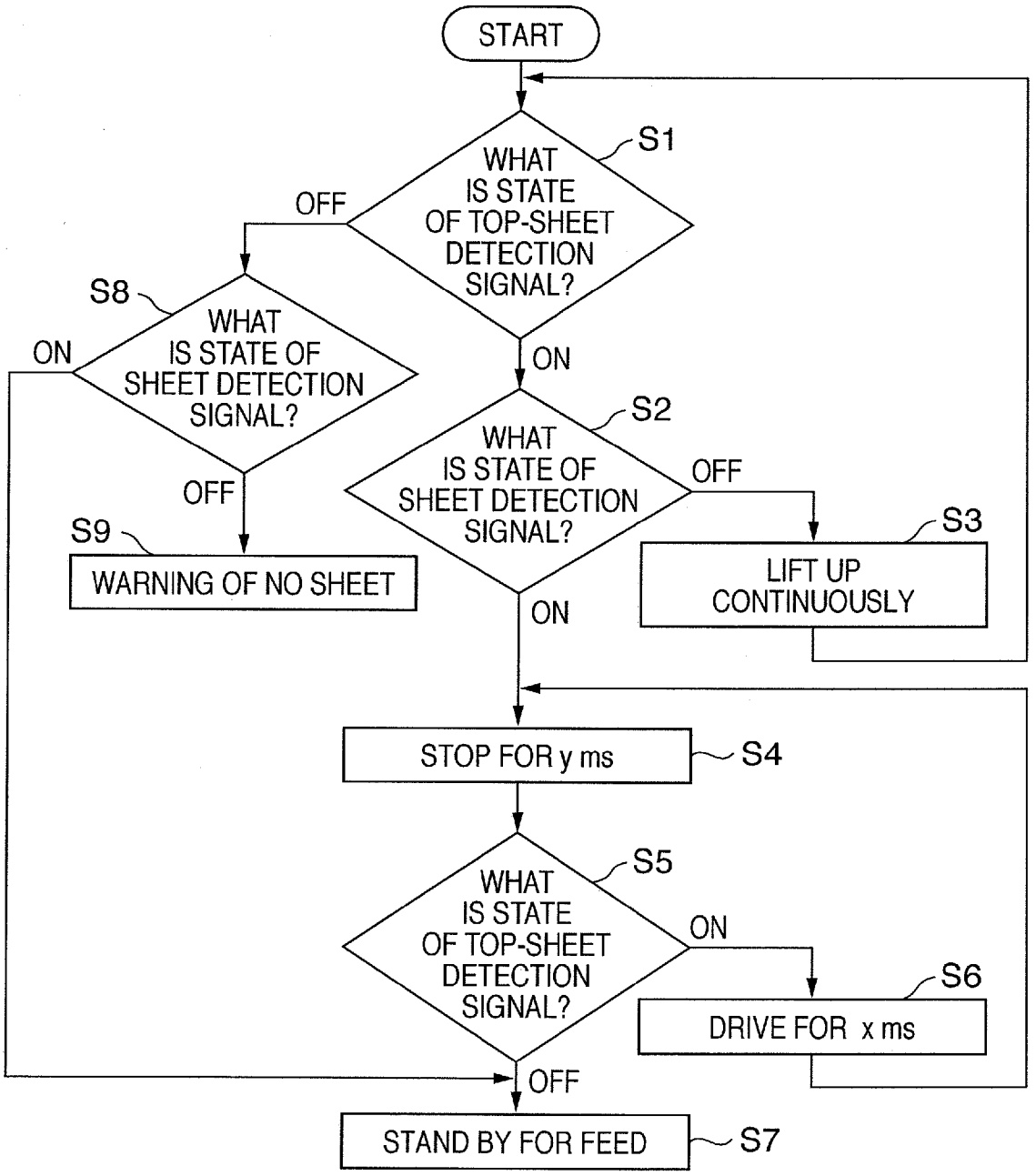

START
S1
WHAT IS STATE OF TOP-SHEET DETECTION SIGNAL?
OFF
ON
S8
WHAT IS STATE OF SHEET DETECTION SIGNAL?
ON
OFF
S9
WARNING OF NO SHEET
S2
WHAT IS STATE OF SHEET DETECTION SIGNAL?
OFF
S3
LIFT UP CONTINUOUSLY
ON
STOP FOR y ms
S4
S5
WHAT IS STATE OF TOP-SHEET DETECTION SIGNAL?
ON
S6
DRIVE FOR x ms
OFF
STAND BY FOR FEED
S7

FIG. 12

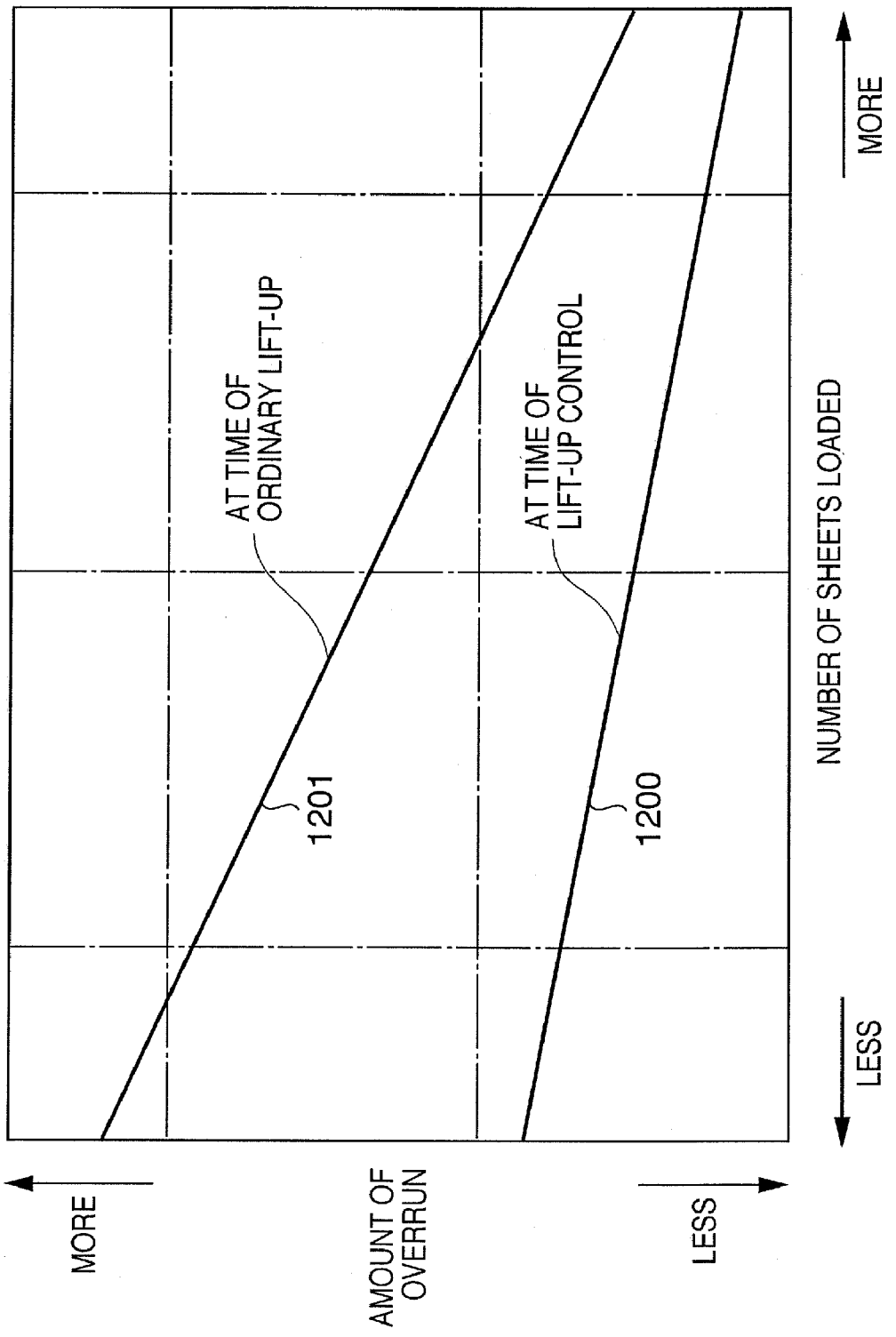
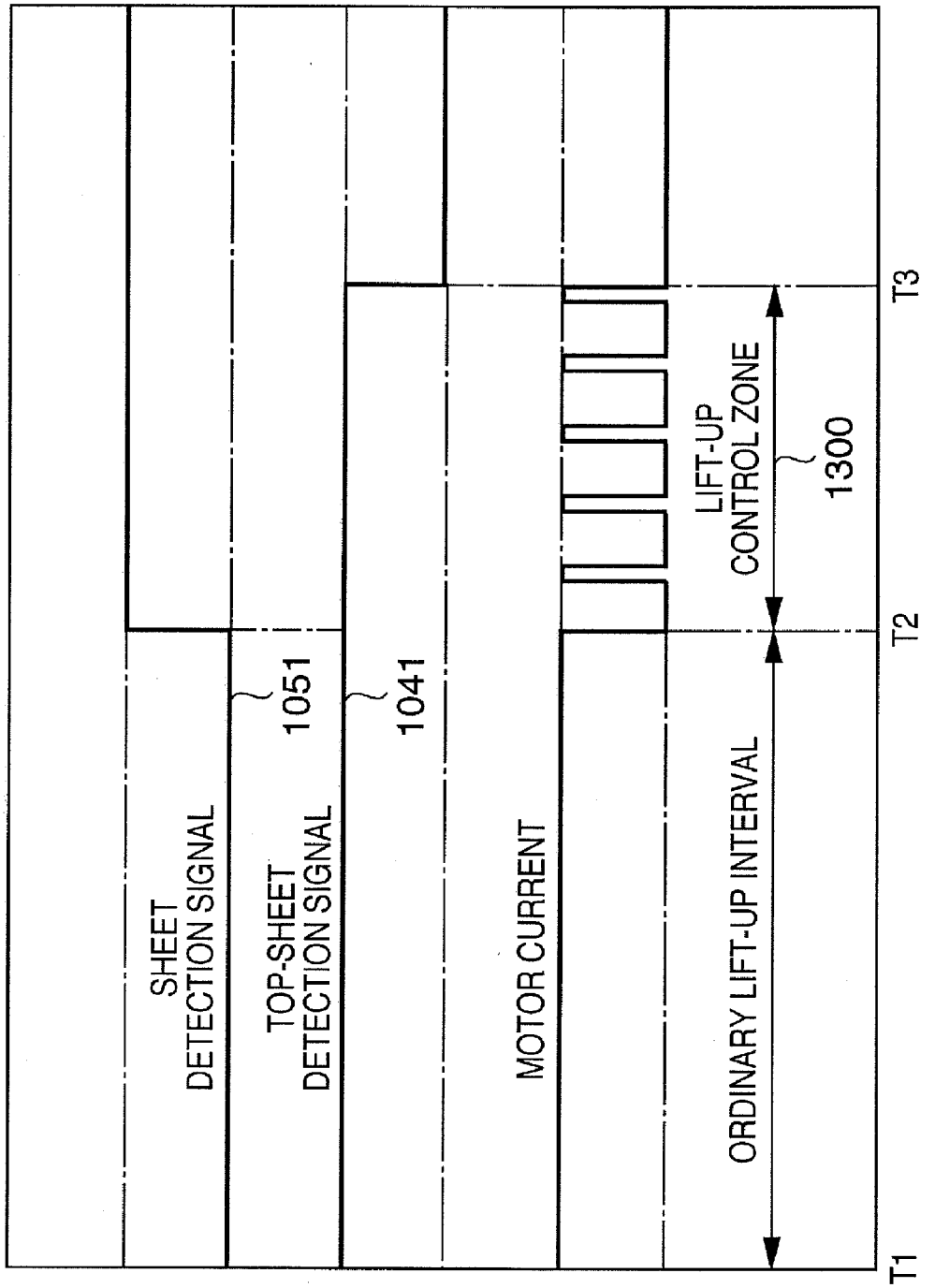

AT TIME OF ORDINARY LIFT-UP
AT TIME OF LIFT-UP CONTROL
1201
1200
MORE
LESS
NUMBER OF SHEETS LOADED
MORE
AMOUNT OF OVERRUN
LESS

FIG. 13


SHEET DETECTION SIGNAL
TOP-SHEET DETECTION SIGNAL
1051
1041
MOTOR CURRENT
LIFT-UP CONTROL ZONE
1300
ORDINARY LIFT-UP INTERVAL
T1
T2
T3

SHEET FEEDER AND IMAGE FORMING APPARATUS HAVING SAID SHEET FEEDER

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a sheet feeder for feeding sheets, and to an image forming apparatus having this sheet feeder.

[0003] 2. Description of the Related Art

[0004] An image forming apparatus such as a printer, copier or facsimile machine is provided with a sheet feeder for feeding sheets to an image forming unit. The sheet feeder accommodates a plurality of sheets in stacked form on a liftable sheet loading member provided in a sheet accommodating section capable of accommodating the sheets, and feeds the sheets by a sheet feeding mechanism after the sheet loading member has been moved (lifted) to a position at which the feeding of sheets is possible. In such a sheet feeder, the sheet accommodating section is capable of being pulled out of the sheet feeder so as to facilitate the loading of sheets in the sheet accommodating section. It is so arranged that when the sheet accommodating portion is pulled out, the sheet loading member is lowered to the prescribed sheet loading position automatically. In particular, with a sheet feeder connected to a printer, a sheet surface sensor is provided for sensing the height of the top sheet of the sheets loaded on the sheet loading member. On the basis of information from the sheet surface sensor, the position of the sheet loading member is controlled in such a manner that the position of the top sheet will always be at a substantially fixed position.

[0005] In the sheet feeding mechanism, a pick-up roller is rotated in abutting contact with the top sheet when a sheet feed signal is sent from the image forming apparatus proper. The top sheet is fed next up to a pair of separation rollers. The separation rollers separate, sheet by sheet, the sheets fed to it by rotation of the pick-up roller and send the separated sheets into the image forming apparatus proper. When the pick-up roller sends sheets into the pair of separation rollers, the pick-up roller is withdrawn above the sheets out of contact with the sheets so as not to be an obstruction when the separation rollers separate the sheets. The sheet feeder repeats this operation whenever it is sent the sheet feed signal, thereby feeding the sheets to the image forming apparatus proper one sheet at a time.

[0006] In order to prevent the non-feeding of sheets or the feeding of overlapping sheets in such a feeding mechanism, it is preferred that the position of the top sheet on the sheet loading member be kept at a position where the pick-up roller will contact the top sheet with an appropriate feed pressure and can feed the sheet to the nip of the pair of separation rollers reliably. However, there are cases where a driving motor is used as the driving source that lifts the sheet loading member. Even if it is attempted to halt rotation of the driving motor in such cases, rotation cannot be halted immediately owing to inertial force (so-called overrun). This causes a variation in the position of the top sheet on the sheet loading member. In particular, when the sheet loading member is moved with a small number of sheets loaded on it, the driving force of the driving motor is too large relative to the weight of the sheets on the loading member. Consequently, the force of inertia also increases and there is a major change in the position of the top sheet.

[0007] As a method of solving this problem, it has been proposed to lift the sheet loading member up to a position at which feed is possible, then lower the sheet loading member temporarily and then reduce the voltage applied to the driving motor to thereby lift the sheet loading member again. As a result, overrun of the driving member can be reduced and the variation in the position of the top sheet on the sheet loading member can be reduced [see the specification of Japanese Patent Application Laid-Open No. 9-086680 (Patent Document 1)].

[0008] In accordance with Patent Document 1, the sheet loading member is lowered temporarily and then the voltage applied to the driving motor is reduced to drive the motor so as to lift the sheet loading member again. This expedient not only complicates control of movement but also leads to an increase in cost because it is necessary to provide circuitry that makes it possible to rotate the motor back and forth and for reducing the voltage applied to the motor. Further, since it is necessary to lift the sheet loading member twice, another problem is prolongation of the time it takes for the feeding of a sheet to become possible.

[0009] Further, in a proposal set forth in the specification of Japanese Patent Application Laid-Open No. 4-159932 (Patent Document 2), a timer for measuring the raising or lowering time of a hopper is provided. If a microswitch for sensing the position of a form in a prescribed period of time is not sensed, the rotation of a motor for raising or lowering the hopper is halted, after which the motor is driven intermittently. As a result, in cases where a large number of sheets of paper have been loaded and overrun therefore is small, the time needed to drive the motor is shortened by raising or lowering the hopper without driving the motor intermittently. In cases where a small number of sheets of paper have been loaded and overrun therefore tends to occur, the hopper is raised or lowered immediately without driving the motor intermittently up to a prescribed period of time that has been set. By then driving the motor intermittently upon elapse of this period of time, the hopper can be raised or lowered in a shorter time and overrun reduced.

[0010] With the arrangement described in Patent Document 2, measurement of the time needed to lift the hopper becomes impossible if the power supply is turned off during the raising of the hopper. This means that hopper overrun cannot be prevented reliably. Further, although lift-up time measured by the timer can be stored on a storage medium (e.g., an EEPROM) that is capable of retaining data even if power is cut off, this necessitates the provision anew of a storage medium or the like and leads to higher cost. An additional problem is more complicated control since processing for storing time on the storage medium constantly is required.

[0011] The specification of Japanese Patent Application Laid-Open No. 1-214528 (Patent Document 3) discloses a paper feeding mechanism having a table on which cut sheets of paper are placed; a table moving mechanism for moving the table up and down; and an upper-limit-position detecting mechanism comprising a lever, light-shielding plate and photo-interpreter for detecting the upper-limit position of the cut sheets of paper on the table. In accordance with this disclosure, the table rises and the lever is pushed upward by the cut sheets of paper, as a result of which the optical path of the photo-interpreter is blocked by the light-shielding plate and the motor raising the table is turned off. The light-shielding plate is formed to include a plurality of slits.

As the table rises, the optical path of the photo-interpreter is blocked by the portions between the plurality of slits in the shielding plate. When this occurs, the motor is turned off and drive for elevating the table is halted. However, owing to inertia of the motor when the motor is stopped, a slit in the shielding plate reaches a position opposite the photo-interpreter, the motor turns on again and the table is lifted up. In other words, as a result of repetition of the on-off operation of the motor, the speed at which the table rises is slowed. Eventually, a slit for continuous feeding of paper comes into position opposing the optical path of the photo-interpreter and the table comes to rest.

[0012] With the arrangement of Patent Document 3, cost rises owing to provision of a special-purpose detection mechanism for controlling movement of the table. Further, since space is required in order to install the special-purpose detection mechanism, the apparatus is increased in size.

SUMMARY OF THE INVENTION

[0013] An aspect of the present invention is to eliminate the problems set forth above.

[0014] According to an aspect of the present invention, there is provided a sheet feeder comprising;

[0015] a tray on which sheets are loaded;

[0016] a feeding member configured to contact and feed a top sheet loaded on the tray;

[0017] a drive unit configured to lift the tray;

[0018] a first sensor configured to sense that the top sheet on the tray lifted by the drive unit is situated at a prescribed position;

[0019] a second sensor configured to sense that the top sheet on the tray lifted by the drive unit is situated at a feed position, at which feed is possible by the feeding member, higher than the prescribed position; and

[0020] a controller configured to control the drive unit so that the drive unit performs a predetermined intermittent driving for lifting the tray response to a sensing of the first sensor when the tray is lifted by the drive unit, and determine whether or not a sheet is present on the tray based upon the sensed states of the first and second sensors.

[0021] According to an aspect of the present invention, there is provided an image forming apparatus comprising: the sheet feeder set forth in claim **1**; and

[0022] an image forming unit configured to form an image on a sheet transported from the sheet feeder.

[0023] Further features and aspects of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate an embodiment of the invention and, together with the description, serve to explain the principles of the invention.

[0025] FIG. **1** depicts an external perspective view illustrating a laser printer according to an exemplary embodiment of the present invention;

[0026] FIG. **2** depicts an external perspective view illustrating a paper feed cassette in a state extracted from the laser printer in the state of FIG. **1**;

[0027] FIG. **3** depicts a schematic sectional view illustrating the overall configuration of the laser printer fitted with a sheet accommodating unit according to the exemplary embodiment;

[0028] FIG. **4** depicts a mechanism view illustrating the details of a sheet feeding section of the paper feed cassette;

[0029] FIG. **5** is a diagram useful in describing a mechanism for lifting up a tray of the paper feed cassette;

[0030] FIG. **6** depicts an external view of the mechanism illustrating the tray in a state lowered from that shown in FIG. **4**;

[0031] FIG. **7** is a diagram useful in describing a state in which the top sheet in a paper feed cassette is fed;

[0032] FIGS. **8**A and **8**B are diagrams useful in describing lift-up of the tray in the paper feed cassette according to this exemplary embodiment;

[0033] FIGS. **9**A and **9**B are diagrams useful in describing a state in which the tray has been lifted to make feeding possible;

[0034] FIG. **10** is a block diagram illustrating the configuration of a laser printer according to this exemplary embodiment;

[0035] FIG. **11** is a flowchart for describing control when lifting a tray, which is a sheet loading base, in the laser printer according to this exemplary embodiment;

[0036] FIG. **12** is a diagram for comparing control of a lift-up operation according to this embodiment and an ordinary lift-up operation based upon number of sheets in a cassette and amount of overrun; and

[0037] FIG. **13** is a timing chart for describing control of the lift-up operation in an laser printer according to this exemplary embodiment.

DESCRIPTION OF THE EMBODIMENT

[0038] A preferred embodiment of the present invention will now be described in detail with reference to the accompanying drawings. It should be noted that the following embodiment does not limit the present invention set forth in the scope of the claims and that all combinations of the features described in the embodiment are not necessarily essential as the inventive means for solving the foregoing problems.

[0039] An embodiment of the present invention will be described taking as an example a sheet accommodating unit connected to a laser printer.

[0040] FIG. **1** depicts an external view illustrating a laser printer **1** according to an embodiment of the present invention.

[0041] The laser printer **1** has a cassette **2** accommodating sheets S in stacked form. The cassette **2** is a single stage only and is provided within the laser printer **1**. A three-stage cassette deck, which constitutes a sheet accommodating unit **51**, serves also as a base on which the laser printer **1** is placed and is disposed below the laser printer **1**. The sheet accommodating unit **51** is provided with paper feed cassettes **52***a*, **52***b* and **52***c*. The paper feed cassettes **52***a*, **52***b* and **52***c* accommodate, in stacked form, multiple sheets of respective ones of various sizes and weights. Casters are attached to the bottom of the sheet accommodating unit **51** at the four corners thereof in view of the fact that the laser printer **1** is moved while placed on the unit **51**. Discharged sheets on which printing has been completed are stacked and accommodated in a discharge tray **12** with their printed side (image side) facing down.

[0042] FIG. **2** depicts an external perspective view illustrating the paper feed cassette **52***a* pulled out of the laser printer **1** in FIG. **1**.

[0043] The paper feed cassette **52***a* has a sheet accommodating section provided with tray **101** on which sheets are loaded and which is free to move up and down within the cassette, and regulating plates **57**, **58** and **59**. The other paper feed cassettes **52***b* and **52***c* have a similar structure.

[0044] FIG. **3** depicts a schematic sectional view illustrating the overall configuration of the laser printer **1** fitted with the sheet accommodating unit. Portions in FIG. **3** similar to those shown in FIGS. **1** and **2** are designated by like reference characters.

[0045] A feed roller (pick-up roller) **3** serving as a feed member is rotated to feed sheets S, which have been loaded in the cassette **2**, from the uppermost side. A pair of retard rollers **4** separate and transport, one at a time, the sheets S fed by rotation of the pick-up **3**. A Sheet S thus separated one at a time is transported within the printer proper by transport rollers **5**, **6**.

[0046] A process cartridge **7** houses a well-known image forming process unit relating to image formation and is provided so as to be removable from the printer proper. The process cartridge **7** incorporates a photosensitive drum **7***a* as an image carrier. A charging unit **7***b* charges the surface of the photosensitive drum **7***a* uniformly. The surface of the photosensitive drum **7***a* charged by the charging unit **7***b* is illuminated with laser light, which conforms to image information, from a laser exposure unit **8**, whereby an electrostatic latent image is formed on the drum surface. A developing unit **7***c* causes toner to attach to the surface of the drum **7***a* on which the electrostatic latent image has been formed, thereby developing the electrostatic latent image into a toner image. A transfer roller **9** is brought into pressured contact with the photosensitive drum **7***a*. When a sheet S transported by the transport rollers **6** passes between the photosensitive drum **7***a* and the transfer roller **9**, the toner image on the drum surface is transferred to the sheet S. A fixing unit **10** applies heat and pressure to the sheet S to which the image has thus been transferred, thereby fixing the transferred image on the sheet. The sheet S on which the image has thus been fixed is transported to a pair of discharge rollers **11**. The sheet is discharged by rotation of the discharge rollers **11**, image side down, onto the discharge tray **12** formed in the top side of the printer body. A cleaning unit **7***d* recovers untransferred toner remaining on the surface of the photosensitive drum **7***a* and cleans off the drum surface.

[0047] The mechanism for feeding sheets from the cassettes **52***a* to **52***c* provided in the sheet accommodating unit **51** will be described next. Since the three feed mechanisms are similar as well as the three cassettes, the description will be rendered taking the uppermost feed mechanism and the cassette **52***a* as an example.

[0048] As illustrated in FIGS. **2** and **3**, each paper feed cassette has a sheet accommodating section provided with the tray **101** on which sheet stack Sa is loaded and which is free to move up and down within the cassette, and regulating plates **57**, **58** and **59**. The mechanism has a pick-up roller **53***a*, which is a sheet feeding roller for feeding a top sheet S1 of the sheet stack Sa placed on the tray **101**. The mechanism further includes a pair of separation rollers formed by a feed roller **54***a* and a retard roller **55***a* for separating a sheet S fed by rotation of the pick-up roller **53***a*. The mechanism further includes a transport roller **56***a* for transporting the sheet S, separated and fed one sheet at a time by the separation rollers, to the image forming apparatus (printer) proper. It should be noted that pick-up rollers **53***b*, **53***c*, feed rollers **54***b*, **54***c*, retard rollers **55***b*, **55***c* and transport rollers **56***b*, **56***c* in the other paper feed cassettes **52***b*, **52***c* perform the same role as the similarly named rollers described above.

[0049] As illustrated in FIGS. **2** and **4**, the tray **101** is connectably provided on a lifter drive unit **103** provided on the sheet accommodating unit **51** via a lift arm **102**. The lifter drive unit **103** includes gears **111**, **112**, **113** and a lift motor **114**, as illustrated in FIG. **5**. FIG. **5** is a diagram useful in describing the lift-up mechanism of the tray **101** of paper feed cassette **52***a*. When the lift motor **114** is driven into rotation, the speed of rotation is slowed down by the gears **111**, **112**, **113** and a gear **110** provided on the cassette **52***a* and a semi-circular gear **109** connected to the lift arm **102** are rotated. As a result, the tray **101** is moved (lifted up) in the upward direction (in the direction of arrow A in FIG. **5**).

[0050] FIG. **4** depicts a mechanism view illustrating the details of a sheet feeding section of a paper feed cassette **52** (the generic term for the cassettes **52***a* to **52***c*). Here the tray **101** is illustrated in the lifted state. In FIG. **4**, rollers **53** to **56** correspond to the above-mentioned pick-up rollers **53***a* to **53***c*, feed rollers **54***a* to **54***c*, retard rollers **55***a* to **55***c* and transport rollers **56***a* to **56***c*, respectively.

[0051] FIG. **6** depicts an external view of the mechanism illustrating the tray **101** in a state lowered from that shown in FIG. **4**.

[0052] FIGS. **8**A and **8**B are diagrams useful in describing lift-up of the tray **101** in a paper feed cassette according to this embodiment, and FIGS. **9**A and **9**B are diagrams useful in describing a state in which the tray has been lifted to make feeding possible. FIG. **9**A illustrates a state in which sheets are present on the tray **101**, and FIG. **9**B a state in which there are no sheets on the tray **101**.

[0053] A sheet detector **105** detects whether sheets have been loaded on the tray **101** and has a first photosensor **106** and a first flag **107** that is moved so as to be capable of turning on and off an infrared beam directed toward the first photosensor **106**. One end of the first flag **107** abuts against and is pushed by the top sheet, whereby the first flag **107** is turned about its axis. The first flag **107** blocking the infrared beam of the first photosensor **106** is moved as a result, whereby the infrared beam is allowed to reach the first photosensor **106** [this state (detection of paper) is the "sensor on" state]. If there is no application of external force, the first flag **107** waits at a position to which it has fallen under its own weight (such a state is illustrated in FIG. **8**A). At such time the infrared beam directed toward the first photosensor **106** is blocked by the first flag **107** [this state (no paper) is the T"sensor off" state].

[0054] The tray **101** is provided with a cut-away portion **108**, as illustrated in FIG. **4**. As a result, when the tray **101** is lifted without any sheets being loaded thereon, the first flag **107** does not contact the tray **101** and remains in the stand-by state under its own weight, as described above. Accordingly, in a case where the tray **101** has been lifted without sheets being loaded on the tray **101**, the first photosensor **106** remains cut off from the infrared beam (sensor off) in the manner set forth above.

[0055] A sheet detection signal **1051** (FIG. **10**), which indicates whether a sheet is present or not, from the sheet

detector **105** changes over from the OFF state to the ON state (the state in which the first flag **107** abuts against a sheet) if a sheet has been placed at a prescribed position on the tray **101** in lift-up thereof.

[0056] A top-sheet detector **104** (FIGS. **4** and **10**) includes a second flag **207** (see FIGS. **8**A, **8**B, **9**A, **9**B) placed above a sheet stack Sa placed upon the tray **101** and capable of being turned by coming into abutting contact with the top sheet of the sheet stack Sa, and a second photosensor **115** (see FIGS. **4**, **6**, **8**A, **8**B, **9**A, **9**B) turned on and off by the second flag **207**. One end of the second flag **207** is pushed by coming into abutting contact with the top sheet, whereby the second flag **207** turns about its axis. When the second flag **207** moves, an infrared beam impinging upon the second photosensor **115** is blocked by the second flag **207**. This state in which the second photosensor **115** is cut off from the beam is the "sensor off" state. If there is no application of external force, the second flag **207** waits at a position to which it has fallen under its own weight (such a state is illustrated in FIG. **8**A). In this stand-by state, the infrared beam reaches the second photosensor **115** (this is the "sensor on" state).

[0057] The position at which the top-sheet detector **104** detects a sheet on the tray **101** is a position above that at which the sheet detector **105** detects a sheet. A top-sheet detection signal **1041** (FIG. **10**) from the top-sheet detector **104** is turned off (feed becomes possible) when the top sheet on the tray **101** has been lifted to a position at which feed becomes possible by the pick-up roller **53**.

[0058] If the tray **101** is lifted without sheets being loaded on the tray **101**, the second flag **207** is contacted by the tray **101** and turns (see FIG. **9**B). Owing to this movement of the second flag **207**, the second photosensor **115** changes over from the sensor-on to the sensor-off state, as described above.

[0059] When the paper feed cassette **52***a* is pulled from the sheet accommodating unit (deck) **51**, as illustrated in FIG. **2**, the tray **101** is released from its connection to the lifter drive unit **103** (FIG. **4**) provided on the sheet accommodating unit **51**. As a result, the tray **101** drops to the lowermost portion of the paper feed cassette **52***a* under its own weight.

[0060] When the placing of the sheet stack Sa on the tray **101** has been completed, the paper feed cassette **52***a* is set in the sheet accommodating unit **51** in the manner depicted in FIG. **1**. A controller (**1001** in FIG. **10**) that has sensed this operation drives the lifter drive unit **103** into rotation, thereby lifting the connected tray **101**. As described above, the first flag **107**, which is capable of being turned by contact with the top sheet of the sheet stack Sa, and the first photosensor **106** turned on and off by the first flag **107** are provided on the upper side of the sheet stack Sa placed on the tray **101**. Further provided is the top-sheet detector **104**, which includes the second flag **207** capable of being turned by contact with the top sheet of the sheet stack Sa and the first photosensor **106** turned on and off by the second flag **207**.

[0061] In a case where the top sheet on the tray **101** is at a position lower than a prescribed position, the second flag **207** in the top-sheet detector **104** moves under its own weight and leaves the position at which it blocks the light of the second photosensor **115**, as a result of which the output of the second photosensor **115** attains the ON state.

[0062] If the tray **101** is thenceforth lifted by the lifter drive unit **103** so that the top sheet on the tray **101** is lifted to the prescribed position, the first flag **107** abuts against the top sheet. If the tray **101** is lifted further, then the second flag **207** is turned to a position at which it blocks the light of the second photosensor **115**, whereby the output of the second photosensor **115** attains the OFF state. It is so arranged that the position at which the output of the second photosensor **115** attains the OFF state is a position at which the top sheet on the tray **101** can be fed by rotation of the sheet pick-up roller **53** and guided smoothly to the nip between pair of separation rollers **54**, **55**. Control is exercised in such a manner that the lifter drive unit **103** halts rotation when the top-sheet detection signal **1041** attains the OFF state (i.e., when the top sheet on the tray **101** is lifted to a position at which feed is possible). As a result, the top sheet on the tray **101** is always placed at a position where it is capable of being fed.

[0063] FIG. **7** is a diagram useful in describing a state in which the sheet in a paper feed cassette is fed. Portions in FIG. **7** similar to those shown in the above described drawings are designated by like reference characters.

[0064] When a sheet feed signal is sent from the image forming apparatus proper, the pick-up roller **53** comes into abutting contact with top sheet S**1** and rotates, as indicated at **53-1**. Owing to rotation of the pick-up roller **53**, the top sheet is fed up to the pair of separation rollers **54**, **55**. The separation rollers **54**, **55** separate and feed, one sheet at a time, sheets fed in by rotation of the pick-up roller **53** and send each sheet into the image forming apparatus. It is so arranged that when the pick-up roller **53** feeds a sheet to the pair of separation rollers **54**, **55**, the pick-up roller **53** is withdrawn above the sheet S**1** out of contact with the sheet S**1** so as not to be an obstruction when the separation rollers **54**, **55** separate the sheets. Thus, whenever a sheet feed signal is sent from the image forming apparatus, the above-described operation is repeated so that sheets are transported to the image forming apparatus one sheet at a time.

[0065] In a state in which the tray **101** has been lowered to the lowermost position, as depicted in FIG. **8**A, the first flag **107** is waiting, under its own weight, at the position shown in FIG. **8**A. At this time the infrared beam directed toward the first photosensor **106** is being blocked by the first flag **107** (the first photosensor **106** is in the OFF state). On the other hand, the second photosensor **115** under these conditions is not cut off from light by the second flag **207** and is in the ON state.

[0066] FIG. **8**A is for describing a lift-up zone in which the tray **101** is lifted up from its lowermost position by ordinary lift-up processing. FIG. **8**B, on the other hand, illustrates a lift-up control interval in which the lift-up operation is controlled, this being performed in a prescribed zone in which the tray **101** is lifted up from its lowermost position to its uppermost position (feed position). The lift-up control interval will be described below in detail. When the sheet detector **105** changes over from the sensor-off state to the sensor-on state during lift-up, the lift-up operation is halted temporarily and lift-up control, described below, is executed, as illustrated in FIG. **8**B.

[0067] FIGS. **9**A and **9**B are diagrams useful in describing a state in which the tray **101** has been lifted to make feeding possible. FIG. **9**A illustrates a state in which sheets are present on the tray **101**, and FIG. **9**B a state in which there are no sheets on the tray **101**.

[0068] With sheets loaded on the tray **101**, the tray **101** is lifted up to the feed position by the lifter drive unit **103**

described above. As the tray **101** is in the process of being lifted, one end of the first flag **107** abuts against the top sheet S1 and is pushed toward the upper side. As a result, the first flag **107** turns in the clockwise direction about a shaft **107***a*. Consequently, as illustrated in FIG. **9**A, the infrared beam of the second photosensor **115** is blocked and the second photosensor **115** is cut off from the beam (i.e., attains the OFF state).

[0069] If the tray **101** is lifted without sheets being loaded thereon, as illustrated in FIG. **9**B, then the first flag **107** passes through the cut-away portion **108** (FIG. **4**) in the tray **101**. As a result, the first flag **107** does not contact the tray **101** and is in the standby state owing to its own weight, in a manner similar to that shown in FIG. **8**A. Accordingly, the infrared beam directed toward the second photosensor **115** remains unobstructed while the infrared beam directed toward the first photosensor **106** remains in the blocked state. If the tray **101** is lifted without sheets being loaded thereon, the second flag **207**, on the other hand, contacts the tray **101** and is turned (see FIG. **9**B). Owing to such motion of the second flag **207**, the second photosensor **115** changes over from the sensor-on state to the sensor-off state.

[0070] If the signal from the first photosensor **106** remains OFF when the tray **101** is lifted and the second photosensor **115** changes over to the OFF state, then a decision is rendered to the effect that there are no sheets placed on the tray **101**. In this case, the feeding operation is inhibited and absence of paper is displayed on a console unit **1004** (FIG. **10**), which is an indication unit on the image forming apparatus, whereby the operator, etc., can be prompted to replenish the sheets of paper.

[0071] FIG. **10** is a block diagram illustrating the configuration of the laser printer **1** according to this embodiment.

[0072] A controller **1001** controls the overall laser printer and includes a CPU **1010** such as a microprocessor, a ROM **1011** for storing programs, which are executed by the CPU **1010**, and data, and a RAM **1012** for storing various data temporarily. A printer engine **1002** has the laser exposure unit **8** shown in FIG. **3**, and various motors and the fixing unit **10** for forming an image following installation of the process cartridge **7**. On the basis of a command from the controller **1001**, a motor driver **1003** rotates the lift motor **114** to control lift-up of the tray **101**. As mentioned above, the top-sheet detector **104** has the first flag **107** and second photosensor **115**. When the top sheet on the tray **101** has been lifted by rotation of the pick-up roller **53** to the position at which feed is possible, the top-sheet detector **104** sends the top-sheet detection signal **1041** to the low level (OFF). As mentioned above, the sheet detector **105** has the first flag **107** and first photosensor **106**. If a sheet has been placed at a prescribed position of the tray **101** in lift-up thereof, then the sheet detector **105** changes over the sheet detection signal **1051** from the OFF to the ON state. The console unit **1004** has a display for displaying messages to the user, and a control panel manipulated by the user. It should be noted that other sensors and mechanisms not referred to in this description of the embodiment are not illustrated in FIG. **10**.

[0073] FIG. **11** is a flowchart for describing control when lifting the tray **101**, which is a sheet loading base, in the laser printer **1** according to this embodiment. The program for executing this processing has been stored in the ROM **1011** and is executed under the control of the CPU **1010**.

[0074] The processing illustrated in FIG. **11** is started by inserting the paper feed cassette **52** into the sheet accommodating unit **51**, by way of example. Sheet cassette sensing means (not shown) senses the insertion of the cassette. Usually the top-sheet detector **104** is in the sensor-on state and the sheet detector **105** in the sensor-off state at this time, as illustrated in FIG. **8**A. In step S1, the CPU **1010** determines whether the top-sheet detection signal **1041** is ON. Since the signal **1041** is ON, control proceeds to step S2, where the CPU **1010** determines whether the sheet detection signal **1051** is ON (sheets present). Since the sheet detection signal **1051** is OFF, control proceeds to step S3. Here the lift motor **114** is rotated via the motor driver **1003** and the CPU **1010** exercises control so as to perform the ordinary lift-up operation. Here "ordinary lift-up operation" refers to an operation in which the tray **101** is lifted by rotating the lift motor **114** continuously.

[0075] If the sheet detection signal **1051** from the sheet detector **105** changes over from the sensor-off state to the sensor-on state during this lift-up, as illustrated in FIG. **8**B, control proceeds from step S2 to step S4. In step S4, the CPU **1010** controls drive of the lift motor **114** in such a manner that rotation of the lift motor **114** is halted to stop the lift-up operation for a given period of time. Here the lift-up operation is stopped for 100 ms, by way of example. Next, control proceeds to step 5S, where the CPU **1010** determines whether the top-sheet detection signal **1041** from the top-sheet detector **104** has turned OFF. When the top-sheet detection signal **1041** turns OFF, this means that the top sheet on the tray **101** has reached the feed position. If the top-sheet detection signal **1041** is still in the ON state, then control proceeds to step S6. Here the CPU **1010** controls drive of the lift motor **114** in such a manner that the lift motor **114** is rotated to perform the lift-up operation for 30 ms, by way of example. Control then proceeds to step S4. Here the rotation of the lift motor **114** is halted again for the prescribed period of time, control proceeds to step S5 and the above-described processing is repeated.

[0076] If the CPU **1010** determines at step S5 that the top-sheet detection signal **1041** has turned OFF, meaning that the top sheet of the tray **101** has reached the feed position, then control proceeds to step S7. Here the feed standby state illustrated in FIG. **9**A is attained.

[0077] If the top-sheet detection signal **1041** is found to be OFF (i.e., the top sheet has reached the feed position) in step S1, on the other hand, then control proceeds to step S8, at which the CPU **1010** determines whether the sheet detection signal **1051** at this time is ON (paper present) or not. If the sheet detection signal **1051** is OFF, then this indicates that there are no sheets in the cassette and control therefore proceeds to step S9. Here a display indicating absence of sheets is presented on the console unit **1004** to warn the user. If the sheet detection signal **1051** is found to be ON (paper present) at step S8, then control proceeds to step S7 and the feed standby state illustrated in FIG. **9**A is attained.

[0078] FIG. **12** is a diagram for comparing control of the lift-up operation according to this embodiment and the ordinary lift-up operation based upon number of sheets in a cassette and amount of overrun.

[0079] Control of the lift-up operation according to this embodiment is indicated at **1200**, and control of the lift-up operation according to the prior art is indicated at **1201**. It will be understood from this comparison that by exercising control according to this embodiment, the amount of over-

run due to the lift-up operation can be kept small even in a state in which a small number of sheets are loaded in the cassette.

[0080] FIG. **13** is a timing chart for describing control of the lift-up operation in the laser printer according to this embodiment.

[0081] Rotation of the lift motor **114** has been started with the top-sheet detection signal **1041** in the ON state and the sheet detection signal **1051** in the OFF state (timing T**1**). At timing T**2**, the sheet detection signal **1051** changes from the OFF to the ON state, as a result of which control proceeds from step S**2** to step S**4** in FIG. **11** and rotation of the lift motor **114** is halted temporarily. In a lift-up control zone **1300**, lift-up drive is performed repeatedly (S**6**) by rotating the lift motor **114** intermittently 30 ms at a time, as in the example described above. At timing T**3**, the top-sheet detection signal **1041** assumes the OFF state ("YES" at S**5**) and the top sheet on the tray **101** attains the state in which feed is possible, whereupon rotation of the lift motor **114** is halted to complete lift-up of the tray **101**.

[0082] By exercising such control, the amount of overrun of the tray **101**, in which the tray **101** is lifted up too much owing to the inertial force of the lift motor **114**, can be reduced more by lift-up control **1200** according to this embodiment in comparison with ordinary lift-up control indicated at **1201**, as illustrated in FIG. **12**. As a result, the feed position at the time of feed is stabilized and problems such as non-feeding of sheets and feeding of overlapping sheets can be prevented.

[0083] Further, by using control according to this embodiment, the time required for lift-up is longer than when lift-up is performed in the ordinary manner. According to this embodiment, however, the zone in which intermittent drive is performed using the result of detection by the sheet detector **105** is limited and therefore the time is takes for lift-up also can be made comparatively short.

[0084] Further, even in a case where the power supply is turned off during lifting of the tray **101**, the next time the power supply is turned on it can be determined by the sheet detector **105** in what state the tray **101** serving as the sheet loading base resides. This means that it is no longer necessary to store the conditions prevailing during lift-up, and the lift-up operation of the tray **101** can be controlled appropriately even if the power supply is turned off during lift-up.

[0085] In another conceivable arrangement, the quantity of sheets remaining in a cassette is detected using a residual-sheet detecting unit, which is for detecting quantity of sheets remaining on the tray **101**, instead of the sheet detector **105**. Then, when a prescribed residual sheet quantity is attained, lift-up control is executed. In this embodiment, a sensor serving as a trigger to start control and a sensor for detecting whether or not a sheet is present are combined. As a result, the number of component parts can be reduced as compared with the conventional arrangement provided with a special-purpose sensor for performing lift-up control. This makes it possible to hold down cost.

[0086] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

[0087] This application claims the benefit of Japanese Patent Application No. 2006-180370, filed Jun. 29, 2006, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A sheet feeder comprising;
a tray on which sheets are loaded;
a feeding member configured to contact and feed a top sheet loaded on said tray;
a drive unit configured to lift said tray;
a first sensor configured to sense that the top sheet on said tray lifted by said drive unit is situated at a prescribed position;
a second sensor configured to sense that the top sheet on said tray lifted by said drive unit is situated at a feed position, at which feed is possible by said feeding member, higher than the prescribed position; and
a controller configured to control said drive unit so that said drive unit performs a predetermined intermittent driving for lifting said tray response to a sensing of said first sensor when said tray is lifted by said drive unit, and determine whether or not a sheet is present on said tray based upon the sensed states of said first and second sensors.

2. The sheet feeder according to claim **1**, wherein said controller controls so that said drive unit stops a driving response to a sensing of said second sensor.

3. The sheet feeder according to claim **1**, further comprising a first flag configured to be moved by coming into contact with the top of a sheet loaded on said tray;
wherein in a case where a sheet is present on said tray, said first flag changes over the sensed state of said first sensor in a case that the top sheet reaches the prescribed position owing to lifting of said tray.

4. The sheet feeder according to claim **3**, further comprising a second flag configured to be moved by coming into contact with the top of a sheet loaded on said tray or with said tray per se;
wherein said second flag changes over the sensed state of said second sensor by coming into contact with the top sheet in a case that the top sheet reaches the feed position owing to lifting of said tray.

5. The sheet feeder according to claim **4**, wherein said controller determines that there are no sheets on said tray in a case that the sensed state of said second sensor has changed, without a change in the sensed state of said first sensor, owing to lifting of said tray.

6. The sheet feeder according to claim **1**, wherein said controller drives said drive unit continuously until said first sensor senses that said tray has reached the prescribed position.

7. An image forming apparatus comprising:
the sheet feeder set forth in claim **1**; and
an image forming unit configured to form an image on a sheet transported from said sheet feeder.

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