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(54) **METHOD OF CORRECTING A MULTI-FEED IN AN AUTOMATIC DOCUMENT FEEDER**

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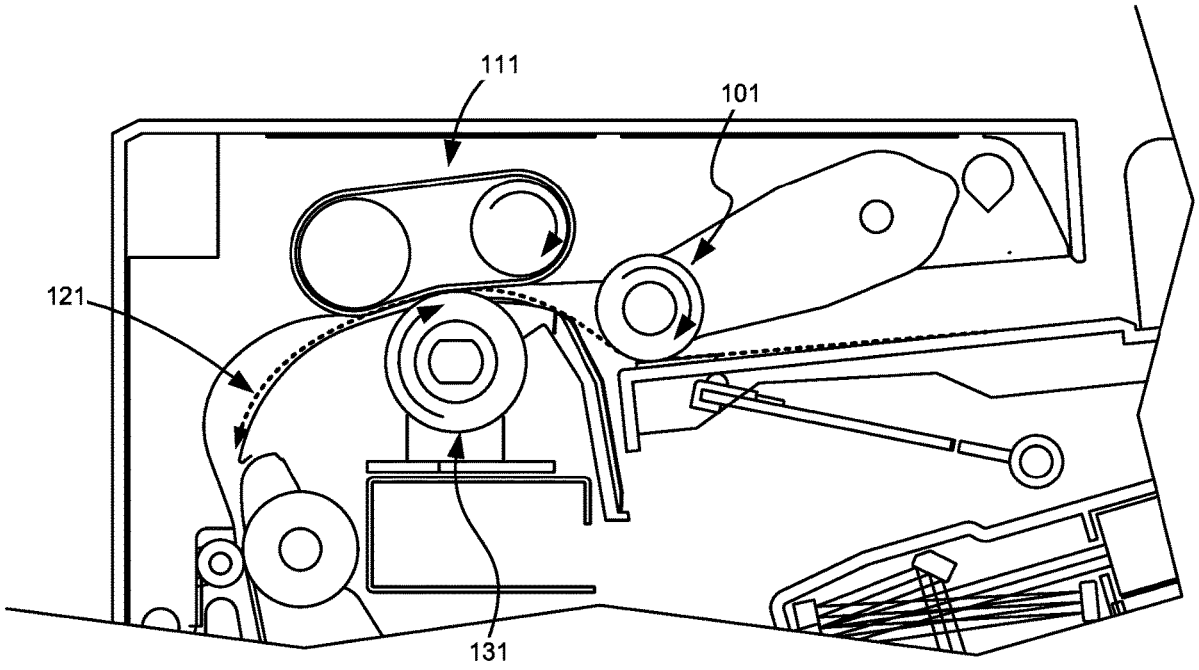
(57) **ABSTRACT**

A method for operating a paper feed system for use in a printing apparatus that detects multi-feeds and separates all sheets while allowing a single sheet to continue is disclosed. The separation method controls a motor for the separator roller that can be torque controlled, allowing varying torques depending on media type and/or user input. The separation method detects multi-feeds, correct the multi-feed, and ultimately feeds one sheet at a time through the automatic document feeder.



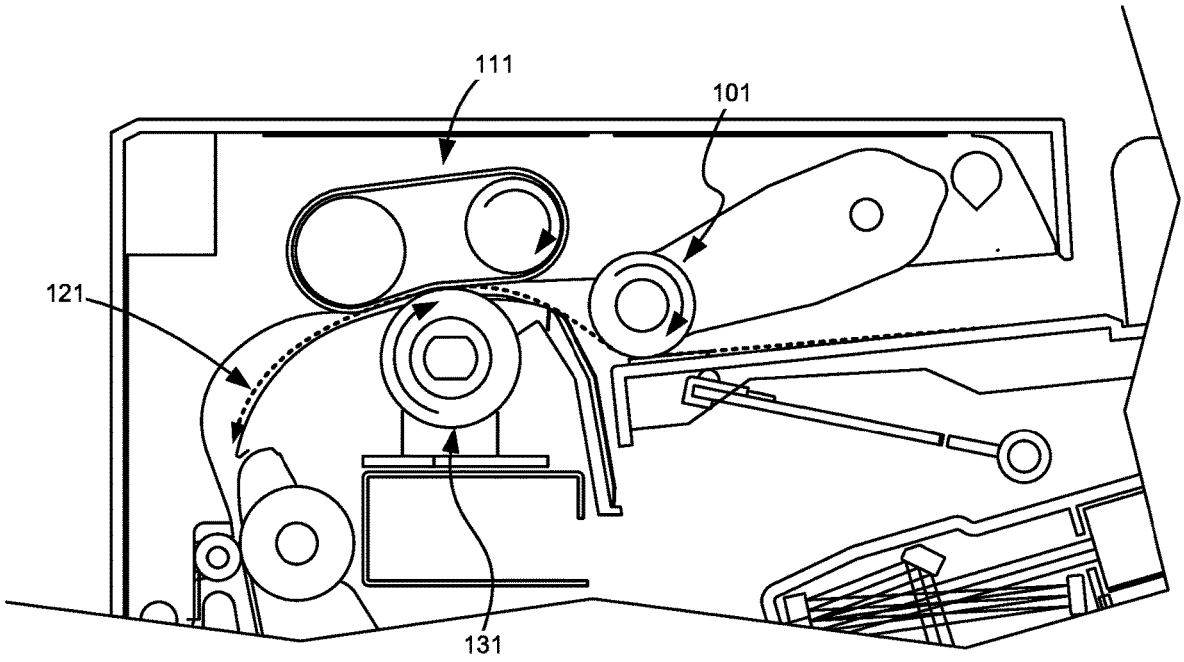


FIG. 1

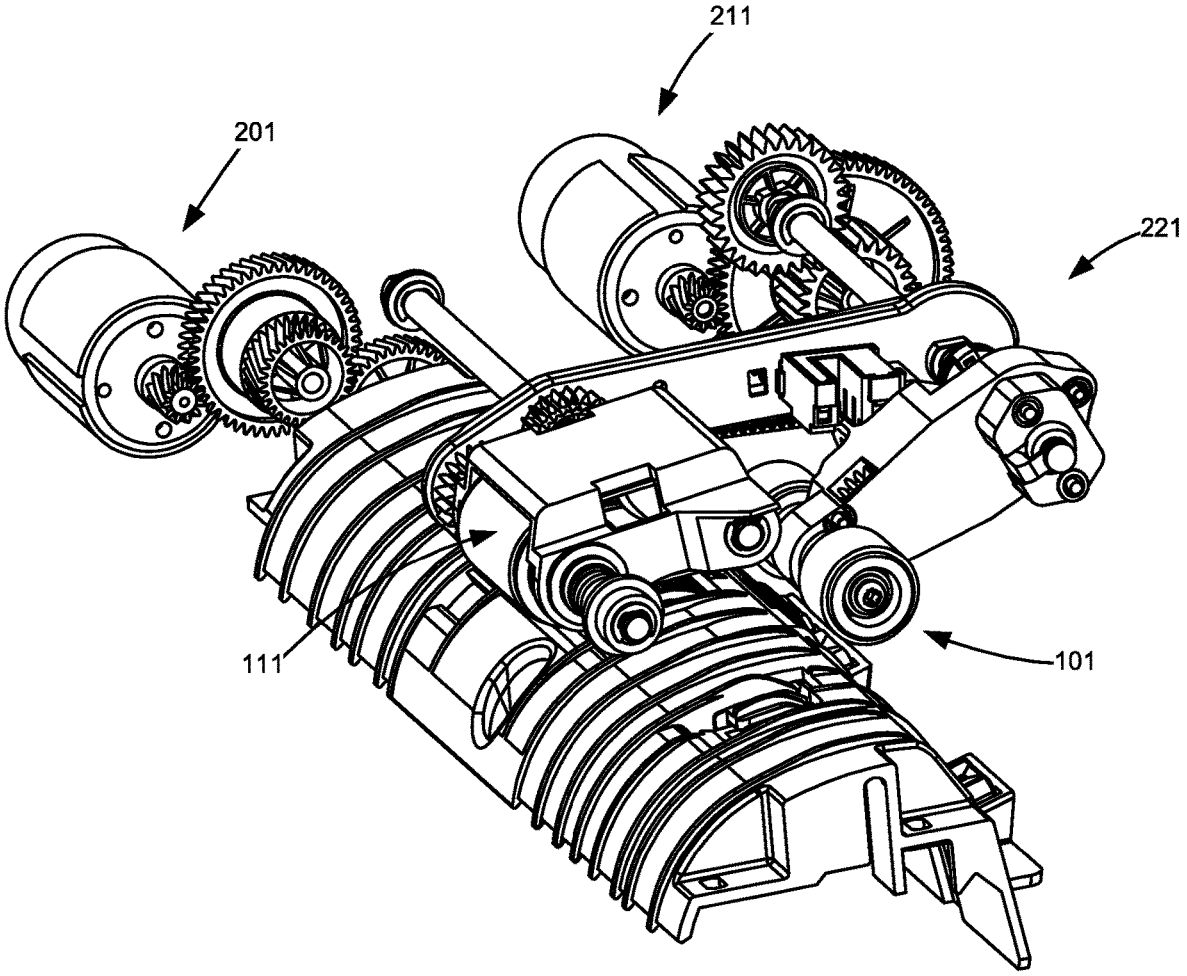


FIG. 2

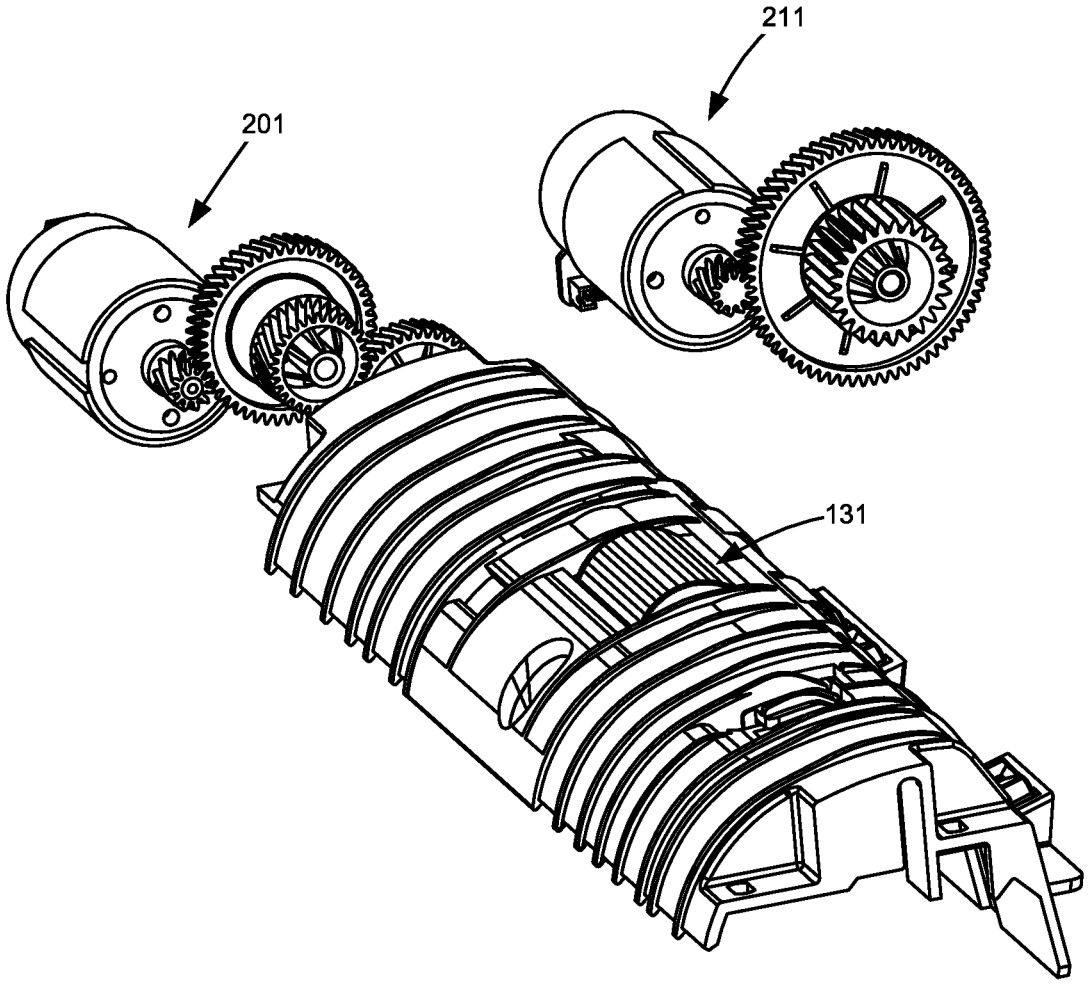


FIG. 3

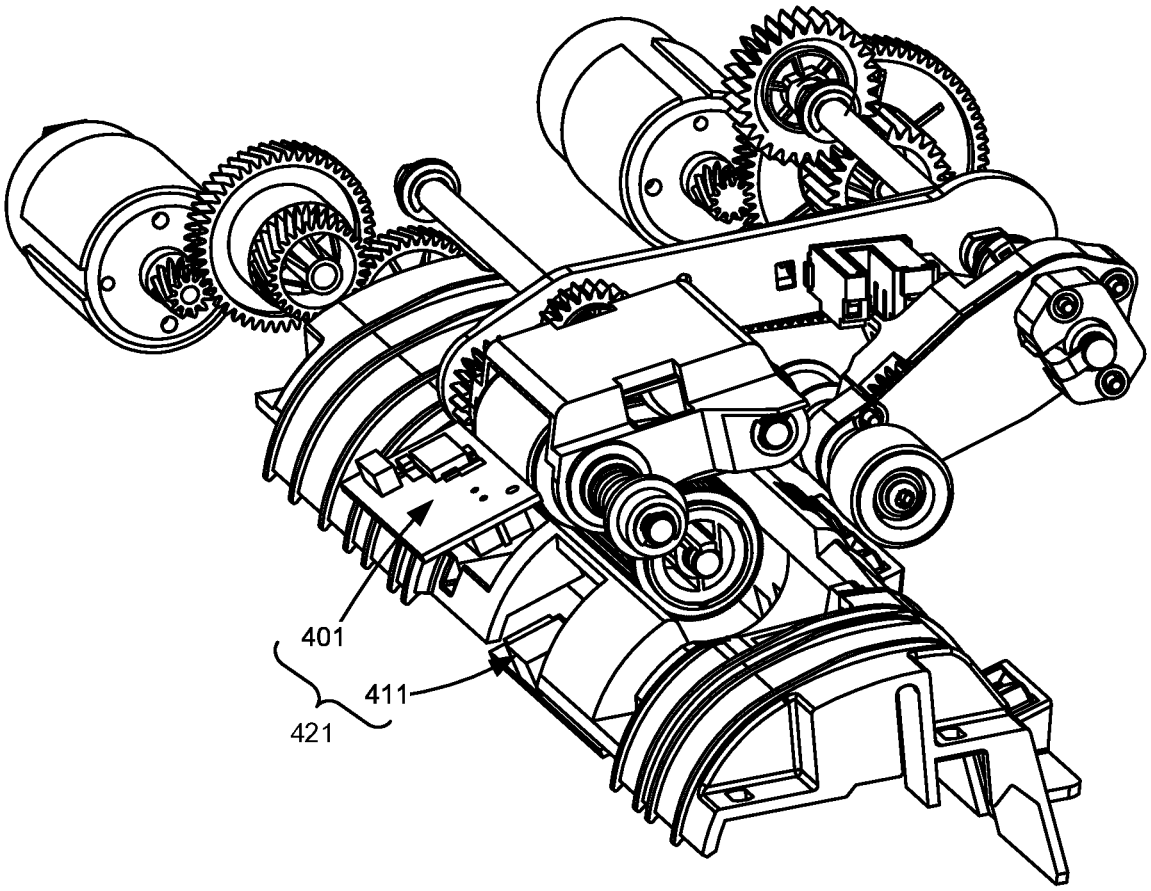


FIG. 3

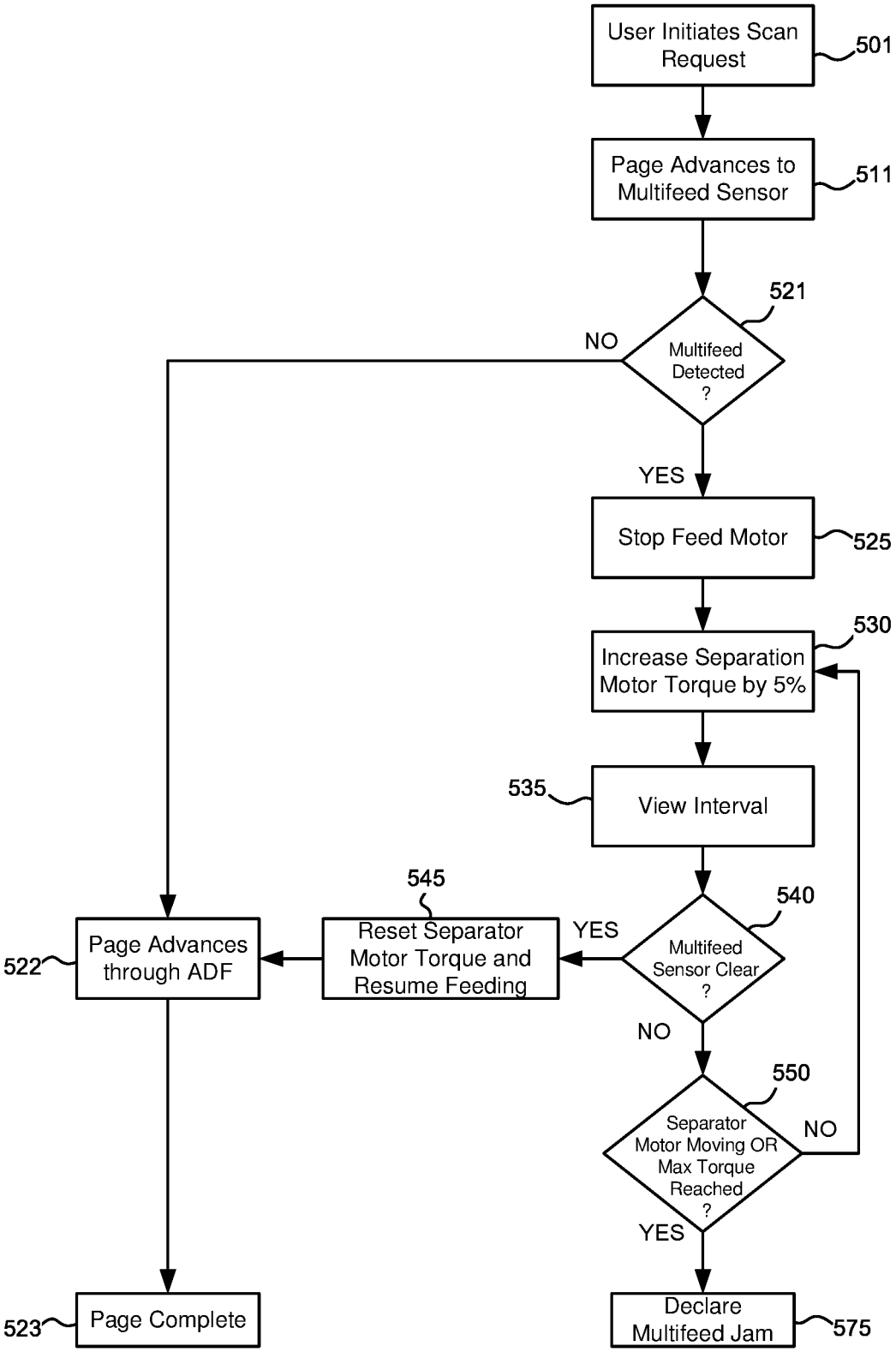

User Initiates Scan Request
501
Page Advances to Multifeed Sensor
511
521
Multifeed Detected ?
NO
YES
Stop Feed Motor
525
530
Increase Separation Motor Torque by 5%
535
View Interval
545
Reset Separator Motor Torque and Resume Feeding
YES
540
Multifeed Sensor Clear ?
522
Page Advances through ADF
NO
550
Separator Motor Moving OR Max Torque Reached ?
NO
YES
523
Page Complete
Declare Multifeed Jam
575

FIG. 5

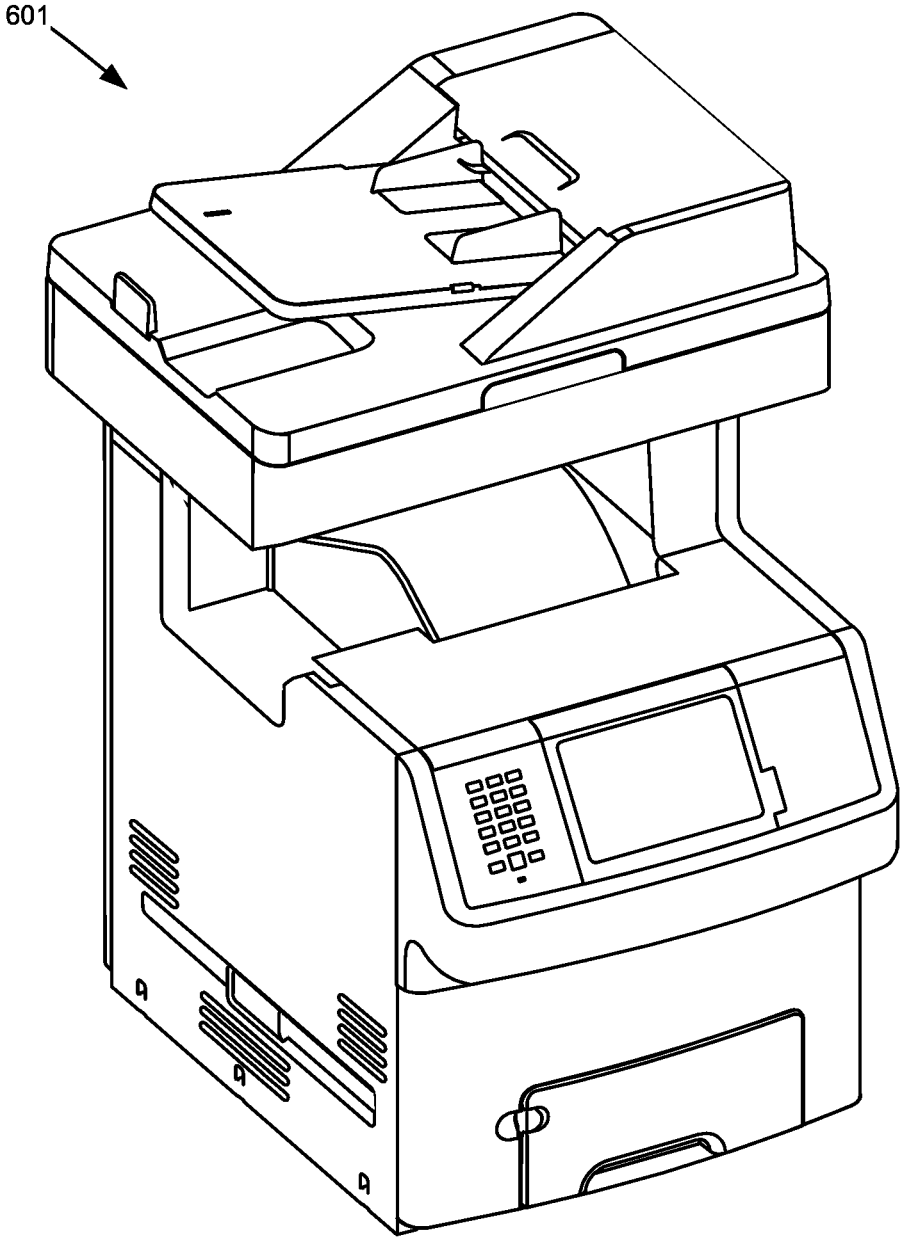


FIG. 6

METHOD OF CORRECTING A MULTI-FEED IN AN AUTOMATIC DOCUMENT FEEDER

CROSS REFERENCES TO RELATED APPLICATIONS

[0001] This patent application is related to the U.S. patent application Ser. No. _____, entitled "Automatic Document Feeder Multi-Feed Corrector," which is filed contemporaneously herewith and assigned to the assignee of the present application.

BACKGROUND

1. Field of the Invention

[0002] This invention relates generally to an automatic document feeder for a scanner in an image forming apparatus, and more particularly, to a separation system that uses a motor for the separator roller. The motor may be torque controlled to allow varying torques depending on media type and/or user input. It can also allow the separation system to detect multi-feeds, correct the multi-feeds, and ultimately feed one sheet at a time through the automatic document feeder for the scanner.

2. Description of the Related Art

[0003] Multi-feeds are a problem when separating and feeding sheets to a scanner in an image forming device. A multi-feed occurs when two or more sheets are fed at once and can cause several problems. Typically, a multi-feed will jam somewhere in a machine. However, if the sheets pass through the machine without jamming, the user may find blank sheets within large print runs, or, in the case of duplex printing, blank sides. Reducing the number of multi-feeds experienced will improve the overall user experience. Multiple solutions have been advanced for detecting and separating multi-feeds.

[0004] United States Pat. App. No. 2012/0306147 discloses a multi-feed detection and correction system. It is a feed system used for a printer that includes a reversing roller driven by a motor. However, the advantage of the invention disclosed here is that the motor is torque controlled and thus allows varying torque to help separate the media. Without this torque control, the reversing roller may slip on the media, and not reverse the multi-fed sheets.

[0005] There is still a need for a multi-feed system that will facilitate detection and separation of sheets while reliably feeding sheets one at a time.

SUMMARY OF THE INVENTION

[0006] An automatic document feeder (ADF) for a scanner generally has a pick and separation system to ensure the proper picking of only one sheet at a time to be imaged. The pick and separation system feeds the sheet to the feed rollers that control the media position and speed of movement through the imaging area. The pick roller initiates the pick process and feeds one or more sheets of an input stack to the separation system.

[0007] In one embodiment of the separation system design, a driving feed belt mated with a counter-rotating separator roller is used. The pick roller and feed belt are rotated in the process direction. The separator roller is counter-rotated to prevent multiple sheets from feeding but torque controlled to allow one sheet to successfully feed. The torque can be controlled using various types of slip clutches or magnetic clutches. However, here, a motor is used to control the torque. The motor has an advantage over the clutches in that it will last the life of the product. Another advantage is that a motor allows the torque to be modified without changing hardware.

[0008] Media sheets may stick together when picked and fed together through the ADF. When two or more sheets are fed together, it is generally called multi-feeding. There are numerous separation mechanisms used that help prevent multi-feeds. For a scanner ADF, however, the input media may not be pristine; rather, it may have folds, wrinkles, creases, and/or have varying friction characteristics between the input sheets. Therefore, it is possible, and, in-fact common, for multi-feeds to occur in scanner ADFs.

[0009] Multi-feeds result in a loss of data, so it is desirable to have only one input sheet fed through a scanner at a time. If the ADF does not have a sensor to detect two or more sheets feeding together, then the additional sheets or sheets may be simply fed through the device without scanning or copying.

[0010] Scanner ADFs may detect multi-feeds in different way, such as by using an ultra-sonic or optical sensors. These sensors alert the user that a multi-feed has occurred, so the scanning job may be suspended or stopped, and thus prevent the loss of data when scanning. The user must, however, open the image forming device and remove the multiple sheets before continuing.

[0011] The invention described herein is a separation system that uses a motor for the separator roller. This motor may be torque controlled to yield varying torques depending on media type and/or user input. The motor can also allow the separation system to detect multi-feeds, correct the multi-feed, and ultimately feed one sheet at a time through the ADF. In one embodiment, a single motor drives the feed belt. The motor and driven feed belt move the sheets in the process direction. A second motor controls the separator roller that separates the multi-fed sheets. By controlling the motor current and duty cycle, the separator motor torque is controlled, which results in a counter-rotating torque applied to the separator roller.

[0012] In normal operation, the separator motor imparts a torque to the separator roller that allows one sheet to be fed successfully by the feed belt. If multiple sheets enter the feed belt/separator roller nip, then the friction between the bottom sheet and the separator roller would be sufficient to overcome the torque and reverses the direction of the bottom sheet or bottom sheets.

[0013] In the case where the friction between the sheets is large enough to overcome the separator torque, the multiple sheets will feed past this nip to the multi-feed sensor. The multi-feed sensor, ultra-sonic or other, will detect the multiple sheets and begin the correction process. At this point, the feed motor is stopped, while the separator motor continues to drive the bottom sheet or bottom sheets backward, while increasing the torque value until the multi-feed sensor detects only one sheet. The feed belt motor then resumes operation, and moves the single sheet of media in the process direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

[0015] FIG. **1** shows the schematic layout of the ADF pick and separation system.

[0016] FIG. **2** shows the ADF pick and separation system.

[0017] FIG. **3** shows the ADF separator motor and roller with the with the feed belt and pick assembly removed.

[0018] FIG. **4** shows the ADF separation system with an ultrasonic multi-feed sensor.

[0019] FIG. **5** shows the multi-feed correction process.

[0020] FIG. **6** shows a printer with an automatic document feeder ("ADF").

DETAILED DESCRIPTION

[0021] It is to be understood that the present disclosure is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the drawings. The present disclosure is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. As used herein, the terms "having," "containing," "including," "comprising," and the like are open ended terms that indicate the presence of stated elements or features, but do not preclude additional elements or features. The articles "a," "an," and "the" are intended to include the plural as well as the singular, unless the context clearly indicates otherwise. The use of "including," "comprising," or "having" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Terms such as "about" and the like are used to describe various characteristics of an object, and such terms have their ordinary and customary meaning to persons of ordinary skill in the pertinent art.

[0022] The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements Like numerals refer to like elements throughout the views.

[0023] Referring initially to FIG. **1**, the ADF layout is shown, which operates inside a printer **601** (see FIG. **6**). The pick tire **101** and feed belt **111** are driven by the pick motor (not shown in this figure) and move the media in the process direction **121** shown. The separator roller **131** is driven in the opposite direction by the separator motor (not shown in this figure).

[0024] Referring now to FIG. **2**, the separator motor **201** and the pick motor **211** are depicted. The separator motor **201** is current controlled to provide a specific torque value. Because motor torque is proportional to motor current, by controlling the current through the separator motor, the proper counter-rotating torque is achieved at the separator roller **131**. The motor current is controlled by adjusting the command signals to the motor driver.

$$I_M = G_{MD} * V_{REF}$$

[0025] I_M: Motor Current (Amp)

[0026] G_{MD}: Motor Driver Gain

[0027] V_{REF}: Reference Voltage (Volt)

$$T_M = K_T * (I_M - I_{NL})$$

[0028] T_M: Motor Torque (mN−m)

[0029] K_T: Motor Torque Constant (mN−m/Amp)

[0030] I_{NL}: Motor No Load Current (Amp)

[0031] FIG. **3** shows the separator roller **131** and motor **201** with the feed belt **111** and pick assembly **221** removed. Since the reference voltage is a value that can be change through the scanner firmware, the torque value at the separator roller **131** can be changed, allowing different torque settings for different media scanned. The torque on the separator roller could also be changed by the user depending on the media used.

[0032] A multi-feed sensor **421** is shown in FIG. **4**. For the multi-feeds that pass the feed/separation system, the ADF has a two-part sensor to identify this situation. This two-part ultrasonic sensor **421** that is downstream of the feed belt/separator roller has an ultrasonic transmitter **401** and an ultrasonic receiver **411**. Alternatively, an optical or infrared sensor may be used to provide the same function as the ultrasonic sensor shown here. The ultrasonic sensor detects when two or more sheets are present due to the air gap between sheets that muffles the sound of the transmitter.

[0033] FIG. **5** shows the multi-feed correction process where the separation motor torque is increased to prevent the multi-feed from advancing. During normal operation, a user initiates a scan request **501** and at least one media page advances to the multi-feed sensor **511**. If the multi-feed sensor does not detect a multi-feed, then the media page advances through the ADF **522** to completion **523**. If a multi-feed is detected **521**, i.e., two or more sheets are present in the path, then the pick motor is stopped **525**. Thus, the driving force on the multiple sheets would stop. The separator motor torque is increased in gradual increments, for example 5% **530**, to provide additional separating torque. The media interval is then viewed **535** and the multi-feed sensor queried to determine if the multi-feed is clear **540**. If the multi-feed is cleared, then the separator motor torque is reset to its default value **545**, and feeding is resumed. If not, then unless the maximum separator motor torque has been reached **550**, then the separator motor torque is increased **530**. The separator motor torque is increased in gradual steps until the bottom sheet(s) reverse direction and the multi-feed sensor **421** reports that a single sheet is present. The pick motor would restart, and the normal feed and separation process would resume. If the maximum separator motor torque is reached **550**, and the multi-feed is not cleared, then multi-feed jam is declared **575**, requiring user intervention.

[0034] It is also possible during the separation process that the separator roller **131** is slipping on the bottom sheet and spinning in reverse. In this case, the multi-feed sensor **421** is monitored, and if there is no change in the status within a certain time period, then the speed of the separator roller **131** is reduced, while increasing the torque. The process would continue until the multi-feed sensor **421** reports a single sheet is present. The pick motor **211** then restarts, and the normal feed and separation process would resume.

[0035] The foregoing description of several embodiments of the invention has been presented for purposes of illustration. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously

many modifications and variations are possible in light of the above teaching. It is intended that the scope of the invention be defined by the claims appended hereto.

We claim:

1. A method of separating multi-feeds in an automatic document feeder, comprising:

initiating a scan request so that at least one media page advances to the multi-feed sensor;

stopping the pick motor if a multi-feed is detected;

increasing the separator motor torque in gradual increments, to provide additional separating torque;

determining if the multi-feed is clear;

restarting pick motor if the multi-feed is clear;

resuming normal feed and separation process.

2. The method of claim **1**, wherein the sensor is ultrasonic.

3. The method of claim **1**, wherein the sensor is optical.

4. The method of claim **1**, wherein a driving feed belt mated with a counter-rotating separator roller is used, and the separator roller is counter-rotated to prevent multiple sheets from feeding.

5. The method of claim **4**, wherein the separator roller is torque controlled with a motor.

* * * * *