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IMAGE READING APPARATUS AND IMAGE FORMING APPARATUS

Abstract

An image reading apparatus includes a support portion, a reading portion, a first cover, a second cover, and a holding mechanism. The first cover moves between a second closed position where the first cover covers the reading portion in a first closed position and a second open position where the first cover opens the reading portion. The second cover moves between a third closed position where the second cover forms a second area of a conveyance path together with the first cover in the second closed position and a third open position where the second cover opens the second area. The holding mechanism prevents the first cover from moving from the second open position to the second closed position and holds the first cover in the second open position when the second cover is in the third open position and the first cover is in the second open position.

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Background/Summary

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an image reading apparatus which reads images from documents, and an image forming apparatus to which the image reading apparatus is applied.

Description of the Related Art

[0002] Image reading apparatuses disposed in image forming apparatuses, such as copying machines and printers, and including an automatic document conveyance apparatus have been widespread. The automatic document conveyance apparatus serves as a sheet conveyance apparatus; and separates a document (hereinafter referred to also as a sheet), one by one, from other documents placed on a document tray and conveys the document. Japanese Patent Application Publication No. 2005-194011 discloses an image reading apparatus that is being developed and that includes a second reading unit in addition to a first reading unit disposed in a reader that includes a glass on which a document is placed. The second reading unit is disposed in the automatic document conveyance apparatus. This configuration enables the 1-pass duplex scanning, which is a function that can read image information of both sides of a document for duplex scanning, without reversing the document.

[0003] The image reading apparatus includes a support portion that includes a frame, a pivot portion that accommodates a second reading unit and that can pivot with respect to the support portion, and an outer cover that forms an upper conveyance path between the outer cover and both the support portion and the pivot portion. The pivot portion serves as a reading portion, accommodates the second reading unit, and forms the upper conveyance path between the pivot portion and the outer cover. Thus, the pivot portion is made larger. By the way, there is a case in which jam handling or cleaning work is performed in a lower conveyance path to which the second reading unit is exposed. The cleaning work is performed for removing dust stuck to a document feeding-reading glass. In this case, a worker can perform the intended work by opening the lower conveyance path, by opening the outer cover and pivoting the pivot portion.

[0004] However, in the image reading apparatus described in Japanese Patent Application Publication No. 2005-194011, since the pivot portion is made larger, it is difficult to design a configuration for keeping the pivoted state. Thus, the pivot portion does not have the configuration for keeping the pivoted state. For this reason, when a user accesses the lower conveyance path to which the second reading unit is exposed, the user has to perform the jam handling or the cleaning work with one hand while holding the large pivot portion with the other hand. This causes poor workability.

[0005] An object of the present invention is to provide an image reading apparatus and an image forming apparatus that can improve the workability of work performed by a user accessing the conveyance path to which the reading portion is exposed.

SUMMARY OF THE INVENTION

[0006] According to a first aspect of the present invention, an image reading apparatus configured to read an image of a document conveyed in a conveyance path, the image reading apparatus including a support portion, a reading portion configured to pivot with respect to the support portion, move between a first closed position in which the reading portion forms a first area of the conveyance path and a first open position in which the reading portion opens the first area, and read an image of a document conveyed in the first area of the conveyance path at the first closed position, a first cover configured to pivot with respect to the support portion and move between a second closed position in which the first cover covers the reading portion located in the first closed position and a second open position in which the first cover opens the reading portion, a second cover configured to move between a third closed position in which the second cover forms a second area of the conveyance path other than the first area together with the first cover located in the second closed position and a third open position in which the second cover opens the second area, and a holding mechanism configured to prevent the first cover from moving from the second open position to the second closed position and hold the first cover in the second open position in a state where the second cover is located in the third open position and the first cover is located in the second open position.
[0007] According to a second aspect of the present invention, an image forming apparatus includes the image reading apparatus, and an image forming portion configured to form an image that has been read by the image reading apparatus, on a sheet.
[0008] Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0009] FIG. **1** is a schematic diagram illustrating an image forming apparatus of the present embodiment.
[0010] FIG. **2** is a perspective view illustrating an image reading apparatus of the present embodiment.
[0011] FIG. **3** is a cross-sectional view illustrating the image reading apparatus of the present embodiment.
[0012] FIG. **4** is a cross-sectional view of a second reading unit of the present embodiment.
[0013] FIG. **5** is a front view illustrating a state where the second reading unit and a separation guide member of the present embodiment are located in closed positions.
[0014] FIG. **6** is a front view illustrating a state where the separation guide member of the present embodiment has been pivoted.
[0015] FIG. **7** is a front view illustrating a state where the separation guide member of the present embodiment is pushing up the second reading unit.
[0016] FIG. **8** is a front view illustrating a state where the second reading unit and the separation guide member of the present embodiment are located in open positions.
[0017] FIG. **9** is a perspective view illustrating the second reading unit and an FFC of the present embodiment.
[0018] FIG. **10** is a perspective view illustrating a position of an exposed portion, positioned in an ADF of the present embodiment.
[0019] FIG. **11** is a perspective view illustrating arrangement of an FFC earth sheet, positioned in the ADF of the present embodiment.
[0020] FIG. **12** is a cross-sectional view illustrating the arrangement of the FFC earth sheet of the present embodiment.
[0021] FIG. **13** is a perspective view illustrating the arrangement of the FFC earth sheet of the

present embodiment, positioned in the second reading unit.
[0022] FIG. **14** is an exploded perspective view illustrating the second reading unit of the present embodiment.
[0023] FIG. **15** is an exploded perspective view illustrating a glass earth sheet of the present embodiment.
[0024] FIG. **16** is a perspective view illustrating a glass earth sheet of a modification of the present embodiment.
[0025] FIG. **17** is a perspective view illustrating a glass earth sheet of another modification of the present embodiment.
[0026] FIG. **18** is a perspective view illustrating an FFC cover member of the present embodiment.
[0027] FIG. **19** is a perspective view illustrating a front side-plate of the present embodiment.
[0028] FIG. **20** is an exploded perspective view illustrating a separation guide member and a cam member of the present embodiment.
[0029] FIG. **21** is an exploded perspective view illustrating the front side-plate and the separation guide member of the present embodiment.
[0030] FIG. **22** is a front view illustrating a pivot regulation portion and a first projection portion of the present embodiment that are in a closed state.
[0031] FIG. **23** is a front view illustrating the pivot regulation portion and the first projection portion of the present embodiment that are located in open positions.
[0032] FIG. **24** is a front view illustrating a pivot regulation portion of a modification of the present embodiment.
[0033] FIG. **25** is a front view illustrating forces applied to the second reading unit of the present embodiment when the second reading unit is located in an open position.
[0034] FIG. **26** is a front view illustrating forces applied to the cam member when the second reading unit of the present embodiment is located in the open position.
[0035] FIG. **27** is a front view illustrating forces applied to the separation guide member of the present embodiment when the separation guide member is located in an open position.
[0036] FIG. **28** is an enlarged front view illustrating a force applied to a second projection portion when the separation guide member of the present embodiment is located in the open position.
[0037] FIG. **29** is a front view illustrating a state where a second reading unit and a separation guide member of another embodiment are located in closed positions.
[0038] FIG. **30** is a perspective view illustrating a fan portion of the other embodiment.
[0039] FIG. **31** is a perspective view illustrating a stopper of the other embodiment.
[0040] FIG. **32** is a front view illustrating a state where the separation guide member of the other embodiment is pivoted.
[0041] FIG. **33** is a front view illustrating a state where the second reading unit and the separation guide member of the other embodiment are located in open positions.

DESCRIPTION OF THE EMBODIMENTS

[0042] Hereinafter, the present embodiment will be described with reference to FIGS. **1** to **28**. First, a schematic configuration of an image forming apparatus of the present embodiment will be described with reference to FIG. **1**. FIG. **1** is a cross-sectional view illustrating an image forming apparatus **1** of the present embodiment. In the present embodiment, the image forming apparatus **1** is a full-color copying machine that includes a plurality of photosensitive drums. However, the image forming apparatus **1** is not limited to this. For example, the image forming apparatus **1** may be a monochrome or monocolor copying machine or printer that includes a single photosensitive drum, or may be an ink-jet printer.

Image Forming Apparatus

[0043] Next, the image forming apparatus **1** will be described with reference to FIG. **1**. The image forming apparatus **1** has a configuration in which an image reading apparatus **10** is disposed above an image forming apparatus body **2**. The image forming apparatus **1** conveys a sheet P conveyed

from a sheet cassette **105**, to an image forming portion **106**; and forms a toner image on the sheet P. Then the image forming apparatus **1** conveys the sheet P, on which the toner image has been formed in the image forming portion **106**, to a fixing apparatus **107**; and causes the fixing apparatus **107** to fix the toner image, still not fixed to the sheet P, to the sheet P by applying heat and pressure to the sheet P. That is, the image forming portion **106** forms an image that has been read by the image reading apparatus **10**, on the sheet. The sheet P may be a paper sheet such as a thin paper sheet or a thick paper sheet, a plastic film such as a sheet (OHP) used for overhead projectors, a paper sheet, such as a coated paper sheet, on which surface treatment has been performed, a specialized shape of sheet such as an envelope, or a cloth sheet.

[0044] The image forming portion **106** includes stations **111**, **112**, **113**, and **114**. The image forming apparatus **1** also includes an intermediate transfer belt **115** and a secondary transfer outer roller **116**. The stations **111**, **112**, **113**, and **114** respectively form toner images of yellow, magenta, cyan, and black on the intermediate transfer belt **115**. The configurations of the stations **111**, **112**, **113**, and **114** are the same as each other, except that the colors of toner are different from each other. The toner images formed by the stations **111**, **112**, **113**, and **114** are transferred onto the intermediate transfer belt **115**. The secondary transfer outer roller **116** transfers the toner image formed on the intermediate transfer belt **115**, onto the sheet P conveyed from the sheet cassette **105**. The fixing apparatus **107** fixes the toner image transferred onto the sheet P, to the sheet P by applying heat and pressure to sheet P. The sheet P to which the toner image has been fixed is discharged to a discharging tray **119**.

Image Reading Apparatus

[0045] FIG. **2** is a perspective view illustrating the image reading apparatus **10**. As illustrated in FIG. **2**, the image reading apparatus **10** includes a reader **103** and an auto document feeder (ADF) **102**, which are disposed above the image forming apparatus body **2**. The reader **103** reads the image of a document that is set by a user. FIG. **3** is a cross-sectional view illustrating the image reading apparatus **10**. As illustrated in FIG. **3**, the ADF **102** conveys a plurality of documents that is set on a document tray **200**, into the interior of the image reading apparatus **10**, so that a first reading unit **306** and a second reading unit **307**, which are disposed in the image reading apparatus **10**, can read the image of the document. Specifically, the document placed on the document tray **200** is conveyed along a conveyance path **11** by a conveyance portion **14**. The conveyance portion **14** includes a feeding roller **300**, a conveyance roller **301**, a conveyance roller **302**, a conveyance roller **303**, a conveyance roller **304**, a discharging roller **305**, and a guide member. The guide member forms the conveyance path **11**.

[0046] The image information of a first side of the document is read, via a first document-feeding-reading glass **312**, by the first reading unit **306** disposed in the reader **103**. The document is further conveyed by the conveyance roller **304**, and the image information of a second side of the document, opposite to the first side, is read, via a second document-feeding-reading glass **313**, by the second reading unit **307** disposed in the ADF **102**. The second reading unit **307** reads the image of a document in a position in which the second reading unit **307** is fixed with respect to the conveyance portion **14** relatively. After the image of the document is read, the document is discharged to a discharging tray **201** by the discharging roller **305**. In addition, the reader **103** includes a document platen glass **104**, and a document can be placed on the document platen glass **104** by opening and closing the ADF **102**. In this case, the reader **103** can read the image of the document by moving the first reading unit **306** in a sub-scanning direction and causing the first reading unit **306** to scan the document.

[0047] In the present embodiment, the ADF **102** includes a main-body unit **102***a* that is one example of a support portion, an outer cover **12** that is one example of a second cover, a separation guide member **500**, and the second reading unit **307**. The main-body unit **102***a* includes a conveyance guide member **507**, a reading-guide member **403**, and a frame such as a below-described front side-plate **1900**. In the main-body unit **102***a*, the conveyance path **11** is formed. As

illustrated in FIG. **2**, the outer cover **12** forms a top face of the ADF **102**. The outer cover **12** is disposed so as to be able to pivot or rotate with respect to the main-body unit **102***a*, and can move between a third closed position in which the outer cover **12** is closed and a third open position in which the outer cover **12** is opened. In the third closed position, the outer cover **12**, together with the separation guide member **500**, forms an upper conveyance path **11***a* of the conveyance path **11**. The upper conveyance path **11***a* is one example of a second area of the conveyance path **11**. In the third open position, the outer cover **12** opens the upper conveyance path **11***a*. In the present embodiment, in the third closed position, the outer cover **12** forms the upper conveyance path **11***a* between the outer cover **12** and both the conveyance guide member **507** and the separation guide member **500**. That is, the outer cover **12** can move between the third closed position in which the outer cover **12** is closed and the third open position in which the outer cover **12** is opened. In the third closed position, the outer cover **12** forms the upper conveyance path **11***a* of the conveyance path **11**, formed between the outer cover **12** and the separation guide member **500** when the separation guide member **500** is located or located in a second closed position (FIG. **5**). In the third open position, the outer cover **12** opens the upper conveyance path **11***a*. The bottom face of the outer cover **12** faces the upper surface of a document that is conveyed, and the top face of the separation guide member **500** faces the lower surface of a document that is conveyed. Here, the third closed position is a position in which the outer cover **12** forms the upper conveyance path **11***a* of the conveyance path **11** other than a lower conveyance path **11***b* together with the separation guide member **500** located in the second closed position.

[0048] The conveyance guide member **507** guides a document in a position positioned downstream of the separation guide member **500**. The reading-guide member **403** is disposed opposite to the separation guide member **500** with respect to the second reading unit **307**, and forms a lower conveyance path **11***b* between the reading-guide member **403** and the second reading unit **307**. The lower conveyance path **11***b* is a portion of the conveyance path **11**, and is continuous with the upper conveyance path **11***a* and disposed downstream of the upper conveyance path **11***a*. That is, the reading-guide member **403** forms one surface of the lower conveyance path **11***b* of the conveyance path **11**. The lower conveyance path **11***b* is one example of a first area of the conveyance path **11**, which is different from the upper conveyance path **11***a* of the conveyance path **11**. The second reading unit **307** is disposed between the upper conveyance path **11***a* and the lower conveyance path **11***b* in the vertical direction. The upper conveyance path **11***a* and the lower conveyance path **11***b* constitute the conveyance path **11**, which is curved and substantially U-shaped.

Second Reading Unit

[0049] FIG. **4** is a cross-sectional view of the second reading unit **307**. The second reading unit **307** is one example of a reading portion and a second reading portion. As illustrated in FIG. **4**, the second reading unit **307** includes a first casing member **400** and a second casing member **401** that are one example of a casing, a CIS **311** that is a contact image sensor, and the second document-feeding-reading glass **313**. The second reading unit **307** moves relative to the conveyance guide member **507** (see FIGS. **5** to **8**) by pivoting and linearly moving with respect to the conveyance guide member **507**. Note that although the second reading unit **307** pivots and linearly moves with respect to the conveyance guide member **507** in the present embodiment, the present disclosure is not limited to this. For example, the second reading unit **307** may simply pivot with respect to the conveyance guide member **507**, may simply move linearly with respect to the conveyance guide member **507**, or may perform other relative movement with respect to the conveyance guide member **507**. The CIS **311** is one example of an image sensor (reading element) that reads the image of a document, and is housed by the first casing member **400** and the second casing member **401**. The CIS **311** is connected to a below-described FFC **9**, and reads the image of a sheet conveyed along the lower conveyance path **11***b* of the conveyance path **11**.

[0050] The second reading unit **307** is disposed so as to be able to pivot with respect to the conveyance guide member **507**, which is disposed in the main-body unit **102***a*. The second reading

unit **307** can move between a first closed position in which the second reading unit **307** is closed and a first open position in which the second reading unit **307** is opened. The second reading unit **307** forms the lower conveyance path **11***b* of the conveyance path **11** in the first closed position. In the first closed position, the second reading unit **307** forms the other surface of the lower conveyance path **11***b*. In the first open position, the second reading unit **307** opens the lower conveyance path **11***b*. The second reading unit **307** reads an image of a document conveyed in the lower conveyance path **11***b*. Note that the first closed position is a position in which the second reading unit **307** reads an image of a document. In addition, the first open position is a position in which the second document-feeding-reading glass **313** is exposed to the outside of the apparatus when viewed from above.

[0051] A portion of the first casing member **400** on a side of the conveyance path is provided with an opening portion **402** for reading the image information of a sheet conveyed. The opening portion **402** is one example of an opening portion. That is, the first casing member **400** includes an edge portion **402***a* that is one example of an opening-portion forming portion. The edge portion **402***a* forms the opening portion **402**, through which the optical path of the CIS **311** extends toward the lower conveyance path **11***b*. That is, the first casing member **400** includes the opening portion **402** through which light passes to the CIS **311**. The second document-feeding-reading glass **313** is stuck on the edge portion **402***a* so as to cover the opening portion **402**. That is, the second document-feeding-reading glass **313** is one example of a transparent member, and covers the opening portion **402** when stuck on the first casing member **400**. The reading-guide member **403** that serves as a conveyance guide member is disposed on the outer side of the second document-feeding-reading glass **313**, that is, on the side of the conveyance path of the second document-feeding-reading glass **313**. The reading-guide member **403** is provided with a white sheet **405** and a protective glass **404**, disposed so as to face the CIS **311**. The protective glass **404** protects the white sheet **405**. The white sheet **405** is disposed for performing the shading compensation of the CIS **311** before the image information of a document is read. The protective glass **404** is disposed so that the surface of the white sheet **405** is not damaged (e.g., scratched) by a document conveyed.

[0052] Next, how the second reading unit **307** pivots in the ADF **102** of the present embodiment will be described with reference to FIGS. **5** to **8**. FIGS. **5** to **8** are front views illustrating a configuration for pivoting the second reading unit **307** of the present embodiment. As illustrated in FIG. **5**, in the interior of the ADF **102**, the separation guide member **500**, the conveyance guide member **507**, and the reading-guide member **403** constitute the conveyance guide. The separation guide member **500** is one example of a first cover, and is a pivot guide member that constitutes half the conveyance guide on the feeding and separation portion side. That is, the separation guide member **500** is disposed so as to be able to pivot with respect to the conveyance guide member **507** disposed in the main-body unit **102***a*. The separation guide member **500** is disposed closer to the upper conveyance path **11***a* than the second reading unit **307** is. That is, the separation guide member **500** is disposed opposite to the lower conveyance path **11***b*. The separation guide member **500** can move between a second closed position (FIG. **5**) in which the separation guide member **500** is closed and a second open position (FIG. **8**) in which the separation guide member **500** is opened. In the second closed position, the separation guide member **500** covers the second reading unit **307** and an exposed portion **90**; in the second open position, the separation guide member **500** opens the second reading unit **307** and the exposed portion **90**. That is, the separation guide member **500** can move between the second closed position in which the separation guide member **500** is closed and the second open position in which the separation guide member **500** is opened. In the second closed position, the separation guide member **500** covers the second reading unit **307** located in the first closed position; in the second open position, the separation guide member **500** opens the second reading unit **307** such that the second reading unit **307** can be opened and closed. Note that as illustrated in FIG. **3**, when the outer cover **12** is located in the third closed position, the outer cover **12** covers the upper portion of the separation guide member **500**. Thus, if the outer

cover **12** is opened until the outer cover **12** is located in the third open position, it becomes possible to pivot the separation guide member **500**.

[0053] The conveyance guide member **507** constitutes half the conveyance guide that is bent. The reading-guide member **403** constitutes a portion of the conveyance guide that the second reading unit **307** faces. The separation guide member **500** is provided with the pivot shaft **502**, and can be pivoted by a user for performing the jam handling or cleaning the second document-feeding-reading glass **313** disposed on the second reading unit **307** and the protective glass **404** disposed for the white sheet **405**. Note that in the present embodiment, members necessary for describing the configuration of the present invention are mainly described schematically.

[0054] Next, a state where the second reading unit **307** and the separation guide member **500** are located in closed positions, as illustrated in FIG. **5**, will be described. In this state, a pressing portion **505** formed in the separation guide member **500** pushes down a pressed portion **506** formed in the second reading unit **307**, downward from above. Thus, the second document-feeding-reading glass **313** of the second reading unit **307** abuts against the reading-guide member **403** that faces the second document-feeding-reading glass **313**, with a predetermined clearance being formed, so that the conveyance path is formed. Furthermore, a cam member **501** is disposed on the pivot shaft **502** of the separation guide member **500**. The cam member **501** is separated from the second reading unit **307** when the separation guide member **500** is located in the second closed position. Since the cam member **501** is not in contact with the second reading unit **307**, it is possible to keep the high positional accuracy of the second reading unit **307**. In addition, the separation guide member **500** is provided with a first contact portion **503**, and the cam member **501** is provided with a second contact portion **504** (see FIG. **20**). That is, the separation guide member **500** includes the first contact portion **503** that is one example of a contacting portion, and the cam member **501** includes the second contact portion **504** that is one example of a contacted portion. The second contact portion **504** can pivot with respect to the separation guide member **500**, and can be contacted with the first contact portion **503** in the pivot direction.

[0055] FIG. **6** is a front view illustrating a state where the separation guide member **500** has been pivoted in a D**1** direction. If the separation guide member **500** is pivoted by a predetermined angle or more, the cam member **501** also pivots in synchronization with the separation guide member **500** (see FIGS. **6** to **8**). Furthermore, the separation guide member **500** is provided with a first projection portion **510**. Thus, if the separation guide member **500** is pivoted by a predetermined angle or more, the first projection portion **510** abuts against a below-described second projection portion **1901**, so that the pivoted state is kept. That is, when the separation guide member **500** pivots from the second closed position toward an intermediate position between the second closed position and the second open position, the first contact portion **503** does not lock on the second contact portion **504**. However, if the separation guide member **500** passes the intermediate position and pivots from the intermediate position toward the second open position, the first contact portion **503** locks on the second contact portion **504**, and the cam member **501** pivots in accordance with the movement of the separation guide member **500**.

[0056] On the other hand, the second reading unit **307** is provided with the pivot shaft **314**. FIG. **7** is a front view illustrating a state where the separation guide member **500** is pushing up the second reading unit **307** in a D**2** direction via the cam member **501**. As illustrated in FIG. **7**, if the separation guide member **500** is pivoted by a predetermined angle or more, a cam portion **509** of the cam member **501**, which pivots in synchronization with the separation guide member **500**, abuts against the second reading unit **307**. Thus, the second reading unit **307** starts to pivot on the pivot shaft **314** in the D**2** direction, in synchronization with the pivot motion of the separation guide member **500**.

[0057] The cam portion **509** includes a first abutment portion **16** and a second abutment portion **17**. When the second reading unit **307** is located in the first closed position, the first abutment portion **16** abuts against a lower portion **307***a* of the second reading unit **307** and presses the second

reading unit **307** upward. After the second reading unit **307** is pivoted by the first abutment portion **16**, the second abutment portion **17** abuts against a side portion **307***b*, which is perpendicular to the lower portion **307***a* of the second reading unit **307**, and presses the second reading unit **307** until the second reading unit **307** is located in the first open position. That is, the side portion **307***b* faces a direction other than a direction in which the lower portion **307***a* faces. Thus, in a simple configuration in which the single cam member **501** is used, the second reading unit **307** can be pushed up by about 90 degrees.

[0058] FIG. **8** is a front view illustrating a state where the second reading unit **307** and the separation guide member **500** are located in open positions. As illustrated in FIG. **8**, if the second reading unit **307** is pivoted by a predetermined angle, a pressed portion **506** formed in the second reading unit **307** abuts against an angle regulation portion **508** formed in the conveyance guide member **507**, so that the second reading unit **307** is prevented from pivoting. In addition, the second reading unit **307** that is prevented from pivoting is caused to slide in a D**3** direction, by the cam member **501**. That is, the cam member **501** is one example of an interlocking member; and when the separation guide member **500** is pivoted from the second closed position to the second open position, the cam member **501** moves in accordance with the movement of the separation guide member **500**, and presses the second reading unit **307** in a direction in which the second reading unit **307** pivots from the first closed position to the first open position. That is, the cam member **501** is configured to move the second reading unit **307** from the first closed position to the first open position interlocked with movement of the separation guide member **500** from the second closed position to the second open position.

[0059] In the state illustrated in FIG. **8**, the pivoted state of the separation guide member **500** is finally kept by a holding mechanism **15** (see FIG. **23**). In this state, the pivoted state of the second reading unit **307** is also kept by the separation guide member **500** whose pivoted state is kept. That is, in the state where the separation guide member **500** is prevented from moving from the second open position to the second closed position by the holding mechanism **15**, the second reading unit **307** is held in the first open position by the cam member **501**. On the other hand, when the state illustrated in FIG. **8** is changed back to the state illustrated in FIG. **5**, the separation guide member **500** held by the holding mechanism **15** is released from the second open position, and pivots from the second open position to the second closed position. Thus, the second reading unit **307** pivots from the first open position to the first closed position due to the self-weight of the second reading unit **307**.

[0060] When documents are being conveyed, a user was not able to access the second document-feeding-reading glass **313** and the protective glass **404** of the white sheet **405**, as illustrated in FIG. **5**. In the present embodiment, however, as illustrated in FIG. **8**, a user can access both the second document-feeding-reading glass **313** and the protective glass **404** of the white sheet **405** by pivoting the second reading unit **307** and the separation guide member **500**. In particular, since the second reading unit **307** slides, as illustrated in FIG. **8**, in the D**3** direction in the latter half of the pivot motion, it becomes possible to secure a cleaning space **801** for cleaning the protective glass **404** of the white sheet **405**.

FFC

[0061] Next, a configuration of the FFC **9**, which is connected to the second reading unit **307**, will be described with reference to FIGS. **9** to **13**. FIG. **9** is a perspective view illustrating a positional relationship between the second reading unit **307** and the FFC **9**. FIGS. **10** to **12** are diagrams illustrating the position of the exposed portion **90** of the FFC **9**, and the arrangement of an FFC earth sheet **3** that serves as a conductive sheet member.

[0062] As illustrated in FIG. **9**, the FFC **9**, which is one example of a flexible cable, is connected to the CIS **311** disposed in the second reading unit **307**; and an FFC cover member **901** covers the connection portion of the FFC **9** so as to conceal the connection portion. As illustrated in FIG. **10**, since the second reading unit **307** is configured so as to be able to pivot in the ADF **102**, a portion

of the FFC **9**, which serves as the exposed portion **90**, is exposed to the outside of the apparatus, when viewed from above, in a state where both the outer cover **12** and the separation guide member **500** are opened. That is, the exposed portion **90** of the FFC **9** bridges a space between the conveyance guide member **507** and the second reading unit **307**, and the FFC **9** transmits an electric signal (i.e., an image signal). The exposed portion **90** is one example of a bridging portion. The exposed portion **90** is located between the main-body unit **102***a* and the second reading unit **307**, and exposes to an outside of the main-body unit **102***a* and the second reading unit **307**. However, if the portion of the FFC **9** is exposed to the outside of the apparatus, the static electricity may fly from fingertips of a user to the exposed portion of the FFC **9** when the user performs work, and may cause the failure of an electric component. Note that the exposed portion **90** is a portion of the FFC **9** that is exposed to the outside in the clearance between the conveyance guide member **507** fixed to the main-body unit **102***a* and the second reading unit **307**, in a state where the outer cover **12** is located in the third open position and the separation guide member **500** is located in the second open position.

[0063] In the present embodiment, as illustrated in FIG. **11**, the FFC earth sheet **3** that is a conductive sheet member is disposed so as to cover the exposed portion **90** from above. That is, the FFC earth sheet **3** covers a surface of the portion of the FFC **9** that is exposed to a user side. In addition, one end of the FFC earth sheet **3** is electrically grounded, via an earth wire **1101**. That is, the FFC earth sheet **3** is one example of a shield member that has conductivity, and that is grounded. The FFC earth sheet **3** is disposed closer to the upper conveyance path **11***a* than the exposed portion **90** is. The FFC earth sheet **3** has conductivity and is grounded, so that the FFC earth sheet **3** discharges the static electricity, which is applied from the outside to the exposed portion **90**, to the ground. The width of the FFC earth sheet **3** is substantially equal to the width of the FFC **9**. However, the present disclosure is not limited to this. That is, the width of the FFC earth sheet **3** may be larger or smaller than the width of the FFC **9**.

[0064] FIG. **12** is a cross-sectional view of the ADF **102** viewed from the front side of the ADF **102**, and illustrates the arrangement of the FFC earth sheet **3**. In the present embodiment, since a user accesses the components from above, the FFC earth sheet **3** is disposed so as to cover the upper side of the exposed portion **90** of the FFC **9**.

[0065] Since the second reading unit **307** pivots as illustrated in FIGS. **5** to **8**, the exposed portion **90** of the FFC **9** and a portion of the FFC earth sheet **3** that corresponds to the exposed portion **90** will be both bent an expected number of times of pivot motion of the second reading unit **307**. Thus, it is necessary that the FFC earth sheet **3** be made of a material that can endure the expected number of bendings. In the present embodiment, the FFC earth sheet **3** is made of a metal-foil composite film. The metal-foil composite film is a composite material in which an aluminum foil is laminated on a PET base material made of polyester film. That is, the FFC earth sheet **3** is a film in which a metal layer and a polyester layer are laminated on each other.

[0066] Preferably, the FFC earth sheet **3** is disposed such that the aluminum-foil surface faces a direction from which the static electricity flies to the FFC **9**, and that the PET base material faces the FFC **9**. Specifically, in the present embodiment, the aluminum-foil surface is disposed above the FFC **9** in FIG. **12**. That is, in the present embodiment, the FFC earth sheet **3** is disposed such that the polyester layer is closer to the FFC **9** than the metal layer is. With this arrangement, the FFC earth sheet **3** shields the FFC **9** against the static electricity while making the durability against bending higher than that of an FFC earth sheet **3** that is a simple aluminum sheet.

[0067] FIG. **13** illustrates a state where the FFC cover member **901**, provided to the second reading unit **307**, is removed from the second reading unit **307**. With reference to FIG. **13**, how the FFC earth sheet **3** is disposed in the second reading unit **307** will be described. FIG. **13** is a diagram illustrating the arrangement of the FFC earth sheet **3** disposed in the second reading unit **307**. The second casing member **401**, which constitutes the second reading unit **307**, is provided with positioning projections **1302**. The positioning projections **1302** are positioned at positions that

correspond to the positions of positioning hole portions **1305** of an FFC positioning sheet **1304**, and to the positions of positioning hole portions **1303** of the FFC earth sheet **3**. The FFC positioning sheet **1304** is stuck on the FFC **9** for positioning the FFC **9**. In the present embodiment, for preventing the FFC **9** and the FFC earth sheet **3** from becoming oblique in the pivot motion of the second reading unit **307**, two positioning projections **1302** are disposed, separated from each other in the width direction. For the same reason, two positioning hole portions **1303** are disposed, separated from each other in the width direction; and two positioning hole portions **1305** are disposed, separated from each other in the width direction.

[0068] The FFC **9** is fixed to the second reading unit **307** by inserting (fitting) the positioning hole portions **1305** of the FFC positioning sheet **1304** in the positioning projections **1302**. After the FFC **9** is fixed to the second reading unit **307**, the positioning hole portions **1303** of the FFC earth sheet **3** are fit, from above, to the positioning projections **1302** for covering the upper side of the FFC **9** with the FFC earth sheet **3**.

[0069] The FFC cover member **901** that serves as a fixing member is provided with an FFC fixing surface **1300**. The FFC **9** and the FFC earth sheet **3** are nipped and fixed by the FFC fixing surface **1300** of the FFC cover member **901** and the top surface of the second casing member **401**. In this configuration, the FFC **9** and the FFC earth sheet **3** are positioned and fixed in the second reading unit **307**.

Second Document-Feeding-Reading Glass

[0070] Next, a configuration for fixing the second document-feeding-reading glass **313**, disposed in the second reading unit **307**, will be described with reference to FIGS. **14** to **17**. FIGS. **14** to **17** are diagrams illustrating configurations of a glass earth sheet **1400** disposed on a portion of the second document-feeding-reading glass **313** of the present embodiment. As illustrated in FIGS. **14** and **15**, the second document-feeding-reading glass **313** is stuck on the first casing member **400**, which constitutes the second reading unit **307**, via the glass earth sheet **1400** such that the glass earth sheet **1400** does not cover the opening portion **402** of the first casing member **400**. Thus, the glass earth sheet **1400** has a shape that does not cover the opening portion **402**. The glass earth sheet **1400** is one example of a shield member. In addition, the glass earth sheet **1400** is stuck on the second document-feeding-reading glass **313**, while having conductivity and grounded. In the present embodiment, the glass earth sheet **1400** is disposed between the first casing member **400** and the second document-feeding-reading glass **313**.

[0071] The glass earth sheet **1400** is a conductive sheet member having adhesiveness. The glass earth sheet **1400** may be a double-sided conductive tape, or may be a member in which an aluminum-foil tape and a double-sided tape are combined with each other. The aluminum-foil tape has an adhesive layer on one side. In the present embodiment, both sides of the glass earth sheet **1400** are adhesive, so that the second document-feeding-reading glass **313** is stuck on the first casing member **400** via the glass earth sheet **1400**. That is, the glass earth sheet **1400** fixes the second document-feeding-reading glass **313** on the first casing member **400** by pasting. In another case, as illustrated in FIG. **15**, the glass earth sheet **1400** may include a first sticking portion **1500** that serves as a double-sided tape, a conductive sheet member **1501**, and a second sticking portion **1502** that serves as a double-sided tape. In this case, the conductive sheet member **1501** may be stuck on the first sticking portion **1500**, and the second sticking portion **1502** may be stuck on the conductive sheet member **1501**. In another case, both sides of the conductive sheet member may be applied with adhesive, and the second document-feeding-reading glass **313** may be stuck on the first casing member **400** via the conductive sheet member **1501**. In another case, the conductive sheet member **1501** may be directly sandwiched between the second document-feeding-reading glass **313** and the first casing member **400**. In this case, the second document-feeding-reading glass **313** may be fixed to the first casing member **400** via a hook portion formed in the first casing member **400**, or via screws.

[0072] The glass earth sheet **1400** includes an electrical-connection portion **1401** that serves as an

electrical contact, for electrically grounding the glass earth sheet **1400**, via the FFC cover member **901**, as described below. That is, in the configuration illustrated in FIG. **15**, the first sticking portion **1500** is disposed for bonding the first casing member **400** and the conductive sheet member **1501**. Thus, the first sticking portion **1500** and the conductive sheet member **1501** have an identical shape, and the electrical-connection portion **1401** of the conductive sheet member **1501**, as well as the other portion of the conductive sheet member **1501** can be stuck on the first casing member **400**. Unlike the first sticking portion **1500**, the second sticking portion **1502** does not have a shape that corresponds to the shape of the electrical-connection portion **1401** of the conductive sheet member **1501**. This is because the second sticking portion **1502** has only to be used for sticking the second document-feeding-reading glass **313** on the conductive sheet member **1501**.

[0073] In the present embodiment, the conductive sheet member **1501** is made of the above-described metal-foil composite film. That is, the metal-foil composite film that serves as the conductive sheet member **1501** is a composite material in which an aluminum foil is laminated on a PET base material made of polyester film. Thus, the conductive sheet member **1501** is a film in which the metal layer and the polyester layer are laminated on each other. The reason is that since the glass earth sheet **1400** has a shape **1503** that does not cover the opening portion **402**, the glass earth sheet **1400** is required to have a certain level of hardness for sticking the glass earth sheet **1400** on the first casing member **400**. If the glass earth sheet **1400** does not have the certain level of hardness, it will become difficult to stick the glass earth sheet **1400** on the first casing member **400**. However, if it is ensured by using a jig or the like that the glass earth sheet **1400** can be stuck on the first casing member **400**, a simple metal foil may be used instead of the metal-foil composite film.

[0074] Note that if the glass earth sheet **1400** is not disposed, a problem as described below may occur. That is, when a user performs work, such as the jam handling or the cleaning work for the second document-feeding-reading glass **313**, in the vicinity of the second document-feeding-reading glass **313**, static electricity may fly from fingertips of the user into the second reading unit **307** through a slight gap between the second document-feeding-reading glass **313** and the first casing member **400**. Similarly, static electricity may fly from a document that is being conveyed, into the second reading unit **307** through a slight gap between the second document-feeding-reading glass **313** and the first casing member **400**. If the static electricity enters the second reading unit **307** through the slight gap between the second document-feeding-reading glass **313** and the first casing member **400**, the static electricity may flow to an electric component, such as an LED element disposed in the CIS **311**; and may cause the failure of the electric component. Conventionally, the second document-feeding-reading glass **313** is stuck on the first casing member **400** via a simple double-sided tape that is not conductive. However, the double-sided tape is the same as an air layer, in terms of electricity. Thus, it is known that even if no gap seems to be formed, the static electricity passes through the double-sided tape, and may cause the failure of an electric component.

[0075] In the present embodiment, however, the whole circumference of the second document-feeding-reading glass **313** is stuck on the first casing member **400** via the conductive sheet member **1501**, as illustrated in FIG. **15**. Thus, the risk caused by the static electricity can be avoided. That is, the glass earth sheet **1400** is disposed on the edge portion **402***a* or the first casing member **400** so as to surround the whole circumference of the opening portion **402**. In this configuration, the glass earth sheet **1400** discharges the static electricity applied from the lower conveyance path **11***b* side to the second document-feeding-reading glass **313**.

[0076] Next, the relationship between the size of the glass earth sheet **1400** and the size of the opening portion **402** will be described. In the present embodiment, the glass earth sheet **1400** is formed such that the size and width of the glass earth sheet **1400** are equal to those of the edge portion **402***a*. As a result, the sticking area of the double-sided tape can be increased, so that the force for sticking the second document-feeding-reading glass **313** to the first casing member **400**

and keeping the second document-feeding-reading glass **313** on the first casing member **400** can be increased. In another case, the glass earth sheet **1400** may be formed like a thin line for discharging the static electricity. In this case, however, since the sticking area of the double-sided tape is decreased, it is necessary to dispose another member, in addition to the glass earth sheet **1400**, that keeps the second document-feeding-reading glass **313** on the first casing member **400**. The glass earth sheet **1400** may overlap with the opening portion **402** unless the glass earth sheet **1400** interferes with the reading operation of the CIS **311**.

[0077] Note that there is a case where it is not necessary to cover the whole circumference of the second document-feeding-reading glass **313** with the conductive sheet member **1501** because of the layout of electric elements. In this case, one portion of the glass earth sheet **1400** may be cut out, for example, as illustrated in FIG. **16**. That is, the glass earth sheet **1400** may be disposed on the edge portion **402***a* or the first casing member **400** so as to extend along a portion of the opening portion **402**. Furthermore, if necessary for the ease of assembly or the like, the glass earth sheet **1400** may be constituted by a plurality of glass earth sheets, as illustrated in FIG. **17**, disposed on different portions of the edge portion **402***a*. That is, the edge portion **402***a* or the opening portion **402** includes a first portion **402***b*, and a second portion **402***c* different from the first portion **402***b*. The first portion **402***b* is provided with a first glass earth sheet **1700** that is one example of a first shield member, and the second portion **402***c* is provided with a second glass earth sheet **1701** that is one example of a second shield member. The first glass earth sheet **1700** and the second glass earth sheet **1701** have the same structure as that of the glass earth sheet **1400**, except that they have shapes different from the shape of the glass earth sheet **1400**.

[0078] If the glass earth sheet **1400** has a shape, as illustrated in FIGS. **16** and **17**, which does not extend along the whole circumference of the opening portion **402**, the glass earth sheet **1400** is required to have a configuration for compensating for the shape. That is, since the area of the double-sided adhesive tape decreases, it is desirable to fully check whether the second document-feeding-reading glass **313** will peel off, and use a double-sided tape in addition to the glass earth sheet, as appropriate. In addition, in a portion of the edge portion **402***a* on which the glass earth sheet **1400** is not stuck, foreign matter may enter the second reading unit **307** through a gap between the second document-feeding-reading glass **313** and the edge portion **402***a*. Thus, it is desirable that the gap be sealed with a double-sided tape.

[0079] Next, a configuration for grounding the electrical-connection portion **1401** of the glass earth sheet **1400** via the FFC cover member **901** will be described with reference to FIG. **18**. FIG. **18** is a diagram illustrating a configuration of the FFC cover member **901** that covers the FFC earth sheet **3** of the present embodiment. As illustrated in FIG. **18**, the FFC cover member **901** is provided with a surface **1801** that abuts against the first casing member **400**, and the surface **1801** also abuts against the electrical-connection portion **1401** of the glass earth sheet **1400**. On the abutment surface **1801**, a catching portion **1800** is formed for catching a hole portion formed in the first casing member **400**. The FFC cover member **901** includes the FFC fixing surface **1300** that fixes the FFC **9** and the FFC earth sheet **3**. The FFC **9** and the FFC earth sheet **3** are nipped by the FFC fixing surface **1300** and the top surface of the second casing member **401**, and thereby fixed.

[0080] The FFC cover member **901** is provided with snap-fit portions **1301**. The snap-fit portions **1301** and the catching portion **1800** can be detachably attached to the second reading unit **307**. In addition, four sponges **1802** that serve as elastic members are provided. Two of the sponges **1802** are disposed on the abutment surface **1801** of the FFC cover member **901**, and the other two of the sponges **1802** are disposed on the FFC fixing surface **1300** of the FFC cover member **901**. In addition, two conductive sheet members **1803** are provided. One of the conductive sheet members **1803** is disposed so as to connect the abutment surface **1801** and one of the sponges **1802** stuck on the FFC fixing surface **1300**, and the other of the conductive sheet members **1803** is disposed so as to connect the abutment surface **1801** and the other of the sponges **1802** stuck on the FFC fixing surface **1300**. The conductive sheet members **1803** are not required to have particular hardness and

durability against bending. Thus, in the present embodiment, each of the conductive sheet members **1803** is an aluminum tape in which an adhesive layer is formed on an aluminum foil.

[0081] In this configuration, when the FFC cover member **901** is assembled to the second reading unit **307**, one end portion of each of the conductive sheet members **1803** is brought into pressure contact with the electrical-connection portion **1401** of the glass earth sheet **1400** by the elastic force of a corresponding sponge **1802**. In addition, the other end portion of each of the conductive sheet members **1803** is brought into pressure contact with the FFC earth sheet **3**. As a result, all of the glass earth sheet **1400**, the FFC earth sheet **3**, and the earth wire **1101** are electrically connected with each other, and are electrically grounded. This configuration can make the number of components smaller than that in a configuration in which the glass earth sheet **1400** and the FFC earth sheet **3** are separately grounded.

Self-Supporting Operation

[0082] Next, a self-supporting state of the separation guide member **500** and the second reading unit **307** will be described with reference to FIGS. **19** to **24**. The self-supporting state is produced when the separation guide member **500** is pivoted until the separation guide member **500** enters the open state illustrated in FIG. **23** or **24**. In the self-supporting state, the separation guide member **500** and the second reading unit **307** are regulated from pivoting. FIG. **19** is a diagram illustrating the second projection portion **1901** formed on the front side-plate **1900** of the present embodiment. FIG. **20** is a diagram illustrating a relationship between the separation guide member **500** and the cam member **501** of the present embodiment. FIG. **21** is a diagram illustrating a relationship between the separation guide member **500** and the front side-plate **1900** of the present embodiment. FIGS. **22** to **24** are diagrams each illustrating a relationship between the second projection portion **1901** and the first projection portion **510** of the present embodiment.

[0083] As illustrated in FIG. **19**, the front side-plate **1900**, which constitutes the main-body unit **102***a* of the ADF **102**, is provided with a fitting groove portion **1003** that corresponds to a front pivot shaft **314** disposed in the second reading unit **307**. The front pivot shaft **314** fits in the fitting groove portion **1003**. In addition, the front side-plate **1900** is provided with a fitting hole portion **1002** that corresponds to a front pivot shaft **502** disposed in the separation guide member **500**. The front pivot shaft **502** fits in the fitting hole portion **1002**. The front side-plate **1900** includes the second projection portion **1901**. The second projection portion **1901** will be described below.

[0084] As illustrated in FIG. **20**, the cam member **501** is attached to a pivot shaft **502** of the separation guide member **500** on the front side-plate **1900** side. The cam member **501** is engaged with the pivot shaft **502** so as to be able to pivot around the pivot shaft **502**. If the separation guide member **500** pivots by a predetermined angle or more (the separation guide member **500** is located in the intermediate position when pivoted by the predetermined angle), the first contact portion **503** formed in the separation guide member **500** and the second contact portion **504** formed in the cam member **501** abut against each other. As a result, the separation guide member **500** and the cam member **501** pivot in synchronization with each other. In the vicinity of the pivot shaft **502** of the separation guide member **500**, the first projection portion **510** is formed. The first projection portion **510** will be described below.

Holding Mechanism

[0085] As illustrated in FIGS. **21** to **23**, the holding mechanism **15** is disposed between the front side-plate **1900** and the pivot shaft **502** of the separation guide member **500**. When the outer cover **12** is located in the third open position and the separation guide member **500** is located in the second open position, the holding mechanism **15** prevents the separation guide member **500** from returning to the second closed position due to the self-weight of the separation guide member **500**, and holds the separation guide member **500** in the second open position. The holding mechanism **15** includes the second projection portion **1901** of the front side-plate **1900** and the first projection portion **510** of the separation guide member **500**.

[0086] The first projection portion **510** is one example of an engaging portion, and is formed so as

to extend from the pivot shaft **502** toward one side of a radial direction of a circle around a rotation axis of the pivot shaft **502** of the separation guide member **500**. That is, the first projection portion **510** is disposed in the separation guide member **500** and extended toward a direction orthogonal to the rotation axis of the pivot shaft **502** of the separation guide member **500**. The second projection portion **1901** is one example of an engaged portion, and is formed in the vicinity of the fitting hole portion **1002** so as to extend toward the other side of the radial direction. The second projection portion **1901** is disposed in the main-body unit **102***a* and the first projection portion **510** is engaged with the second projection portion **1901**. In addition, the second projection portion **1901** is disposed at a position that overlaps with a movement trajectory P**1** (see FIG. **22**) of the first projection portion **510**. The second projection portion **1901** is formed in the vicinity of the fitting hole portion **1002** of the front side-plate **1900**, and functions as a pivot regulation portion. That is, the second projection portion **1901** abuts against the first projection portion **510**, so that the second projection portion **1901** keeps the pivoted posture of the separation guide member **500** and prevents the separation guide member **500** from returning to its original posture.

[0087] Specifically, as illustrated in FIG. **23**, when the separation guide member **500** pivots from the second closed position in the opening direction, the first projection portion **510** abuts against and climbs over the second projection portion **1901** on the movement trajectory P**1** (illustrated in FIG. **22**). The position of the separation guide member **500** in which the first projection portion **510** is in contact with the second projection portion **1901** in the closing direction, opposite to the opening direction, due to the self-weight of the separation guide member **500** is the second open position in which the separation guide member **500** is held. In the state where the separation guide member **500** is held in the second open position, the second reading unit **307** is located in the first open position, via the cam member **501**.

[0088] As described above, the front side-plate **1900** and the separation guide member **500** are assembled to each other such that the pivot shaft **502** of the separation guide member **500** fits in the fitting hole portion **1002** of the front side-plate **1900**. If the first projection portion **510** of the separation guide member **500** climbs over the second projection portion **1901** formed on the front side-plate **1900**, the separation guide member **500** is prevented from returning to its original posture even if a user releases a hand from the separation guide member **500**, so that the pivoted posture of the separation guide member **500** can be kept.

[0089] In addition, since the first contact portion **503** of the separation guide member **500** and the second contact portion **504** of the cam member **501** are in contact with each other, the pivoted posture of the cam member **501** is also kept. Furthermore, since the cam portion **509** of the cam member **501** supports the second reading unit **307**, the pivoted posture of the second reading unit **307** is also kept. Thus, a user can perform the cleaning work for the second document-feeding-reading glass **313**, which is disposed on the second reading unit **307**, and the protective glass **404**, which protects the white sheet **405**, and the jam handling in a state where the hand of the user is separated from the separation guide member **500**.

[0090] If external force is applied to the separation guide member **500** toward the second closed position when the separation guide member **500** is located in the second open position, the first projection portion **510** that is in contact with the second projection portion **1901** climbs over the second projection portion **1901**. In this manner, the separation guide member **500** held in the second open position is released.

[0091] In the present embodiment, the description has been made for the case where only the second projection portion **1901** is used as the pivot regulation portion. However, the present disclosure is not limited to this. For example, as illustrated in FIG. **24**, a holding mechanism **18** may be used as the pivot regulation portion. The holding mechanism **18** includes an abutting portion **1902** formed at a position to which the first projection portion **510** climbs over the second projection portion **1901**. The abutting portion **1902** is disposed in the front side-plate **1900**, and is formed in the vicinity of the fitting hole portion **1002** so as to extend toward the other side of the

radial direction. In addition, the abutting portion **1902** is disposed at a position that overlaps with the movement trajectory P**1** of the first projection portion **510**, and is closer to the opening direction than the second projection portion **1901** is. In this case, when the separation guide member **500** is held in the second open position, the first projection portion **510** is prevented from pivoting toward the closing direction by the second projection portion **1901**, and from pivoting toward the opening direction by the abutting portion **1902**. In the present embodiment, the second projection portion **1901** and the abutting portion **1902** form a recess portion. Thus, when the separation guide member **500** is located in the second open position, the first projection portion **510** is prevented from pivoting over the abutment portion **1902** in the opening direction. As a result, the stability of the separation guide member **500** can be increased, so that the vibration or unstable movement of the separation guide member **500** can be suppressed. Note that on the back side of the main-body unit **102***a*, a back side-plate (not illustrated) is disposed, and in the back side-plate, a fitting groove portion and a fitting hole portion that are the same as those of the front side-plate **1900** are formed. The back side-plate supports the second reading unit **307** and the separation guide member **500**, like the front side-plate **1900** does.

[0092] Next, one example of dynamic computation for achieving the self-supporting design that uses the first projection portion **510** and the second projection portion **1901**, which serves as a pivot regulation portion, will be described with reference to FIGS. **25** to **28**. FIGS. **25** to **28** are diagrams for describing, in dynamics, the self-support of the second reading unit **307** achieved by the second projection portion **1901** and the first projection portion **510** of the present embodiment. Note that the computation is one example of simplified computation that is performed under the condition in which a dynamic model is represented by a system of particles. Thus, the below-described computation may not necessarily be performed. For example, necessary forces may be computed through a three-dimensional simulation that uses a mechanism analysis tool or the like.

[0093] First, the equilibrium of forces applied to the second reading unit **307**, and the equilibrium of moments applied to the second reading unit **307** are determined for the computation, by using FIG. **25**. In FIG. **25**, a parameter M.sub.1g is a self-weight of the second reading unit **307**, a parameter F.sub.1 is a force applied to the second reading unit **307** from the cam member **501**, a parameter F.sub.2 is a force applied to the second reading unit **307** from the angle regulation portion **508**, and a parameter F.sub.3 is a force applied to the second reading unit **307** from the fitting groove portion **1003**. In addition, a parameter **11** is a distance between the vector of the force F.sub.1 and a point of application of the force F.sub.2, a parameter **13** is a distance between the vector of the force F.sub.3 and the point of application of the force F.sub.2, a parameter l.sub.g1 is a distance between the vector of the force of the self-weight M.sub.1g and the point of application of the force F.sub.2, and a parameter θ.sub.1 is a pivot angle of the second reading unit **307** with respect to the horizontal plane. The parameters l.sub.1, l.sub.3, l.sub.g1, θ.sub.1, and M.sub.1g are known parameters, and the parameters F.sub.1, F.sub.2, and F.sub.3 are unknown parameters.

[0094] In consideration of the equilibrium of forces in the vertical direction, the equilibrium of forces in the horizontal direction, and the equilibrium of moments around the point of application of the force F.sub.2, the following equations (1) to (3) are satisfied.

[00001] $M_1 g - F_1 \sin\ _1 - F_2 \cos\ _1 - F_3 \cos\ _1 = 0$ (1)

$F_1 \cos\ _1 - F_2 \sin\ _1 - F_3 \sin\ _1 = 0$ (2) $M_1 \mathrm{gl}_{g1} - F_1 l_1 - F_3 l_3 = 0$ (3)

[0095] By solving the simultaneous equations (1) to (3), equations (4) to (6) can be obtained as solutions.

[00002] $F_1 = M_1 g \sin\ _1$ (4) $F_2 = \frac{l_3 \cos\ _1 + l_1 \sin\ _1 - l_{g1}}{l_3} M_1 g$ (5) $F_3 = \frac{l_{g1} - l_1 \sin\ _1}{f_3} M_1 g$ (6)

[0096] Next, the equilibrium of forces applied to the cam member **501**, and the equilibrium of moments applied to the cam member **501** are determined for the computation, by using FIG. **26**. A parameter M.sub.2g is a self-weight of the cam member **501**, a parameter F.sub.1 is a reaction force

(of the calculated force) applied from the second reading unit **307** to the cam member **501**, and a parameter F.sub.4 is a force applied from the first contact portion **503** of the separation guide member **500** to the second contact portion **504** of the cam member **501**. A parameter F.sub.5 is a force applied from the pivot shaft **502** of the separation guide member **500** to a fitting portion of the cam member **501** that fits to the separation guide member **500**. In addition, a parameter **14** is a distance between the vector of the force F.sub.4 and the axis of the pivot shaft **502**, a parameter **15** is a distance between the vector of the force F.sub.1 and the axis of the pivot shaft **502**, and a parameter **192** is a distance between the vector of the force of the self-weight M.sub.2g and the axis of the pivot shaft **502**. A parameter θ.sub.4 is an angle of the vector of the force F.sub.4 with respect to the horizontal plane, and a parameter θ.sub.5 is an angle of the vector of the force F.sub.5 with respect to the horizontal plane. The parameters l.sub.4, l.sub.5, l.sub.g2, θ.sub.4, F.sub.1, and M.sub.2g are known parameters, and the parameters F.sub.4, F.sub.5, and θ.sub.5 are unknown parameters.

[0097] In consideration of the equilibrium of forces in the vertical direction, the equilibrium of forces in the horizontal direction, and the equilibrium of moments around the axis of the pivot shaft **502**, the following equations (7) to (9) are satisfied.

[00003] $M_2 g + F_1 \sin\ _1 - F_5 \sin\ _5 - F_4 \sin\ _4 = 0$ (7) $F_1 \cos\ _1 + F_4 \cos\ _4 - F_5 \cos\ _5 = 0$ (8)

$M_2 \mathrm{gl}_{g2} + F_1 l_5 - F_4 l_4 = 0$ (9)

[0098] By solving the simultaneous equations (7) to (9), equations (10) to (12) can be obtained as solutions.

[00004] $F_4 = \frac{1}{l_4}(M_2 \mathrm{gl}_{g2} + M_1 g \sin\ _1 l_5)$ (10) $F_5 = \sqrt{\ ^2 + \ ^2}$ (11)

$_5 = \arccos(\frac{}{\sqrt{\ + \ ^2}})$ (12)

[0099] Note that in the equations (11) and (12), parameters a and β are known parameters defined in equations (13) and (14).

[00005] $= M_2 g + F_1 \sin\ _1 - F_4 \sin\ _4$ (13) $= F_1 \cos\ _1 + F_4 \cos\ _4$ (14)

[0100] Next, the equilibrium of forces applied to the separation guide member **500**, and the equilibrium of moments applied to the separation guide member **500** are determined for the computation, by using FIG. **27**. A parameter M.sub.3g is a self-weight of the separation guide member **500**; a parameter F.sub.4 is a reaction force of the above-described force, applied from the second contact portion **504** of the cam member **501** to the first contact portion **503** of the separation guide member **500**; and a parameter F.sub.5 is a reaction force of the above-described force, applied from the fitting portion of the cam member **501** to the pivot shaft **502**. A parameter F.sub.6 is a force applied from a user to release the separation guide member **500** from the self-supporting state. The parameter F.sub.6 is a design parameter for determining the force to release the separation guide member **500** from the self-supporting state. A parameter F.sub.7 is a force applied from the fitting hole portion **1002** of the front side-plate **1900** to the pivot shaft **502**. In addition, a parameter l.sub.4 is a distance between the vector of the force F.sub.4 and the axis of the pivot shaft **502**, and a parameter l.sub.g3 is a distance between the vector of the force of the self-weight M.sub.3g and the axis of the pivot shaft **502**. A parameter θ.sub.4 is an angle of the vector of the force F.sub.4 with respect to the horizontal plane, a parameter θ.sub.5 is an angle of the vector of the force F.sub.5 with respect to the horizontal plane, and a parameter θ.sub.7 is an angle of the vector of the force F.sub.7 with respect to the horizontal plane. If the first projection portion **510** and the second projection portion **1901** are not formed, the separation guide member **500** is caused to return to the original posture by the above-described forces. A parameter M is a moment produced around the pivot shaft **502** and necessary for preventing the separation guide member **500** from returning to the original posture. The parameters l.sub.4, l.sub.6, l.sub.g3, θ.sub.4, θ.sub.5, F.sub.4, F.sub.5, F.sub.6, and M.sub.3g are known parameters, and the parameters F.sub.7, θ.sub.7,

and M are unknown parameters.

[0101] In consideration of the equilibrium of forces in the vertical direction, the equilibrium of forces in the horizontal direction, and the equilibrium of moments around the axis of the pivot shaft **502**, the following equations (15) to (17) are satisfied.

[00006] $M_3 g + F_4 \sin\ _4 + F_6 \sin\ _4 + F_5 \sin\ _5 - F_7 \sin\ _7 = 0$ (15)

$F_4 \cos\ _4 + F_6 \cos\ _4 - F_5 \cos\ _5 + F_7 \cos\ _7 = 0$ (16) $M - F_4 l_4 + M_3 \mathrm{gl}_{g3} - F_6 l_6 = 0$ (17)

[0102] By using the equations (10) and (17), the following equation (18) can be obtained. By using the equation (18), the moment M necessary for the self-support of the separation guide member **500** can be calculated. The description of the parameters F.sub.7 and θ.sub.7 will be omitted because they are not used in the following calculations.

[00007] $M = M_1 \sin\ _1 l_5 + M_2 g l_{g2} - M_3 \mathrm{gl}_{g3} + F_6 l_6$ (18)

[0103] Next, as illustrated in FIG. **28**, a force F.sub.8 applied to the first projection portion **510** of the separation guide member **500** by the second projection portion **1901** of the front side-plate **1900** and necessary for the self-support of the separation guide member **500** is determined. A parameter **18** is a distance between the vector of the force F.sub.8 and the axis of the pivot shaft **502**, a parameter R is a distance between the leading end of the first projection portion **510** and the axis of the pivot shaft **502** in a radial direction.

[0104] By using the equation of the equilibrium of moments and the equation (18), the following equation (19) is satisfied.

[00008] $F_8 = \frac{1}{l_8}(M_1 \sin\ _1 l_5 + M_2 \mathrm{gl}_{g2} - M_3 \mathrm{gl}_{g3} + F_6 l_6)$ (19)

[0105] Thus, the force applied to the leading end of the first projection portion **510**, and the force applied to the second projection portion **1901** as the reaction force can be determined by using the equation (19). In addition, the load determined by using the equation (19) may be designed by using a static structure simulation tool, such as the finite element method. For example, the radius R and the amount of engagement δ between the first projection portion **510** and the second projection portion **1901** may be designed such that if the force F.sub.6 is smaller than a target force for releasing the separation guide member **500** from the self-supporting state, the amount of deformation of the second projection portion **1901** is smaller than the amount of engagement δ of the first projection portion **510**. In addition, the radius R and the amount of engagement δ between the first projection portion **510** and the second projection portion **1901** may be designed such that if the force F.sub.6 is equal to or larger than the target force for releasing the separation guide member **500** from the self-supporting state, the amount of deformation of the second projection portion **1901** is larger than the amount of engagement δ of the first projection portion **510**.

[0106] The design has to be performed so that the second projection portion **1901** deforms within an elastic deformation range. In addition, the design has to be performed in consideration of the characteristics (e.g., S-N curve) of the material of the second projection portion **1901** so that the second projection portion **1901** is not plastically deformed in shape or damaged before the expected number of pivots is reached. In the present embodiment, it is preferable that the front side-plate **1900**, which forms the second projection portion **1901**, be made of ABS, the force F.sub.6 be 110 gf, the radius R be 16.7 mm, and the amount of engagement δ be 0.6 mm.

[0107] By the way, Japanese Patent Application Publication No. 2005-194011 describes the image reading apparatus that includes a pivot unit that accommodates the CIS used for the back side of a sheet, and that forms the upper conveyance path. In such an image reading apparatus, it is possible to access the lower conveyance path, to which the CIS used for the back side of a sheet is exposed, by opening the outer cover, and by opening the lower conveyance path by pivoting the pivot unit. In the image reading apparatus, however, since the pivot shaft of the pivot unit and the CIS used for the back side of a sheet are separated significantly from each other, the FFC is bent more when the pivot unit pivots, which may deteriorate the durability. For solving this problem, it was conceived

that the pivot unit is divided into two units such that the two units are both opened upward, and that one unit includes the CIS used for the back side of a sheet and the other unit forms the upper conveyance path. In this configuration alone, however, since the CIS used for the back side of a sheet and the upper conveyance path have to be held separately when a user accesses the lower conveyance path, the workability is poor. In the present embodiment, the opening and closing of the second reading unit **307** is performed in accordance with the opening and closing of the separation guide member **500** that forms the upper conveyance path **11***a*. In addition, by holding the separation guide member **500**, the access to the lower conveyance path **11***b* is made easier.

[0108] As described above, the image forming apparatus **1** of the present embodiment includes the holding mechanism **15** or **18**, and the cam member **501**. Thus, when the outer cover **12** is located in the third open position and the separation guide member **500** is located in the second open position, the separation guide member **500** can be prevented from returning to the second closed position due to the self-weight of the separation guide member **500**, and can be held in the second open position. In addition, when the separation guide member **500** is pivoted from the second closed position to the second open position, the cam member **501** moves in accordance with the movement of the separation guide member **500**, and presses the second reading unit **307** in a direction in which the second reading unit **307** pivots from the first closed position to the first open position. In this manner, the second reading unit **307** is held in the first open position. As a result, the access to the lower conveyance path **11***b* can be made easier, and the workability for a user to access the lower conveyance path **11***b*, to which the second reading unit **307** is exposed, and perform the work can be improved.

[0109] In addition, in the image forming apparatus **1** of the present embodiment, since the holding mechanisms **15** and **18** have a configuration in which one projection portion engages with another projection portion, the configuration can be achieved simply and inexpensively.

[0110] In the above-described embodiment, the cam member **501** presses the second reading unit **307** upward, and the second reading unit **307** pivots to the closed position due to the self-weight of the second reading unit **307** when the separation guide member **500** is moved to the closed position. However, the present disclosure is not limited to this. For example, the interlocking member may serve as a positive motion cam, and link the separation guide member **500** and the second reading unit **307**. In this case, regardless of whether the self-weight of the second reading unit **307** is applied to the second reading unit **307**, the second reading unit **307** can be moved to the closed position in accordance with the movement of the separation guide member **500** to the closed position. In another case, the separation guide member **500** and the second reading unit **307** may be linked with each other via a gear train, and moved with each other. In this case, a surface of a gear serves as the interlocking member, and the second reading unit **307** is pivoted by the pivot of the separation guide member **500**.

[0111] In addition, in the above-described embodiment, the description has been made for the case where the cam member **501**, which is a component separate from the separation guide member **500**, is used as the interlocking member. However, the present disclosure is not limited to this. For example, the interlocking member may be formed integrally with a portion of the separation guide member **500**, and the second reading unit **307** may be pressed by the interlocking member.

Another Embodiment

[0112] Next, another embodiment of the present invention will be described in detail with reference to FIGS. **29** to **33**. The present embodiment differs from the above-described embodiment in that a holding mechanism **19** that uses a fan portion **520** and a stopper **530** is used instead of the holding mechanism **15**, which includes the first projection portion **510** and the second projection portion **1901**. Since the other configuration of the present embodiment is the same as that of the above-described embodiment, a component identical to a component of the above-described embodiment is given an identical symbol and the detailed description thereof will be omitted.

[0113] In the present embodiment, an image reading apparatus **10** includes a separation guide

member **500**A and a front side-plate **1900**A. As illustrated in FIG. **29**, the holding mechanism **19** includes the fan portion **520** formed integrally with the separation guide member **500**A, and the stopper **530** disposed in the front side-plate **1900**A.

[0114] As illustrated in FIGS. **29** and **30**, the fan portion **520** pivots around the pivot shaft **502** in accordance with the pivot of the separation guide member **500**A. The fan portion **520** includes a portion shaped like a fan when viewed from the axial direction of the pivot shaft **502**. The fan-shaped portion of the fan portion **520** includes a first side **521** and a second side **522** that are linear, and that form an angle of about 90 degrees. That is, the fan portion **520** is one example of an engaging portion, and is disposed in the separation guide member **500**A so as to extend toward a radial direction of a circle around the rotation axis of the separation guide member **500**A.

[0115] As illustrated in FIGS. **29** and **31**, the stopper **530** is made of resin, and the upper portion of the stopper **530** is fixed to the front side-plate **1900**A via a screw. The lower end of the stopper **530** serves as a leading end, and can elastically deform in the axial direction of the pivot shaft **502**. The stopper **530** is disposed in front of the fan portion **520** in the axial direction of the pivot shaft **502**. In a lower portion of the stopper **530**, a first surface **531** and a second surface **532** are formed. The first surface **531** projects backward in the axial direction of the pivot shaft **502**, and is sloped so as to face an obliquely downward direction. The second surface **532** projects backward in the axial direction of the pivot shaft **502**, and is sloped so as to face an obliquely upward direction. The first surface **531** is formed so as to be continuous with the lower portion of the second surface **532**, and a projecting leading-edge portion **533** is formed in a continuous portion between the first surface **531** and the second surface **532**. The first surface **531**, the second surface **532**, and the leading-edge portion **533** elastically move back and forth in the axial direction of the pivot shaft **502**, in accordance with the elastic deformation of the lower portion of the stopper **530**. The stopper **530** is one example of an engaged portion, and is disposed in the front side-plate **1900**A so as to extend toward the rotation-axis direction. In addition, the stopper **530** is disposed at a position that overlaps with a movement trajectory of the fan portion **520**. Note that although the first surface **531** and the second surface **532** are flat surfaces in the present embodiment, the first surface **531** and the second surface **532** are not limited to flat surfaces. For example, the first surface **531** and the second surface **532** may be curved surfaces.

[0116] Next, an operation performed by the holding mechanism **19** for allowing the self-support of the separation guide member **500**A will be described with reference to FIGS. **29**, **31**, and **32**. As illustrated in FIG. **29**, in a state where the separation guide member **500**A is closed, the first side **521** of the fan portion **520** and the first surface **531** of the stopper **530** are located, with a predetermined clearance being formed between the first side **521** and the first surface **531**. If the pivot of the separation guide member **500**A is started, the first side **521** of the fan portion **520** and the first surface **531** of the stopper **530** contact each other. Then, as illustrated in FIG. **32**, the stopper **530** bends in the rotation-axis direction, so that the leading-edge portion **533** of the stopper **530** and a front surface of the fan portion **520** contact each other. While the separation guide member **500**A is pivoting, the leading-edge portion **533** of the stopper **530** and the front surface of the fan portion **520** continue to be in contact with each other.

[0117] As illustrated in FIG. **33**, if the separation guide member **500**A is further pivoted and opened by about 90 degrees, the leading-edge portion **533** of the stopper **530** and the front surface of the fan portion **520** are no longer in contact with each other, and the second side **522** of the fan portion **520** and the second surface **532** of the stopper **530** contact each other. If a user releases the separation guide member **500**A from his/her hand, the self-supporting state of the separation guide member **500**A is kept in a state where the second side **522** of the fan portion **520** is in contact with the second surface **532** of the stopper **530**. This is because the elastic force of the stopper **530** is stronger than the self-weight of the separation guide member **500**A and the like. That is, since the setting is performed so that the holding force of the stopper **530** endures the weight of components, including the CIS **311**, the stopper **530** can hold the separation guide member **500**A. Thus, in a state

where the separation guide member **500**A is held in the second open position, the separation guide member **500**A is held by the elastic force of the stopper **530**, in a position to which the fan portion **520** has climbed over the stopper **530** after abutting against the stopper **530** on the movement trajectory.

[0118] The fan portion **520** and the stopper **530** do not wear even if the separation guide member **500**A is further pivoted repeatedly. Thus, the holding of the separation guide member **500**A can be kept. In addition, while the separation guide member **500**A is being pivoted, the fan portion **520** always receives force from the leading-edge portion **533** of the stopper **530**. Thus, the damper effect is produced, so that the impact caused by closing the separation guide member **500**A can be reduced.

[0119] The present invention can improve the workability of work performed by a user accessing the conveyance path to which the reading portion is exposed.

OTHER EMBODIMENTS

[0120] 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.

[0121] This application claims the benefit of Japanese Patent Application No. 2022-147718, filed Sep. 16, 2022, and Japanese Patent Application No. 2023-99422, filed Jun. 16, 2023 which are hereby incorporated by reference herein in their entirety.

Claims

1. An image reading apparatus comprising: a main-body unit (e.g., a main-body unit **102***a*) including a conveyance roller (e.g., conveyance rollers **301** to **304** and a discharging roller **305**) configured to convey a sheet through a conveyance path and a conveyance guide (e.g., a conveyance guide member **507**) configured to form the conveyance path; a reading portion including a transparent member and a reading sensor configured to read the image on a sheet through the transparent member, the reading portion being configured to pivot, with respect to the main-body unit, between a first closed position in which the transparent member forms a part of the conveyance path and a first open position in which the transparent member is exposed to an outside of the image reading apparatus when viewed from above; and a holding mechanism (e.g., holding mechanisms **15** and **19**) configured to hold the reading portion in the first open position.

2. The image reading apparatus according to claim 1, further comprising: a first cover (e.g., a separation guide member **500**) configured to pivot between a second closed position in which the first cover covers the reading portion and a second open position in which the first cover opens the reading portion; and a cam member (e.g., a cam member **501**) configured to move the reading portion from the first closed position to the first open position interlocked with movement of the first cover from the second closed position to the second open position.

3. The image reading apparatus according to claim 2, further comprising: a second cover (e.g., an outer cover **12**) configured to pivot between a third closed position in which the second cover forms the conveyance path with the first cover located in the second closed position and a third open position in which the second cover opens the conveyance path.

4. The image reading apparatus according to claim 2, wherein the cam member is separated from the reading portion in a state where the first cover is positioned in the second closed position.

5. The image reading apparatus according to claim 2, wherein the cam member includes a first abutment portion and a second abutment portion, the first abutment portion being configured to abut against a lower surface portion of the reading portion and press the reading portion upward in a case where the reading portion is positioned in the first closed position, the second abutment portion being configured to abut against a side surface portion of the reading portion and press the

reading portion to the first open position after the reading portion is pivoted by the first abutment portion.

6. The image reading apparatus according to claim 2, wherein the first cover includes a contacting portion, wherein the cam member is configured to pivot with respect to the first cover and include a contacted portion configured to be contacted with the contacting portion in a pivot direction, wherein in a case where the first cover pivots from the second closed position toward an intermediate position between the second closed position and the second open position, the contacting portion does not contact with the contacted portion, and wherein in a case where the first cover passes the intermediate position and pivots toward the second open position, the contacting portion contacts with the contacted portion and the cam member pivots in accordance with pivot of the first cover.

7. The image reading apparatus according to claim 2, wherein the holding mechanism includes an engaging portion and an engaged portion, the engaging portion being disposed in the first cover and extended toward a direction orthogonal to a rotation axis of the first cover, the engaged portion being disposed in the main-body unit and with which the engaging portion is engaged.

8. The image reading apparatus according to claim 2, wherein the holding mechanism includes a stopper (e.g., a stopper **530**) configured to elastically deform and prevent the first cover from moving from the second open position to the second closed position.

9. An image forming apparatus comprising: the image reading apparatus according to claim 1; and an image forming portion configured to form an image that has been read by the image reading apparatus, on a sheet.