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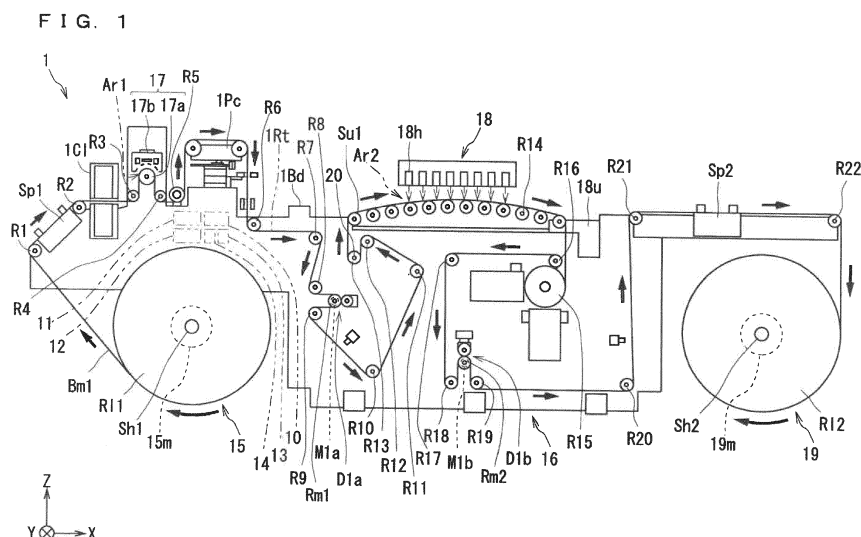
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(54) **IMAGE FORMING APPARATUS WITH PRETREATMENT UNIT, CORRESPONDING IMAGE FORMING METHOD AND PROGRAM**

(57) Performed are surface reformation processing of reforming a surface of a base material in a first region along a transport path and image forming processing of forming an image on the surface reformed by the surface reformation processing of the base material in a second region along the transport path while transporting the base material in the first transport direction along the transport path. Next, the base material having a formation-completed portion in which the image is formed on the surface is transported in a second transport direction opposite to the first transport direction along the transport

path. Next, when the surface reformation processing and the image forming processing are performed while the base material having the formation-completed portion is transported in the first transport direction along the transport path, the image is formed on the surface of the base material in the second region in such a manner that a multiple surface reforming region, in which the number of executions of surface reformation processing in the first region in the surface of the base material is larger than that in a surrounding region, can be distinguished.



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an image forming apparatus, an image forming method, and a program.

Description of the Background Art

[0002] Known is an image forming apparatus in which a sheet-like elongated base material (paper or plastic, for example) is rolled out from a cylindrical roll, and an image is formed on a surface of the base material by ink-jet printing, for example.

[0003] In this image forming apparatus, if ink is easily fixed on the surface of the base material in the ink-jet printing, for example, a quality of the image (image quality) printed on the surface of the base material is improved. Thus, preprocessing for activating the surface of the base material is performed by corona discharge or the like before the printing in some cases (for example, Japanese Patent Application Laid-Open Nos. 2013-169708 and 2015-66739).

SUMMARY OF THE INVENTION

[0004] The present invention is directed to an image forming apparatus.

[0005] According to one aspect of the present invention, an image forming apparatus includes: a feed unit configured to supply a base material; a transport mechanism configured to transport the base material supplied from the feed unit along a transport path; a recovery unit configured to recover the base material transported by the transport mechanism along the transport path; a surface reforming unit configured to perform surface reformation processing of reforming a surface of the base material in a first region along the transport path; an image forming unit configured to form an image on a surface reformed in the surface reformation processing on the base material in a second region between the surface reforming unit and the recovery unit along the transport path; and a control unit configured to make the transport mechanism and the image forming unit form an image on the surface of the base material based on image data. The control unit makes the transport mechanism execute a first transport operation of transporting the base material in a first transport direction toward the recovery unit along the transport path and a second transport operation of transporting the base material in a second transport direction toward the feed unit opposite to the first transport direction along the transport path. When the control unit makes the transport mechanism perform the first transport operation of transporting the base material having a formation-completed portion in which an image is formed on a surface by the image forming unit in the first

transport direction along the transport path after performing the second transport operation of transporting the base material in the second transport direction along the transport path, the control unit makes the image forming unit form an image on the surface of the base material in such a manner that a multiple surface reforming region, in which a total number of executions of the surface reformation processing in the surface of the base material is larger than a total number of executions of the surface reformation processing in a surrounding region, can be distinguished.

[0006] For example, a portion in which the quality of the image is different from that of the surrounding portion in the base material can be easily distinguished from the surrounding portion while effectively using the base material.

[0007] According to another aspect of the present invention, an image forming apparatus includes: a feed unit configured to supply a base material; a transport mechanism configured to transport the base material supplied from the feed unit along a transport path; a recovery unit configured to recover the base material transported by the transport mechanism along the transport path; a surface reforming unit configured to give energy to a surface of the base material in a first region along the transport path to perform surface reformation processing of reforming the surface of the base material; an image forming unit configured to form an image on the surface of the base material in a second region between the surface reforming unit and the recovery unit along the transport path; and a control unit configured to control the transport mechanism, the surface reforming unit, and the image forming unit based on image data to make the transport mechanism, the surface reforming unit, and the image forming unit form an image on a surface reformed in the surface reformation processing of the base material. The control unit controls the transport mechanism, the surface reforming unit, and the image forming unit to make them execute a first operation, a second operation, and a third operation. The first operation includes an operation of performing the surface reformation processing on the surface of the base material and forming a first image on a first processing region on which the surface reformation processing is performed in the surface of the base material while transporting the base material in a first transport direction toward the recovery unit along the transport path. The second operation includes an operation of transporting the base material, in which the first image is formed on the surface in the first operation, in a second transport direction toward the feed unit opposite to the first transport direction along the transport path in a state where the surface reformation processing is not performed on the surface of the base material after the first operation. The third operation includes an operation of performing the surface reformation processing on a second processing region other than the first processing region in the surface of the base material and forming the second image on the second

processing region while transporting the base material in which the first image is formed in the first transport direction along the transport path after the second operation.

[0008] For example, the quality of the image formed on the base material can be improved while reducing the wasteful use of the base material.

[0009] The present invention is also directed to an image forming method.

[0010] According to one aspect of the present invention, an image forming method includes: (a) performing surface reformation processing of reforming a surface of a base material in a first region along a transport path and image forming processing of forming an image on the surface reformed by the surface reformation processing of the base material in a second region along the transport path while transporting the base material in the first transport direction along the transport path; (b) transporting the base material having a formation-completed portion in which an image is formed on a surface in the (a) in a second transport direction opposite to the first transport direction along the transport path; and (c) when performing the image reformation processing and the image forming processing while transporting the base material having the formation-completed portion in the first transport direction along the transport path after the (b), forming an image on the surface of the base material in the second region in such a manner that a multiple surface reforming region, in which a total number of executions of the surface reformation processing in the first region in the surface of the base material is larger than a total number of executions of the surface reformation processing in a surrounding region, can be distinguished.

[0011] For example, a portion in which the quality of the image is different from that of the surrounding portion in the base material can be easily distinguished from the surrounding portion while effectively using the base material.

[0012] According to another aspect of the present invention, an image forming method includes: (a) giving energy to a surface of a base material in a first region along a transport path to perform surface reformation processing of reforming the surface of the base material, and forming a first image on a first processing region, in the surface of the base material, on which the surface reformation processing is performed in the second region along the transport path while transporting the base material in a first transport direction along the transport path; (b) transporting the base material, in which the first image is formed on the surface in the (a), in a second transport direction opposite to the first transport direction along the transport path in a state where the surface reformation processing is not performed on the surface of the base material; and (c) performing the surface reformation processing on a second processing region other than the first processing region in the surface of the base material and forming a second image on the second processing region while transporting the base material in which the

first image is formed in the first transport direction along the transport path after the (b).

[0013] For example, the quality of the image formed on the base material can be improved while reducing the wasteful use of the base material.

[0014] The present invention is also directed to a program.

[0015] According to one aspect of the present invention, a program, when executed by a processing unit included in an image forming apparatus, makes the image forming apparatus function as an image forming apparatus including a feed unit, a transport mechanism, a recovery unit, a surface reforming unit, an image forming unit, and a control unit. Herein, the feed unit supplies a base material. The transport mechanism transports the base material supplied from the feed unit along a transport path. The recovery unit recovers the base material transported along the transport path by the transport mechanism. The surface reforming unit performs surface reformation processing of reforming a surface of the base material in a first region along the transport path. The image forming unit forms an image on a surface reformed in the surface reformation processing on the base material in a second region between the surface reforming unit and the recovery unit along the transport path. The control unit makes the transport mechanism and the image forming unit form an image on the surface of the base material based on image data. The control unit makes the transport mechanism execute a first transport operation of transporting the base material in a first transport direction toward the recovery unit along the transport path and a second transport operation of transporting the base material in a second transport direction toward the feed unit opposite to the first transport direction along the transport path. When the control unit makes the transport mechanism perform the first transport operation of transporting the base material having a formation-completed portion in which an image is formed on a surface by the image forming unit in the first transport direction along the transport path after performing the second transport operation of transporting the base material in the second transport direction along the transport path, the control unit makes the image forming unit form an image on the surface of the base material in such a manner that a multiple surface reforming region, in which a total number of executions of the surface reformation processing in the surface of the base material is larger than a total number of executions of the surface reformation processing in a surrounding region, can be distinguished.

[0016] For example, a portion in which the quality of the image is different from that of the surrounding portion in the base material can be easily distinguished from the surrounding portion while effectively using the base material.

[0017] According to another one aspect of the present invention, a program, when executed by a processing unit included in an image forming apparatus, makes the image forming apparatus function as an image forming

apparatus including a feed unit, a transport mechanism, a recovery unit, a surface reforming unit, an image forming unit, and a control unit. The feed unit supplies a base material. The transport mechanism transports the base material supplied from the feed unit along a transport path. The recovery unit recovers the base material transported along the transport path by the transport mechanism. The surface reforming unit gives energy to a surface of the base material in a first region along the transport path to perform surface reformation processing of reforming the surface of the base material. The image forming unit forms an image on the surface of the base material in a second region between the surface reforming unit and the recovery unit along the transport path. The control unit controls the transport mechanism, the surface reforming unit, and the image forming unit based on image data to make them form an image on a surface reformed in the surface reformation processing of the base material. The control unit controls the transport mechanism, the surface reforming unit, and the image forming unit to make them execute a first operation, a second operation, and a third operation. In the first operation, the surface reformation processing is performed on the surface of the base material and a first image is formed on a first processing region on which the surface reformation processing is performed in the surface of the base material while the base material is transported in a first transport direction toward the recovery unit along the transport path. In the second operation, the base material in which the first image is formed on the surface in the first operation is transported in a second transport direction toward the feed unit opposite to the first transport direction along the transport path in a state where the surface reformation processing is not performed on the surface of the base material after the first operation. In the third operation, the surface reformation processing is performed on a second processing region other than the first processing region in the surface of the base material and the second image is formed on the second processing region while the base material in which the first image is formed is transported in the first transport direction along the transport path after the second operation.

[0018] For example, the quality of the image formed on the base material can be improved while reducing the wasteful use of the base material.

[0019] Therefore, a first object of the present invention is to provide an image forming technique capable of easily distinguishing the portion, in which the quality of the image is different from that of the surrounding portion in the base material, from the surrounding portion while effectively using the base material.

[0020] A second object of the present invention is to provide an image forming technique improving the quality of the image formed on the base material while reducing wasteful use of the base material.

[0021] These and other objects, features, aspects and advantages of the present invention will become more

apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

5 BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

Fig. 1 is a drawing illustrating an example of a schematic configuration of an image forming apparatus common to a first embodiment and a second embodiment.

Fig. 2 is a block diagram illustrating an example of a functional configuration of the image forming apparatus common to the first embodiment and the second embodiment.

Fig. 3 is a schematic diagram for describing an example of an image forming operation in the image forming apparatus according to the first embodiment.

Fig. 4 is a schematic diagram for describing an example of an image forming operation in the image forming apparatus according to the first embodiment.

Fig. 5 is a plan view illustrating an image formed on a surface of a base material in the image forming apparatus according to the first embodiment.

Fig. 6 is a plan view illustrating an image formed on the surface of the base material in the image forming apparatus according to the first embodiment.

Fig. 7 is a flow chart illustrating an example of an operation flow according to an image forming method in the first embodiment.

Fig. 8 is a schematic diagram illustrating an example of a first operation in the image forming apparatus according to the second embodiment.

Fig. 9 is a graph illustrating an example of a relationship between a transport distance and a transport speed of the base material at a time of starting the first operation according to the second embodiment.

Fig. 10 is a schematic diagram illustrating an example of a second operation in the image forming apparatus according to the second embodiment.

Fig. 11 is a schematic diagram illustrating an example of a third operation in the image forming apparatus according to the second embodiment.

Fig. 12 is a flow chart illustrating an example of an operation flow according to an image forming method in the second embodiment.

Fig. 13 is a schematic diagram for describing an example of an image forming operation in an image forming apparatus according to a first reference example.

Fig. 14 is a schematic diagram for describing an example of an image forming operation in an image forming apparatus according to a second reference example.

Fig. 15 is a schematic diagram illustrating an exam-

ple of an operation in an image forming apparatus according to a third reference example.

Fig. 16 is a schematic diagram illustrating an example of an operation in an image forming apparatus according to a fourth reference example.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] In some image forming apparatus in which a sheet-like elongated base material is rolled out from a cylindrical roll, and an image is formed on a surface of the base material by ink-jet printing or the like, the surface of the base material is reformed into a state appropriate for the printing by corona processing or the like, for example. Performed in such an image forming apparatus is sequential printing processing of, for example, starting transporting the base material in accordance with one printing job, increasing a transport speed of the base material to stabilize the transport of the base material, and subsequently forming the image on the surface of the base material and reducing the transport speed of the base material, thereby suspending the transport of the base material. The stabilization of the transport of the base material includes, for example, a stabilization of the transport speed of the base material, a stabilization by reducing a flapping of the base material in a normal line direction of the surface of the base material, and a stabilization by reducing a meandering in a width direction of the base material. In the sequential printing processing, an image in which the same pattern is repeated may be formed on the surface of the base material or an image in which different patterns are continued may be formed. An image of approximately several tens of meters to several thousand meters may be formed in this sequential printing processing, for example.

[0024] Fig. 13 is a schematic diagram for describing an example of an operation of forming an image by the printing processing in the image forming apparatus according to a first reference example. The image forming apparatus according to the first reference example performs sequential printing processing (also referred to as first printing processing) corresponding to a first printing job, for example. In the first printing processing, as illustrated in Fig. 13(a), a transport of a base material Bm1 in a first transport direction D1 is started, and after a transport speed of the base material Bm1 is stabilized, ink is discharged from a plurality of print heads included in an image forming unit 18 on a region (also referred to a one-time surface reforming region) Rf1, in a surface Su1 of the base material Bm1, which is reformed into a state appropriate for the printing by corona processing performed by a surface reforming unit 17 to form an image (also referred to as a first image) Pc1. In Fig. 13, an oblique-line hatching is provided in the one-time surface reforming region Rf1 in the base material Bm1. Next, printing processing (also referred to as second printing processing) corresponding to a second printing job is performed while maintaining the transport of the base ma-

terial Bm1 in the first transport direction D1. In the second printing processing, as illustrated in Fig. 13(a), ink is discharged from the plurality of print heads included in the image forming unit 18 on the one-time surface reforming region Rf1, in the surface Su1 of the base material Bm1, which is reformed into the state appropriate for the printing by the corona processing performed by the surface reforming unit 17 to form an image (also referred to as a second image) Pc2. Then, the transport speed of the base material Bm1 is reduced to suspend the transport of the base material Bm1 as illustrated in Fig. 13(b). Afterward, the image forming apparatus according to the first reference example performs sequential printing processing (also referred to as third printing processing) corresponding to a third printing job, for example. In the third printing processing, as illustrated in Fig. 13(c), the transport of the base material Bm1 in the first transport direction D1 is started, and after the transport speed of the base material Bm1 is stabilized, ink is discharged from the plurality of print heads included in the image forming unit 18 on the one-time surface reforming region Rf1, in the surface Su1 of the base material Bm1, which is reformed into the state appropriate for the printing by the corona processing performed by the surface reforming unit 17 to form an image (also referred to as a third image) Pc3. At this time, the transport speed of the base material Bm1 is reduced in the end of the second printing processing, and the transport speed of the base material Bm1 is increased in the beginning of the third printing processing, thus as illustrated in Fig. 13(c), a blank Bk0 where no image is formed, that is so-called a waste portion, significantly occurs between the second image Pc2 and the third image Pc3 on the surface Su1 of the base material Bm1. Herein, when post-processing such as a UV light irradiation to the first image Pc1 and the second image Pc2 is performed after the first image Pc1 and the second image Pc2 are formed on the surface Su1 of the base material Bm1, for example, a length L0 of such a waste portion may further increase. Also considered is a case where the length L0 ranges from several meters to several tens of meters, for example.

[0025] Accordingly, it is considered that the base material Bm1 is rolled back to some degree by a reverse transport (backward feed) after the second printing processing, and then the third printing processing is performed to reduce the length of the waste portion.

[0026] Fig. 14 is a schematic diagram for describing an example of an operation of forming an image by printing processing in an image forming apparatus according to a second reference example. The image forming apparatus according to the second reference example performs the first printing processing corresponding to the first printing job, for example. In the first printing processing, as illustrated in Fig. 14(a), the transport of the base material Bm1 in the first transport direction D1 is started, and after the transport speed of the base material Bm1 is stabilized, ink is discharged from the plurality of print heads included in the image forming unit 18 on the one-

time surface reforming region Rf1, in the surface Su1 of the base material Bm1, which is reformed into the state appropriate for the printing by the corona processing performed by the surface reforming unit 17 to form the first image Pc1. Also in Fig. 14, an oblique-line hatching is provided in the one-time surface reforming region Rf1 in the base material Bm1. Next, the second printing processing corresponding to the second printing job is performed while maintaining the transport of the base material Bm1 in the first transport direction D1. In the second printing processing, as illustrated in Fig. 14(a), ink is discharged from the plurality of print heads included in the image forming unit 18 on the one-time surface reforming region Rf1, in the surface Su1 of the base material Bm1, which is reformed into the state appropriate for the printing by the corona processing performed by the surface reforming unit 17 to form the second image Pc2. Then, the transport speed of the base material Bm1 is reduced to suspend the transport of the base material Bm1 as illustrated in Fig. 14(b). Afterward, the image forming apparatus according to the second reference example performs a backward feed of transporting the base material Bm1 in a second transport direction D2 opposite to the first transport direction D1 as illustrated in Fig. 14(c), for example. Next, the image forming apparatus according to the second reference example performs the third printing processing corresponding to the third printing job, for example. In the third printing processing, as illustrated in Fig. 14(d), the transport of the base material Bm1 in the first transport direction D1 is started, and after the transport speed of the base material Bm1 is stabilized, ink is discharged from the plurality of print heads included in the image forming unit 18 on regions Rf1 and Rf3, in the surface Su1 of the base material Bm1, which are reformed into the state appropriate for the printing by the corona processing performed by the surface reforming unit 17 to form the third image Pc3. Next, fourth printing processing corresponding to a fourth printing job is performed while maintaining the transport of the base material Bm1 in the first transport direction D1. In the fourth printing processing, as illustrated in Fig. 14(e), ink is discharged from the plurality of print heads included in the image forming unit 18 on the one-time surface reforming region Rf1, in the surface Su1 of the base material Bm1, which is reformed into the state appropriate for the printing by the corona processing performed by the surface reforming unit 17 to form an image (also referred to as a fourth image) Pc4. Then, the transport speed of the base material Bm1 is reduced to suspend the transport of the base material Bm1. Herein, as illustrated in Fig. 14(d) and Fig. 14(e), the backward feed of the base material Bm1 is performed after the second printing processing, thus the blank Bk0 which is to be so-called the waste portion is reduced.

[0027] However, when the backward feed of the base material Bm1 is performed while the corona processing is performed by a corona processing device, for example, the one-time surface reforming region Rf1 on which the

corona processing has been performed once and a region on which the corona processing has been performed three times (also referred to as a three-time surface reforming region or a multiple surface reforming region) Rf3 occur on the surface Su1 of the base material Bm1. In Fig. 14(c), an oblique-line cross-hatching is provided in a region in the base material Bm1 on which the second reformation is performed in the corona processing by the surface reforming unit 17 (also referred to as a two-time surface reforming region) Rf2. In Fig. 14(d) and Fig. 14(e), an oblique-line cross-hatching and a sandy hatching are overlapped each other and provided in the multiple surface reforming region Rf3 in the base material Bm1 on which the third reformation is performed in the corona processing by the surface reforming unit 17. In the example in Fig. 14(e), the third image Pc3 has a portion formed on the multiple surface reforming region Rf3, in the surface Su1 in the base material Bm1, on which the third reformation has been performed in the corona processing. Specifically, a portion of a length L10 in the third image Pc3 located near the second image Pc2 is formed on the multiple surface reforming region Rf3, in the surface Su1 in the base material Bm1, on which the corona processing has been performed three times. A portion in the third image Pc3 located away from the second image Pc2 is formed on the one-time surface reforming region Rf1, in the surface Su1 in the base material Bm1, on which the corona processing has been performed once.

[0028] Thus, a difference in quality of the image formed on the surface Su1 in the base material Bm1 may occur between the one-time surface reforming region Rf1 and the multiple surface reforming region Rf3, in the surface Su1 in the base material Bm1, in which the number of executions of corona processing is different from each other. For example, in the third image Pc3, a density in a portion located on the multiple surface reforming region Rf3 may be lower than a density in a portion located on the one-time surface reforming region Rf1.

[0029] However, when the base material Bm1 has an elongated shape, for example, it is not easy to distinguish an image, in a plurality of images formed on the surface Su1 in the base material Bm1, which has the difference in image quality caused by the difference in the number of executions of surface reformation processing.

[0030] Such a problem is common in a general image forming technique having reforming the surface of the base material before forming the image on the surface of the base material, for example. Thus, the image forming technique has a room for improvement in being able to easily distinguish the portion in which the quality of the image is different from that of a surrounding portion in the base material from the surrounding portion while effectively using the base material, for example.

[0031] Thus, the present inventors have created a technique, in an image forming technique, capable of easily distinguishing a portion in which a quality of image is different from that of a surrounding portion in a base

material from the surrounding portion while effectively using the base material.

[0032] In this regard, a first embodiment is described with reference to the drawings hereinafter.

[0033] Fig. 15 is a schematic diagram illustrating an example of an operation of forming an image by printing processing in an image forming apparatus according to a third reference example. The image forming apparatus according to the third reference example performs sequential printing processing (also referred to as first printing processing) corresponding to the first printing job, for example. In the first printing processing, as illustrated in Fig. 15(a), the transport of the base material Bm1 in the first transport direction D1 is started, and after the transport of the base material Bm1 is stabilized, ink is discharged from the plurality of print heads included in the image forming unit 18 on a region (also referred to as a one-time processing region) Ap1, in the surface Su1 of the base material Bm1, which is reformed into the state appropriate for the printing in the corona processing performed by the surface reforming unit 17 to form the image (also referred to as the first image) Pc1. Then, the transport speed of the base material Bm1 is reduced to suspend the transport of the base material Bm1. Next, the image forming apparatus according to the third reference example performs the sequential printing processing (also referred to as the second printing processing) corresponding to the second printing job, for example. In the second printing processing, the transport of the base material Bm1 in the first transport direction D1 is started, and after the transport of the base material Bm1 is stabilized, as illustrated in Fig. 15(b), ink is discharged from the plurality of print heads included in the image forming unit 18 on the one-time processing region Ap1, in the surface Su1 of the base material Bm1, which is reformed into the state appropriate for the printing in the corona processing performed by the surface reforming unit 17 to form the image (also referred to as the second image) Pc2. Then, the transport speed of the base material Bm1 is reduced to suspend the transport of the base material Bm1. At this time, the transport speed of the base material Bm1 is reduced in the end of the first printing processing, and the transport speed of the base material Bm1 is increased in the beginning of the second printing processing, thus as illustrated in Fig. 15(b), a blank Bk0 where no image is formed, that is so-called a waste portion, occurs between the first image Pc1 and the second image Pc2 on the surface Su1 of the base material Bm1. Herein, when post-processing such as a UV light irradiation to the ink is performed after the ink is applied on the surface Su1 of the base material Bm1, for example, the length L0 of such a waste portion may further increase. Also considered is a case where the length L0 ranges from several meters to several tens of meters, for example.

[0034] Accordingly, it is considered that the base material Bm1 is rolled back to some degree by a reverse transport (backward feed) after the first printing processing, and then the second printing processing is performed

to reduce the length of the waste portion.

[0035] Fig. 16 is a schematic diagram illustrating an example of an operation of forming an image by printing processing in an image forming apparatus according to a fourth reference example. The image forming apparatus according to the fourth reference example performs the first printing processing corresponding to the first printing job, for example. In the first printing processing, as illustrated in Fig. 16(a), the transport of the base material Bm1 in the first transport direction D1 is started, and after the transport of the base material Bm1 is stabilized, ink is discharged from the plurality of print heads included in the image forming unit 18 on the one-time processing region Ap1, in the surface Su1 of the base material Bm1, which is reformed into the state appropriate for the printing in the corona processing performed by the surface reforming unit 17 to form the first image Pc1. Then, the transport speed of the base material Bm1 is reduced to suspend the transport of the base material. Next, the image forming apparatus according to the fourth reference example performs the backward feed of transporting the base material Bm1 in the second transport direction D2 opposite to the first transport direction D1 as illustrated in Fig. 16(b), for example. Subsequently, the image forming apparatus according to the fourth reference example performs the second printing processing corresponding to the second printing job, for example. In the second printing processing, the transport of the base material Bm1 in the first transport direction D1 is started, and after the transport of the base material Bm1 is stabilized, as illustrated in Fig. 16(c), ink is discharged from the plurality of print heads included in the image forming unit 18 on regions the Ap1 and Ap3, in the surface Su1 of the base material Bm1, which are reformed into the state appropriate for the printing in the corona processing performed by the surface reforming unit 17 to form the second image Pc2. Then, the transport speed of the base material Bm1 is reduced to suspend the transport of the base material. Herein, as illustrated in Fig. 16(c), the backward feed of the base material Bm1 is performed after the first printing processing, thus the blank Bk0 which is to be so-called the waste portion is reduced.

[0036] In the meanwhile, when the backward feed of the base material Bm1 is performed while the corona processing is performed, for example, the one-time processing region Ap1 on which the corona processing has been performed once and a region on which the corona processing has been performed three times (also referred to as a multiple processing region) Ap3 occur on the surface Su1 of the base material Bm1. In the example in Fig. 16(c), a portion of a length L10 in the second image Pc2 located near the first image Pc1 is formed on the multiple processing region Ap3, in the surface Su1 in the base material Bm1, on which the corona processing has been performed three times. In Fig. 16(c), an oblique-line hatching is provided in the one-time processing region Ap1, and a cross hatching is provided in the multiple processing region Ap3. A portion in the second image

Pc2 located away from the first image Pc1 is formed on the one-time processing region Ap1, in the surface Su1 in the base material Bm1, on which the corona processing has been performed once.

[0037] However, a difference in quality of the second image Pc2 formed on the surface Su1 in the base material Bm1 may occur between the one-time processing region Ap1 and the multiple processing region Ap3, in the surface Su1 in the base material Bm1, in which the number of executions of corona processing is different from each other. For example, in the second image Pc2, a density in a portion located on the multiple processing region Ap3 may be lower than a density in a portion located on the one-time processing region Ap1.

[0038] Such a problem is common in a general image forming technique having reforming the surface of the base material before forming the image on the surface of the base material, for example. Thus, the image forming technique has a room for improvement in increasing the quality of the image formed on the base material while reducing wasteful use of the base material, for example.

[0039] Thus, the present inventors have created a technique, in an image forming technique, of increasing the quality of the image formed on the base material while reducing wasteful use of the base material.

[0040] In this regard, a second embodiment is described with reference to the drawings hereinafter.

[0041] In each drawing, identical reference signs are given to parts having similar configurations and functions, and an overlapping explanation is omitted in the following description. The drawings are schematically illustrated. Illustrated in Fig. 1 is a right-handed XYZ coordinate system in which a direction, in which a rotational axis Sh1 of a feed unit 15 and a rotational axis Sh2 of a recovery unit 19 extend (also referred to as an axial direction), is defined as a Y axis direction. Rotational directions of rolls R11 and R12 and a transport direction of the base material Bm1 are indicated by thick-line arrows in Figs. 1, 3 to 6, 8, 10, 11, and 13 to 16 described above. In Fig. 3 and Fig. 4, an oblique-line hatching is provided in the one-time surface reforming region Rf1 in the base material Bm1 in the manner similar to Fig. 13 and Fig. 14 described above. In Fig. 4, in the manner similar to Fig. 14 described above, an oblique-line cross-hatching is provided in the two-time surface reforming region Rf2 in the base material Bm1, and an oblique-line cross-hatching and a sandy hatching are overlapped each other and provided in the three-time surface reforming region Rf3 in the base material Bm1.

<1. Configuration of image forming apparatus>

[0042] Fig. 1 is a drawing illustrating an example of a schematic configuration of an image forming apparatus 1 common to the first embodiment and the second embodiment. Fig. 2 is a block diagram illustrating an example of a functional configuration of the image forming apparatus 1 common to the first embodiment and the sec-

ond embodiment. The image forming apparatus 1 includes, for example, the feed unit 15, a transport mechanism 16, the surface reforming unit 17, the image forming unit 18, the recovery unit 19, and a control unit 10.

5 The image forming apparatus 1 includes, for example, an input unit 11, an output unit 12, a storage unit 13, and a communication unit 14. The image forming apparatus 1 may include a detection unit 20, for example. The image forming apparatus 1 may further include a first splice unit Sp1, a second splice unit Sp2, and a cleaning unit 1Cl, for example.

<1-1. Feed unit>

15 **[0043]** The feed unit 15 can supply the base material Bm1 to a predetermined transport path 1Rt. The predetermined transport path 1Rt is a path along which the base material Bm1 is transported from the feed unit 15 to the recovery unit 19. The feed unit 15 rolls out the elongated sheet-like (band-like) base material Bm1 from the roll R11 around which the base material Bm1 is cylindrically rolled, thereby being able to supply the base material Bm1 to the transport path 1Rt. Paper, a film made of polyethylene terephthalate (PET) or the like, for example, is adopted as the base material Bm1. In the example in Fig. 1, the feed unit 15 has the rotational axis Sh1. The rotational axis Sh1 is provided in a housing 1Bd or the like of the image forming apparatus 1, so as to be rotatable around a virtual axis along the Y axis direction. The roll R11 is attached to an outer peripheral part of the rotational axis Sh1. When the roll R11 is attached to the rotational axis Sh1, the rotational axis Sh1 is inserted into a through hole of a roll core in the roll R11, for example. Then, when the base material Bm1 rolled out from an outer peripheral part of the roll R11 is transported along the transport path 1Rt by the transport mechanism 16 and rolled up by the recovery unit 19, for example, the roll R11 rotates with the rotational axis Sh1 around the virtual axis along the Y axis direction. The base material Bm1 is thereby rolled out from the outer peripheral part of the roll R11, and one sheet of the base material Bm1 is peeled from the outer peripheral part of the roll R11. The feed unit 15 can also roll back the base material Bm1 which has been rolled out once from the roll R11, using a rotation of the rotational axis Sh1 caused by drive force of a first motor 15m, for example.

<1-2. Transport mechanism>

50 **[0044]** The transport mechanism 16 can transport the base material Bm1 supplied from the feed unit 15 along the transport path 1Rt. The transport mechanism 16 has, for example, first to twenty-second rollers R1 to R22, a meandering correction unit 1Pc, a first drive unit D1a, and a second drive unit D1b. The first to twenty-second rollers R1 to R22 are provided in the housing 1Bd and the like of the image forming apparatus 1 so as to be each rotatable around the virtual axis along the Y axis

direction. The transport mechanism 16 may include the first motor 15m and a second motor 19m.

[0045] In the example in Fig. 1, the base material Bm1 supplied from the feed unit 15 can go sequentially through each outer peripheral part of the first to third rollers R1 to R3 and reach the surface reforming unit 17. The base material Bm1 which has passed through the surface reforming unit 17 can go sequentially through each outer peripheral part of a fourth roller R4 and a fifth roller R5 and reach the meandering correction unit 1Pc. The meandering correction unit 1Pc can reduce the meandering of the base material Bm1 transported along the transport path 1Rt, for example. Applicable to the meandering correction unit 1Pc is a mechanism controlling at least one of a position of an end portion of the base material Bm1 in a width direction and a position of a center of the base material Bm1 in the width direction, for example. The base material Bm1 which has passed through the meandering correction unit 1Pc can go through each outer peripheral part of sixth to eighth rollers R6 to R8 and reach the first drive unit D1a. The first drive unit D1a has a drive roller Rm1 rotatable around a virtual axis along the Y direction by drive force of the first drive motor M1a, and can transport the base material Bm1 along the transport path 1Rt by a rotation of the drive roller Rm1, for example. The base material Bm1 which has passed through the first drive unit D1a can go through each outer peripheral part of ninth to thirteenth rollers R9 to R13, a plurality of fourteenth rollers R14, and fifteenth to eighteenth rollers R15 to R18 and reach the second drive unit D1b. The second drive unit D1b has a drive roller Rm2 rotatable around a virtual axis along the Y direction by drive force of the second drive motor M1b, and can transport the base material Bm1 along the transport path 1Rt by a rotation of the drive roller Rm2, for example. The base material Bm1 which has passed through the second drive unit D1b can go through each outer peripheral part of nineteenth to twenty-second rollers R19 to R22 and reach the recovery unit 19.

<1-3. Surface reforming unit>

[0046] The surface reforming unit 17 can perform processing of reforming the surface Su1 of the base material Bm1 (also referred to as surface reformation processing) in a first region Ar1 (described hereinafter) along the transport path 1Rt, for example. Herein, processing of giving energy to the surface Su1 of the base material Bm1 is applied to the surface reformation processing, for example. Thus, the first region Ar1 is a region being set on the transport path 1Rt and in which the energy can be given from the surface reforming unit 17 to the base material Bm1. Herein, the surface Su1 of the base material Bm1 before the image is formed is activated by processing of giving the energy (preprocessing), and ink is easily fixed on the surface Su1.

[0047] In the first embodiment and the second embodiment, the surface reforming unit 17 has a support roller

17a and a reformation processing unit 17b, for example. The support roller 17a can rotate around a virtual axis along the Y axis direction, and can support the base material Bm1 on an outer peripheral part of the support roller 17a so that the surface Su1 faces the reformation processing unit 17b. The reformation processing unit 17b can give energy to the surface Su1 of the base material Bm1 supported by the outer peripheral part of the support roller 17a, for example. Herein, applicable to the reformation processing unit 17b is a unit which gives the energy to the surface Su1 of the base material Bm1 by an irradiation of ion generated by corona discharge, thereby being able to reform the surface Su1 of the base material Bm1 (also referred to as a corona discharge unit). Also applicable to the reformation processing unit 17b is a unit of reforming the surface Su1 of the base material Bm1 which gives the energy to the surface Su1 of the base material Bm1 by an irradiation of plasma (also referred to as a plasma irradiation unit).

<1-4. Image forming unit>

[0048] The image forming unit 18 can form an image on the surface Su1 of the base material Bm1 in a second region Ar2 (described hereinafter) located between the surface reforming unit 17 and the recovery unit 19 along the transport path 1Rt, for example. Specifically, in the second region Ar2, the image forming unit 18 can form an image on the surface Su1 in the base material Bm1 which is reformed in the surface reformation processing by the surface reforming unit 17. The second region Ar2 is a region being set on the transport path 1Rt and in which the image can be formed on the surface Su1 of the base material Bm1 by the image forming unit 18. In the first embodiment and the second embodiment, the second region Ar2 is located in part of the transport path 1Rt where the base material Bm1 is supported by the plurality of fourteenth rollers R14 from below. In the first embodiment and the second embodiment, the image forming unit 18 has a unit (also referred to as a discharge unit) 18h capable of discharging ink toward the surface Su1 of the base material Bm1, for example. Accordingly, the image can be formed on the surface Su1 of the base material Bm1 by ink-jet printing or the like, for example. Thus, herein, the second region Ar2 is a region being set on the transport path 1Rt and in which the image can be formed by discharging ink drops or the like toward the base material Bm1 from the image forming unit 18.

[0049] The image forming unit 18 has one or more discharge units 18h capable of discharging ink of one or more colors, for example. Herein, assuming a case where an image in full color is formed on a sheet of white paper, ink of four colors (cyan, magenta, yellow, and black), for example, is applied to the ink of one or more colors. Herein, assuming a case where an image in full color is formed on a transparent film, ink of five colors (cyan, magenta, yellow, black, and white), for example, is applied to the ink of one or more colors. Ink of the other

color such as blue and violet, for example, may be applied to the ink of one or more colors. In the example in Fig. 1, the eight discharge units 18h are arranged on an upper side of the second region Ar2 in a direction in which the base material Bm1 is transported.

[0050] When the ink of one or more colors is a type of ink hardened in accordance with ultraviolet (UV) light irradiation (also referred to as a UV cure ink), the image forming unit 18 may include a lamp (also referred to as a UV lamp) 18u capable of irradiating, with the UV light, the UV cure ink of one or more colors attached on the surface Su1 of the base material Bm1 by one or more discharge units 18h, for example.

<1-5. Recovery unit>

[0051] The recovery unit 19 can recover the base material Bm1 transported along the transport path 1Rt by the transport mechanism 16, for example. The recovery unit 19 rolls up the band-like base material Bm1 on which the image is formed by the image forming unit 18, thereby being able to recover the base material Bm1 from the transport path 1Rt, for example. In the example in Fig. 1, the recovery unit 19 has the rotational axis Sh2. The rotational axis Sh2 is provided in the housing 1Bd or the like of the image forming apparatus 1 so as to be rotatable around the virtual axis along the Y axis direction. Herein, the base material Bm1 is rolled up around the outer peripheral part of the rotational axis Sh2 by a rotation of the rotational axis Sh2 caused by drive force of the second motor 19m, thus the roll Rl2 is formed around the rotational axis Sh2.

<1-6. Control unit>

[0052] The control unit 10 has an arithmetic unit (also referred to as a processing unit) such as a central processing unit (CPU) and an electrical circuit such as a memory, for example. The control unit 10 executes a program stored in a storage unit 13 using the arithmetic unit, thereby being able to collectively control each unit in the image forming apparatus 1. In other words, the control unit 10 can achieve the functions of the image forming apparatus 1. For example, the control unit 10 can form the image on the surface Su1 of the base material Bm1 using the transport mechanism 16 and the image forming unit 18. More specifically, for example, the control unit 10 controls the transport mechanism 16, the surface reforming unit 17, and the image forming unit 18 based on image data, thereby being able to form the image on the surface Su1 of the base material Bm1 reformed in the surface reformation processing. Herein, the image data may be included in various types of data stored in the storage unit 13, for example.

<1-7. Other configuration>

[0053] The input unit 11 can input a signal correspond-

ing to an operation and the like of an operator using the image forming apparatus 1, for example. The input unit 11 may include an operation unit, a microphone, and various sensors, for example. The operation unit may include a mouse, a keyboard and the like through which the signal corresponding to the operation of the operator can be input. The microphone can input a signal corresponding to a voice of the operator. The various sensors can input a signal corresponding to a motion of the operator.

[0054] The output unit 12 can output various types of information in the image forming apparatus 1, for example. The output unit 12 may include a display unit, a speaker and the like, for example. The display unit can visually output various types of information in such a form as the operator can recognize, for example. A liquid crystal display, an organic EL display or the like, for example, may be applied to the display unit. In the display unit, a display panel serves as a region where the various types of information are visually output (also referred to as a display region). The display unit may have a form of a touch panel integrated with the input unit 11. The speaker can audibly output various types of information in such a form as the operator can recognize, for example.

[0055] The storage unit 13 can store various types of information, for example. The storage unit 13 may be made up of a storage medium such as a hard disk or a flash memory, for example. Adoptable in the storage unit 13 is a configuration having one storage medium, a configuration integrally having two or more storage media, and a configuration having two or more storage media separately in two or more parts. The storage unit 13 may store a program and various types of data, for example.

[0056] The communication unit 14 can perform a data communication with an external device 3 via a communication line 2, for example. The communication unit 14 can obtain a program and various types of data such as image data from the external device 3 via the communication line 2, for example. The storage unit 13 may appropriately store the program and the various types of data obtained in the communication unit 14.

[0057] The detection unit 20 can detect an index (the number of rotations, a rotational angle and the like) on a rotation of the roller included in the transport mechanism 16, for example. In the example in Fig. 1, a rotary encoder capable of detecting an index on a rotation of the fifteenth roller R15 is applied to the detection unit 20. In this case, the control unit 10 can recognize a transport direction, a transport distance and the like of the base material Bm1 along the transport path 1Rt in the transport mechanism 16, for example, based on a signal corresponding to the index detected in the detection unit 20. Thus, the control unit 10 can control a direction in which the base material Bm1 is transported and a distance at which the base material Bm1 is transported based on the signal corresponding to the index on the rotation transmitted from the detection unit 20, for example. For example, when the second drive motor M1b in the transport mechanism

16 is a pulse motor, the control unit 10 may control the distance at which the base material Bm1 is transported in a direction (also referred to as a first transport direction) D1 toward the recovery unit 19 along the transport path IRt by using the number of pulses for driving the second drive motor M1b. For example, when the first drive motor M1a in the transport mechanism 16 is a pulse motor, the control unit 10 may control the distance at which the base material Bm1 is transported in a direction (also referred to as a second transport direction) D2 toward the feed unit 15 opposite to the first transport direction D1 along the transport path IRt by using the number of pulses for driving the first drive motor M1a.

[0058] The first splice unit Sp1 can overlap and cut a tail of the base material Bm1 lead out from the first roll R11 and a head of the base material Bm1 lead out from the second roll R11, and then splice them on a table along the transport path 1Rt when a second roll R11 is attached to the feed unit 15 after the first roll R11 is attached.

[0059] The second splice unit Sp2 can overlap and cut the head the base material Bm1 after being cut and the band-like base material Bm1 located to be rolled up by the rotational axis Sh2 after cutting a part of the base material Bm1 rolled up by a third roll R12, and then splice them on a table along the transport path 1Rt when the third roll R12 is detached from the recovery unit 19 and a next fourth roll R12 is formed in the recovery unit 19, for example.

[0060] The cleaning unit 1Cl can clean the surface Su1 of the base material Bm1, for example. In the example in Fig. 1, the cleaning unit 1Cl is located between the first splice unit Sp1 and the surface reforming unit 17.

<2. Image forming operation in image forming apparatus according to first embodiment>

[0061] Each of Fig. 3 and Fig. 4 is a schematic diagram for describing an example of an operation of forming an image by printing processing (also referred to as an image forming operation) in the image forming apparatus 1 according to the first embodiment.

[0062] Fig. 3(a) illustrates an initial state of the image forming apparatus 1. That is to say, the transport of the base material Bm1 performed by the transport mechanism 16, the reformation of the base material Bm1 performed by the surface reforming unit 17, and the formation of the image on the base material Bm1 performed by the image forming unit 18 are suspended. The transport mechanism 16 can transport the base material Bm1 in a direction indicated by a thick-line arrow D1 (referred to as the first transport direction D1). In other words, the control unit 10 can make the transport mechanism 16 perform the operation of transporting the base material Bm1 in the first transport direction D1 along the transport path IRt (also referred to as a first transport operation), for example. Herein, a region in which the energy can be given from the surface reforming unit 17 to the base material Bm1 is set on the transport path IRt. This region is

referred to as the first region Ar1. Herein, an end portion on an upstream side of the first region Ar1 in a forward direction of the transport (the first transport direction) D1 is defined as a first position P1, and an end portion on a downstream side of the first region Ar1 in the first transport direction D1 is defined as a second position P2. A region in which the image can be formed by discharging ink drops toward the base material Bm1 from the image forming unit 18 is set on the transport path IRt. This region is referred to as the second region Ar2. Herein, an end portion on an upstream side of the second region Ar2 in the first transport direction D1 is defined as a third position P3, and an end portion on a downstream side of the second region Ar2 in the first transport direction D1 is defined as a fourth position P4.

[0063] Fig. 3(b) illustrates a state immediate after the beginning of the giving the energy from the surface reforming unit 17 to the base material Bm1 while the transport mechanism 16 transports the base material Bm1 in the first transport direction D1. In this time, the region on which the surface reformation processing is performed by the surface reforming unit 17 only once (one-time surface reforming region) Rf1 is sequentially formed on the base material Bm1 in parallel with the transport of the base material Bm1. Herein, an end portion on a downstream side of the one-time surface reforming region Rf1 in the first transport direction D1 is referred to as a first end portion t1.

[0064] The following Fig. 3(c) illustrates a state where the transport mechanism 16 further transports the base material Bm1 in the first transport direction D1. More specifically, Fig. 3(c) illustrates a state where the image forming unit 18 completes the formation of the first image Pc1 as a primary image. The first image Pc1 is formed in response to a command of forming the image corresponding to first image data (for example, the first printing job or the like). The image forming unit 18 starts discharging the ink drop toward the one-time surface reforming region Rf1 to form the first image Pc1 at the time when the first end portion t1 of the base material Bm1 passes through the third position P3.

[0065] The following Fig. 3(d) illustrates a state where the transport mechanism 16 further transports the base material Bm1 in the first transport direction D1. More specifically, Fig. 3(d) illustrates a state where the image forming unit 18 forms the second image Pc2 as a secondary image. The second image Pc2 is formed in response to a command of forming the image corresponding to second image data (for example, the second printing job or the like). Herein, a region where no image is formed (also referred to as a first non-image forming region) B1 is disposed between the first image Pc1 and the second image Pc2 on the base material Bm1. In other words, the first non-image forming region B1 constitutes a portion between the first image Pc1 and the second image Pc2. The first image Pc1 and the second image Pc2 are separated by an interval d1 in the first transport direction D1 on the one-time surface reforming region Rf1. However, for ex-

ample, an end portion of each of the first image Pc1 and the second image Pc2 may be in contact with each other in the first transport direction D1. In this case, the interval d1 is set to zero. In other words, the portion between the first image Pc1 and the second image Pc2 may simply constitute a boundary between the first image Pc1 and the second image Pc2.

[0066] The following Fig. 4(a) illustrates a state where the transport of the base material Bm1 performed by the transport mechanism 16 is suspended after the image forming unit 18 completes the formation (image recording) of the second image Pc2. Herein, an end portion on an upstream side of the second image Pc2 in the first transport direction D1 is defined as a second end portion t2. Herein, the control unit 10 gradually reduces the transport speed of the base material Bm1 transported by the transport mechanism 16, and suspends the base material Bm1 after the formation of the second image Pc2 is completed. Thus, the second end portion t2 is located nearer the downstream side in the first transport direction D1 in relation to the fourth position P4 in the state of Fig. 4(a). Herein, a position of the second end portion t2 in the first transport direction D1 at this time is defined as a fifth position P5. An end portion on an upstream side of the one-time surface reforming region Rf1 in the first transport direction D1 at the time of suspending the transport of the base material Bm1 is defined as a third end portion t3.

[0067] Next, the transport mechanism 16 can achieve the transport of the base material Bm1 in the second transport direction D2 (also referred to as a reverse transport or a backward feed). The second transport direction D2 is opposite to the first transport direction D1 that is the transport direction at the time of forming the first image Pc1 and the second image Pc2 on the surface Su1 of the base material Bm1. In other words, the control unit 10 can make the transport mechanism 16 perform the operation of transporting the base material Bm1 having a portion where the image is formed (also referred to as an image formation-completed portion) in the second transport direction D2 along the transport path 1Rt (also referred to as a second transport operation), for example. Thus, the third image Pc3 can be formed in response to a command of forming the image corresponding to third image data (for example, the third printing job or the like) in a region immediately behind the second image Pc2 which has been already formed (the upstream side in the first transport direction D1) on the surface Su1 of the base material Bm1, for example. Accordingly, the length of so-called the waste portion can be reduced.

[0068] Herein, the distance of the backward feed of the base material Bm1 may be recognized based on the signal corresponding to the index on the rotation detected in the detection unit 20, for example. In this case, the control unit 10 can control a distance of the backward feed of the base material Bm1 based on the signal corresponding to the index on the rotation transmitted from the detection unit 20, for example. For example, when

the first drive motor M1a in the transport mechanism 16 is a pulse motor, the control unit 10 may control the distance of the backward feed of the base material Bm1 by using the number of pulses for driving the first drive motor M1a.

[0069] The following Fig. 4(b) illustrates a state where the transport of the base material Bm1 in the second transport direction D2 performed by the transport mechanism 16 is suspended. The transport mechanism 16 suspends the transport of the base material Bm1 in the second transport direction D2 when the second end portion t2 reaches a sixth position P6. Here, the base material Bm1 is suspended when the second end portion t2 moves by a sum of a first distance L1a (an interval between the third position P3 and the fifth position P5) and a second distance L2a (an interval between the third position P3 and the sixth position P6) in the second transport direction D2. Herein, the first distance L1a is a distance between an end portion on the upstream side of the second region Ar2 in the first transport direction D1 (the third position P3) and an end portion on the upstream side in the first transport direction D1 of the image located on an uppermost stream side in the first transport direction D1 (the second image Pc2) at the time of suspending the transport of the base material Bm1 in the first transport direction D1 (the state illustrated in Fig. 4(a)). A meaning of the second distance L2a is described hereinafter. Herein, the surface reforming unit 17 gives the energy to the one-time surface reforming region Rf1 in the base material Bm1 in accordance with the movement of the base material Bm1 in the second transport direction D2. The surface reforming unit 17 thereby forms the region on which the surface reformation processing has been performed twice (the two-time surface reforming region) Rf2 in the surface Su1 of the base material Bm1. Fig. 4(b) illustrates an end portion on a downstream side of the two-time surface reforming region Rf2 in the second transport direction D1 as a fourth end portion t4. In the example in Fig. 4(b), the surface reformation processing is performed on a region in the second image Pc2 ranging from the second end portion t2 on the upstream side in the first transport direction D1 to a portion p4 from above the second image Pc2.

[0070] The following Fig. 4(c) illustrates a state where the transport mechanism 16 starts transporting the base material Bm1 in the first transport direction D1 again. Herein, the surface reforming unit 17 firstly performs second surface reformation processing on the region in the second image Pc2 ranging from portion p4 to the second end portion t2 from above the second image Pc2. Subsequently, the surface reforming unit 17 gives the energy to the surface Su1 with the fourth end portion t4 in the lead, and forms the region (the three-time surface reforming region) Rf3 on which third surface reformation processing has been performed to overlap with the two-time surface reforming region Rf2. The three-time surface reforming region Rf3 is a reforming region, in the surface Su1 of the base material Bm1, in which the

number of executions of surface reformation processing performed by the surface reforming unit 17 is larger than that in a surrounding region, and is also referred to as the multiple surface reforming region. The image forming unit 18 starts forming the image from a position located on the upstream side in the first transport direction D1 away from a back-end portion of the second image Pc2 (the second end portion t2) by an interval d2. The formation of the primary image (also referred to as the third image) Pc3 after the restart of the image formation is thereby started. The third image Pc3 is formed in response to a command of forming the image corresponding to third image data (for example, the third printing job or the like). Herein, a region where no image is formed (also referred to as a second non-image forming region) B2 is disposed between the second image Pc2 and the third image Pc3 on the base material Bm1. In other words, the second non-image forming region B2 constitutes a portion between the second image Pc2 and the third image Pc3. The second image Pc2 and the third image Pc3 are separated by the interval d2 in the first transport direction D1 on the three-time surface reforming region (the multiple surface reforming region) Rf3. Herein, an end portion on a downstream side of the third image Pc3 in the first transport direction D1 is defined as a fifth end portion t5.

[0071] Herein, the transport mechanism 16 gradually increases the transport speed of the base material Bm1 and transports the base material Bm1 in the first transport direction D1 from the state illustrated in Fig. 4(b) (the state where the second end portion t2 is located in the sixth position P6). The transport speed of the base material Bm1 is preferably increased to a speed appropriate to form the image performed by the image forming unit 18 on the surface Su1 of the base material Bm1 before the second end portion t2 reaches the third position P3. In this case, the second distance L2a which is the interval between the third position P3 and the sixth position P6 needs to be set to a distance necessary to increase the speed of the base material Bm1 transported by the transport mechanism 16.

[0072] The following Fig. 4(d) illustrates a state where the transport mechanism 16 further transports the base material Bm1 in the first transport direction D1. More specifically, Fig. 4(d) illustrates a state where the image forming unit 18 forms the secondary image (also referred to as the fourth image) Pc4 after the restart of the image formation. The fourth image Pc4 is formed in response to a command of forming the image corresponding to fourth image data (for example, the fourth printing job or the like). Herein, a region where no image is formed (also referred to as a third non-image forming region) B3 is disposed between the third image Pc3 and the fourth image Pc4 on the base material Bm1. In other words, the third non-image forming region B3 constitutes a portion between the third image Pc3 and the fourth image Pc4. The third image Pc3 and the fourth image Pc4 are separated by the interval d1 in the first transport direction D1

on the one-time surface reforming region Rf1. However, for example, an end portion of each the third image Pc3 and the fourth image Pc4 may be in contact with each other in the first transport direction D1. In this case, the interval d1 is set to zero. In other words, the portion between the third image Pc3 and the fourth image Pc4 may simply constitute a boundary between the third image Pc3 and the fourth image Pc4.

[0073] In the meanwhile, as illustrated in Fig. 4(c) and Fig. 4(d), the interval d1 between the first image Pc1 and the second image Pc2 sequentially formed before the transport of the base material Bm1 in the first transport direction D1 is suspended and the interval d2 between the second image Pc2 and the third image Pc3 sequentially formed with the suspension of the transport of the base material Bm1 in the first transport direction D1 in between have sizes (lengths) different from each other in the first transport direction D1. In other words, the first non-image forming region B1 between the first image Pc1 and the second image Pc2 and the second non-image forming region B2 between the second image Pc2 and the third image Pc3 have the sizes (lengths) different from each other. As illustrated in Fig. 4(d), the interval d2 between the second image Pc2 and the third image Pc3 sequentially formed with the suspension of the transport of the base material Bm1 in the first transport direction D1 in between and the interval d1 between the third image Pc3 and the fourth image Pc4 sequentially formed after the restart of the transport of the base material Bm1 in the first transport direction D1 have sizes (lengths) different from each other in the first transport direction D1. In other words, the second non-image forming region B2 between the second image Pc2 and the third image Pc3 and the third non-image forming region B3 between the third image Pc3 and the fourth image Pc4 have the sizes (lengths) different from each other.

[0074] Herein, each of the first non-image forming region B1 with the interval d1, the second non-image forming region B2 with the interval d2, and the third non-image forming region B3 with the interval d1 is a region in blank where no image is formed (also referred to as a blank region). Thus, a worker can distinguish whether each blank region is a region formed on the one-time surface reforming region Rf1 or a region formed on the three-time surface reforming region Rf3 based on the difference in the size (the width and the area, for example) of the blank region. In the present embodiment, the blank region having relatively a small area (the region corresponding to the interval d1) is a region formed on the one-time surface reforming region Rf1 and the blank region having relatively a large area (the region corresponding to the interval d2) is a region formed on the three-time surface reforming region Rf3. Accordingly, the image formed on the multiple surface reforming region Rf3 (the third image Pc3 herein) can be easily distinguished from the image formed on the one-time surface reforming region (the first image Pc1, the second image Pc2, and the fourth image Pc4 herein) based on the size

of the width of the blank region as the interval formed between the images. Herein, the blank region having relatively the large area may be associated with the one-time surface reforming region Rf1, and the blank region having relatively the small area may be associated with the three-time surface reforming region Rf3. One of the interval d1 and the interval d2 may be set to zero. The interval d1 of the first non-image forming region B1 and the interval d1 of the third non-image forming region B3 may be different from each other to some degree within a range in which a magnitude relationship between the interval d1 and the interval d2 can be visually recognized easily, for example.

[0075] In the present embodiment, as illustrated in Fig. 4(b) and Fig. 4 (c), the second image Pc2 is formed on the one-time surface reforming region Rf1. The surface reformation processing is not performed on a tip portion side of the second image Pc2 (a portion on a side nearer the first image Pc1) from above the second image Pc2, however, the surface reformation processing is performed twice on a back-end portion side of the second image Pc2 (a portion ranging from the portion p4 to the second portion t2) from above the second image Pc2. Thus, there is a possibility that a color of the image is different between the tip portion side and the back-end portion side of the second image Pc2. A risk of occurrence of such a defect can be reduced by setting the timing of suspending the transport (backward feed) of the base material Bm1 in the second transport direction D2 and restarting the transport of the base material Bm1 in the first transport direction D1 later than the timing illustrated in Fig. 4(b), for example. That is to say, the risk of occurrence of the above defect can be reduced by making the distance L2a longer than the length illustrated in Fig. 4(b). More specifically, for example, it is sufficient that the transport of the base material Bm1 in the second transport direction D2 is suspended and the transport of the base material Bm1 in the first transport direction D1 is restarted, at a time when the tip portion on the downstream side of the second image Pc2 in the first transport direction D1 reaches the second position P2.

[0076] Herein, when the second image Pc2 or the third image Pc3 is an image in which the same pattern is repetitively formed without space in the first transport direction D1 or patterns different from each other are sequentially formed without space, the interval d2 may be set to a multiple of a natural number of a unit length of one pattern in the first transport direction D1, for example. A length for one page may be applied to the unit length of one pattern, for example. Accordingly, a gap hardly occurs between a pitch at which the patterns are arranged in the second image Pc2 or the third image Pc3 and the width d2 of the second non-image forming region B2, for example. As a result, workability in cutting the base material Bm1 is hardly reduced when the base material Bm1 is cut along the pattern formed on the surface Su1 of the base material Bm1 after the roll R12 is carried

out of the image forming apparatus 1, for example. When the second image Pc2 is an image formed of one pattern, the interval d2 may be set to a multiple of a natural number of the length of the second image Pc2 in the first transport direction D1, and when the third image Pc3 is an image formed of one pattern, the interval d2 may be set to a multiple of a natural number of the length of the third image Pc3 in the first transport direction D1, for example.

[0077] Fig. 5 is a plan view illustrating an image formed on the surface Su1 of the base material Bm1 in the image forming apparatus 1 according to the first embodiment.

[0078] In the example in Fig. 5(a), the one-time surface reforming region Rf1, the multiple surface reforming region Rf3 (a width L3), and the one-time surface reforming region Rf1 are formed in this order from the downstream side in the first transport direction D1 in the surface Su1 of the base material Bm1. The first image Pc1 and the second image Pc2 are formed on the first one-time surface reforming region Rf1, the third image Pc3 are formed on the subsequent multiple surface reforming region Rf3, and part of the third image Pc3, the fourth image Pc4, and the fifth image Pc5 are formed on the further subsequent one-time surface reforming region Rf1.

[0079] The first non-image forming region B1 (the width d1) intervenes between the first image Pc1 and the second image Pc2, the second non-image forming region B2 (the width d2) intervenes between the second image Pc2 and the third image Pc3, the third non-image forming region B3 (the width d1) intervenes between the third image Pc3 and the fourth image Pc4, and the fourth non-image forming region B4 (the width d1) intervenes between the fourth image Pc4 and the fifth image Pc5.

[0080] In the example in Fig. 5(a), the length of the width d2 of the second non-image forming region B2 and the length of the width d1 of the third non-image forming region B3 differ from each other. This configuration can indicate that the third image Pc3 is formed on the multiple surface reforming region Rf3 and the fourth image Pc4 is formed on the one-time surface reforming region Rf1.

[0081] Fig. 5(b) illustrates a case where the width L3 of the multiple surface reforming region Rf3 is larger than that in the example in Fig. 5(a). The width L3 of the multiple surface reforming region Rf3 increases, thus part of the fourth image Pc4 is formed on the multiple surface reforming region Rf3 in the example in Fig. 5(b). In the example in Fig. 5(b), the width of the third non-image forming region B3 is changed from d1 to d2 in response to this. This configuration can indicate that the part of the fourth image Pc4 is formed on the multiple surface reforming region Rf3. In this case, the length of the width d2 of the second non-image forming region B2 and the length of the width d2 of the third non-image forming region B3 may be different from each other to some degree within a range in which a worker, for example, can visually recognize a magnitude relationship between the width d1 and the width d2 easily.

[0082] In the example in Figs. 5(a) and 5(b), non-image forming regions B (specifically, a Yth non-image forming

region BY (Y is a natural number)) having widths different from each other intervene between the sequential plurality of images Pc (specifically, an X^{th} image PcX (X is a natural number)), thus the X^{th} image PcX formed on the multiple surface reforming region Rf3 can be distinguished from the other X^{th} image PcX. However, it is also applicable that a specific image is formed instead of intervening the Y^{th} non-image forming region BY, thus the X^{th} image PcX formed on the multiple surface reforming region Rf3 can be distinguished from the other X^{th} image PcX.

[0083] For example, in the example in Fig. 5(c), the second image Pc2 is formed on the one-time surface reforming region Rf1 and the third image Pc3 is formed on the multiple surface reforming region Rf3. Thus, in the example in Fig. 5(c), a specific pattern is formed on a region (also referred to as a specific image region) B2A between the second image Pc2 and the third image Pc3 to indicate that the third image Pc3 is formed on the multiple surface reforming region Rf3. The specific pattern is not particularly limited as long as it can be distinguished from the region between the other X^{th} regions PcX (the region B1 between the first image Pc1 and the second image Pc2, the region B3 between the third image Pc3 and the fourth image Pc4, and the region B4 between the fourth image Pc4 and the fifth image Pc5). For example, a color, a density, or a contrast may differ. Widths of these four regions B1 to B4 may be the same or different from each other. However, when the widths are the same, there is an advantage that a pitch of the first image Pc1 to the fifth image Pc5 can be maintained.

[0084] Alternatively, as illustrated in Fig. 5(d), a region in which a broken line or the like having almost no width in the first transport direction D1 is drawn may be applied to the region B2A. Herein, for example, when the second image Pc2 or the third image Pc3 is an image in which the same pattern is repetitively formed without space in the first transport direction D1 or patterns different from each other are sequentially formed without space, a difference hardly occurs between a pitch at which the patterns are arranged in the second image Pc2 or the third image Pc3 and the specified image region B2A as long as the width d3 of the region B2A in the first transport direction D1 is set to a multiple of a natural number of a unit length of one pattern in the first transport direction D1.

[0085] For example, as illustrated in Fig. 6(a) and Fig. 6(b), the non-image forming region having the width d2 similar to that of the second non-image forming region B2 may be formed along the third end portion t3 on an upstream side of the multiple surface reforming region Rf3 in the first transport direction D1. For example, as illustrated in Fig. 6(c) and Fig. 6(d), the specific image region B2A may be formed along the third end portion t3 on the upstream side of the multiple surface reforming region Rf3 in the first transport direction D1. The position of the third end portion t3 may be recognized by the control unit 10 in accordance with the transport direction and the transport distance of the base material Bm1 along

the transport path 1Rt in the transport mechanism 16 recognized based on the signal corresponding to the index detected in the detection unit 20, for example. Accordingly, the non-image forming region and the specific image region B2A corresponding to the third end portion t3 can be formed. When such a configuration is adopted, an existence region of the multiple surface reforming region Rf3 can be recognized in more detail, for example.

[0086] Fig. 7 is a flow chart illustrating an example of an operation flow according to an image forming method according to the first embodiment in the image forming apparatus 1. This operation flow is an example of an operation flow in a case where the third image Pc3 and the fourth image Pc4 are sequentially formed after the first image Pc1 and the second image Pc2 are formed on the elongated band-like base material Bm1 by controlling each unit in the image forming apparatus 1 under control of the control unit 10, for example. In this operation flow, processing of a first step S1, processing of a second step S2, and processing of a third step S3 are performed in this order, thus the first image Pc1, the second image Pc2, the third image Pc3, and the fourth image Pc4 may be sequentially formed on the surface Su1 of the base material Bm1.

[0087] In the first step S1, as illustrated in Figs. 3(c) and 3(d), while the transport mechanism 16 transports the base material Bm1 in the first transport direction D1 along the transport path 1Rt, the surface reforming unit 17 performs the surface reformation processing of reforming the surface Su1 of the base material Bm1 in the first region Ar1 along the transport path 1Rt and the image forming unit 18 performs first image forming processing of forming the first image Pc1 and the second image Pc2 on the surface Su1 reformed in the surface reformation processing of the base material Bm1 in the second region Ar2 along the transport path 1Rt.

[0088] In the second step S2, as illustrated in Fig. 4(a) and Fig. 4(b), the transport mechanism 16 transports the base material Bm1 having a formation-completed portion in which the first image Pc1 and the second image Pc2 are formed on the surface Su1 in the first step S1 in the second transport direction D2 opposite to the first transport direction D1 along the transport path 1Rt.

[0089] In the third step S3, as illustrated in Fig. 4(c) and Fig. 4(d), when the surface reformation processing by the surface reforming unit 17 and the image forming processing by the image forming unit 18 are performed while the base material Bm1 having the formation-completed portion in which the first image Pc1 and the second image Pc2 are formed is transported in the first transport direction D1 along the transport path 1Rt after the second step S2, a second image forming processing of forming the third image Pc3 and the like on the surface Su1 of the base material Bm1 in the second region Ar2 is performed in such a manner that the multiple surface reforming region Rf3, in which the number of executions of surface reformation processing in the first region Ar1 in the surface Su1 of the base material Bm1 is larger than

that in the surrounding region, can be distinguished. Herein, it is also applicable that, for example, when the control unit 10 makes the image forming unit 18 form the plurality of images (for example, the first to fourth images Pc1 to Pc4) so as to be arranged in the first transport direction D1 on the base material Bm1, the control unit 10 makes the width d1 in the first transport direction D1 of the portion between the images on the one-time surface reforming region Rf1 on which the surface reformation processing is performed once and the width d2 in the first transport direction D1 of the portion between the images on the multiple surface reforming region Rf3 different from each other, or makes the image forming unit 18 form the specific image region B2A in the portion between the images on the multiple surface reforming region Rf3. It is also applicable that the control unit 10 makes the image forming unit 18 form the specific image region B2A in the portion between the images on the one-time surface reforming region Rf1 and does not make the image forming unit 18 form the specific image region B2A in the portion between the images on the multiple surface reforming region Rf3.

[0090] According to such an image forming method, the portion in which the quality of the image formed in the base material Bm1 is different from that of the surrounding portion in the base material Bm1 can be easily distinguished from the surrounding portion, for example. Accordingly, for example, the wasteful use (the waste portion) of the base material Bm1 is reduced to effectively use the base material Bm1, and the portion in which the quality of the image is different from that of the surrounding portion in the base material Bm1 can be easily distinguished from the surrounding portion.

<3. Outline of first embodiment>

[0091] As described above, the image forming apparatus 1 according to the first embodiment forms the first image Pc1 and the second image Pc2 on the surface Su1 of the base material Bm1 while transporting the base material Bm1 in the first transport direction D1, performs the backward feed of transporting the base material Bm1 in the second transport direction D2 after suspending the transport of the base material Bm1 in the first transport direction D1, and then restarts the transport of the base material Bm1 in the first transport direction D1 to form the third image Pc3 on the surface Su1 of the base material Bm1, for example. Accordingly, the base material Bm1 can be effectively used by reducing the wasteful use (the waste portion) of the base material Bm1, for example. For example, at the time of forming the third image Pc3 on the surface Su1 of the base material Bm1 after the backward feed of the base material Bm1, the third image Pc3 is formed on the surface Su1 of the base material Bm1 in such a manner that the multiple surface reforming region Rf3, in which the number of executions of surface reformation processing in the surface Su1 of the base material Bm1 is different from that in the sur-

rounding region, can be distinguished. Accordingly, the portion in which the quality of the image formed in the base material Bm1 is different from that of the surrounding portion in the base material Bm1 can be easily distinguished from the surrounding portion. Accordingly, for example, the wasteful use (the waste portion) of the base material Bm1 is reduced to effectively use the base material Bm1, and the portion in which the quality of the image is different from that of the surrounding portion in the base material Bm1 can be easily distinguished from the surrounding portion.

[0092] For example, even when the execution and non-execution of the corona discharge cannot be controlled freely in a configuration in which the corona discharge unit is applied to the surface reforming unit 17, the portion in which the quality of the image is different from that of the surrounding portion in the base material Bm1 can be easily distinguished from the surrounding portion.

[0093] For example, when the quality of the image in the base material Bm1 is different in accordance with the number of executions of the surface reformation processing for promoting the fixing of the ink on the surface Su1 in the configuration in which the discharge unit 18h capable of discharging the ink toward the surface Su1 of the base material Bm1 is applied to the image forming unit 18, the region in which the quality of the image is different from that of the surrounding portion in the base material Bm1 can be easily distinguished from the surrounding portion.

<4. Image forming operation in image forming apparatus according to second embodiment>

[0094] Assumed herein is a case where in the image forming apparatus 1 according to the second embodiment, the second image Pc2 is formed on the surface Su1 of the base material Bm1 after forming the first image Pc1. In this case, the control unit 10 controls the transport mechanism 16, the surface reforming unit 17, and the image forming unit 18, thereby being able to make them execute an operation of forming the first image Pc1 on the surface Su1 of the base material Bm1 (also referred to as a first operation), an operation of performing the backward feed of the base material Bm1 subsequent to the first operation (also referred to as a second operation), and an operation of forming the second image Pc2 on the surface Su1 of the base material Bm1 subsequent to the second operation (also referred to as a third operation).

<4-1. First operation>

[0095] Fig. 8 is a schematic diagram illustrating an example of the first operation in the image forming apparatus 1 according to the second embodiment. In Fig. 8 and Fig. 10 and Fig. 11 described hereinafter, an oblique-line hatching is provided in the one-time processing region Ap1 on which the surface reformation processing is

performed by the surface reforming unit 17 once in the surface Su1 of the base material Bm1. Fig. 9 is a graph illustrating an example of a relationship between a transport distance and a transport speed of the base material Bm1 at a time of starting the first operation.

[0096] In the first operation, for example, while the transport mechanism 16 transports the base material Bm1 in the first transport direction D1 along the transport path 1Rt, the surface reforming unit 17 performs the surface reformation processing on the surface Su1 of the base material Bm1 and the image forming unit 18 forms the first image Pc1 on a one-time processing region (also referred to as a first processing region) Ap1a on which the surface reformation processing is performed in the surface Su1 of the base material Bm1 (Fig. 8(b)). Accordingly, the base material Bm1 has the first image Pc1 formed on the surface Su1 by the image forming unit 18. Herein, the image forming unit 18 can form the first image Pc1 on the surface Su1 of the base material Bm1 in response to a command of forming the image corresponding to the first image data (for example, the first printing job or the like) transmitted from the control unit 10, for example.

[0097] In starting the first operation, it is also applicable the control unit 10 controls the transport mechanism 16, the surface reforming unit 17, and the image forming unit 18 to form the first image Pc1 on the surface Su1 of the base material Bm1 in such a manner that an end portion (also referred to as a region end portion) E0a on a recovery unit 19 side of the first processing region Ap1a and an end portion (also referred to as an image end portion) E0p on the recovery unit 19 side of the first image Pc1 coincide with each other in the first transport direction D1 along the transport path 1Rt, for example. This configuration can suppress an excessive extension of the first processing region Ap1a on which the surface reformation processing is performed once in relation to the region where the first image Pc1 is formed in the surface Su1 of the base material Bm1, for example.

[0098] Herein, for example, a speed of the base material Bm1 transported by the transport mechanism 16 in the first transport direction D1 at the time of forming the first image Pc1 on the surface Su1 of the base material Bm1 is defined as a predetermined value V1, and a distance of the transport of the base material Bm1 until the transport speed of the base material Bm1 reaches the predetermined value V1 after the transport mechanism 16 starts transporting the base material Bm1 in the first transport direction D1 is defined as a predetermined value X0. Herein, for example, a distance of the transport of the base material Bm1 until the transport of the base material Bm1 transported by the transport mechanism 16 at the transport speed V1 in the first transport direction D1 is stabilized after the transport speed of the base material Bm1 in the first transport direction D1 reaches the predetermined value V1 is defined as a predetermined value Xst. In this case, for example, the transport distance of the base material Bm1 from when the transport mech-

anism 16 starts transporting the base material Bm1 in the first transport direction D1 until when the base material Bm1 enters a state where the image forming unit 18 can start forming the first image Pc1 on the surface Su1 of the base material Bm1 is a distance X1 which is a sum of the predetermined value X0 and the predetermined value Xst. In other words, the distance X1 is a distance required to increase the transport speed and stabilize the transport of the base material Bm1 at the time of starting transporting the base material Bm1 in the first transport direction D1. Each of the predetermined value V1, the predetermined value X0, and the predetermined value Xst may be obtained from a design value or setting value of the transport mechanism 16, or may be obtained from an actual measured value which is previously measured, for example. Herein, a distance from the first region Ar1 to the second region Ar2 on the transport path 1Rt is defined as A0, for example.

[0099] Considered herein as illustrated in Fig. 9(a), for example, is a configuration that when the distance A0 is equal to or larger than the distance X1, the surface reforming unit 17 starts the surface reformation processing on the surface Su1 of the base material Bm1 as illustrated in Fig. 8(a) at a timing of when the transport mechanism 16 starts transporting the base material Bm1 in the first transport direction D1, and subsequently, the image forming unit 18 starts forming the first image Pc1 on the surface Su1 of the base material Bm1 at a timing of when the transport distance of the base material Bm1 transported by the transport mechanism 16 in the first transport direction D1 reaches the distance A0. Accordingly, for example, as illustrated in Fig. 8(b), the image forming unit 18 may form the first image Pc1 on the first processing region Ap1a on which the surface reformation processing has been performed in the surface Su1 of the base material Bm1 so that the region end portion E0a and the image end portion E0p coincide with each other.

[0100] Considered herein as illustrated in Fig. 9(b), for example, is a configuration that when the distance A0 is smaller than the distance X1, the surface reforming unit 17 starts the surface reformation processing on the surface Su1 of the base material Bm1 as illustrated in Fig. 8(a) at a timing of when the transport distance of the base material Bm1 transported by the transport mechanism 16 in the first transport direction D1 reaches a distance (X1-A0) obtained by subtracting the distance A0 from the distance X1, and subsequently, the image forming unit 18 starts forming the first image Pc1 on the surface Su1 of the base material Bm1 at a timing of when the transport distance of the base material Bm1 transported by the transport mechanism 16 in the first transport direction D1 reaches the distance X1. Accordingly, for example, as illustrated in Fig. 8(b), the image forming unit 18 may form the first image Pc1 on the first processing region Ap1a on which the surface reformation processing has been performed in the surface Su1 of the base material Bm1 so that the region end portion E0a and the image end portion E0p coincide with each other.

[0101] In finishing the first operation, it is also applicable the control unit 10 controls the transport mechanism 16, the surface reforming unit 17, and the image forming unit 18 to form the first image Pc1 on the surface Su1 of the base material Bm1 in such a manner that an end portion (also referred to as a first region end portion) E1a on a first region Ar1 side of the first processing region Ap1a and an end portion (also referred to as a first image end portion) E1p on the first region Ar1 side of the first image Pc1 coincide with each other in the first transport direction D1 along the transport path 1Rt, for example. This configuration can suppress an excessive extension of the first processing region Ap1a on which the surface reformation processing is performed once in relation to the region where the first image Pc1 is formed in the surface Su1 of the base material Bm1, for example. Reduced is an occurrence of defect that the second image Pc2 is formed on the surface Su1, in the base material Bm1, on which the surface reformation processing has been repetitively performed when the second image Pc2 is formed on the surface Su1 of the base material Bm1 after the first image Pc1 is formed, for example. As a result, the quality of the second image Pc2 formed on the base material Bm1 is hardly reduced, for example.

[0102] Herein, for example, in the first operation, the length of the first image Pc1 formed on the surface Su1 of the base material Bm1 along the transport path 1Rt in the first transport direction D1 is defined as L1. Considered in this case, as illustrated in Fig. 8(c), for example, is a configuration that the control unit 10 makes the surface reforming unit 17 finish the surface reformation processing on the surface Su1 of the base material Bm1 at a timing of when the transport distance of the base material Bm1 transported by the transport mechanism 16 in the first transport direction D1 reaches a value (L1-A0) obtained by subtracting the distance A0 from the length L1, applying the timing of when the image forming unit 18 starts forming the first image Pc1 on the surface Su1 of the base material Bm1 as a basis. In this manner, for example, the formation of the first image Pc1 on the surface Su1 of the base material Bm1 can be finished in accordance with the first region end portion E1a as a terminal portion of the first processing region Ap1a on which the surface reformation processing is performed in the surface Su1 of the base material Bm1 in the first transport direction D1. Subsequently, in the first operation, as illustrated in Fig. 8(d), the transport of the base material Bm1 by the transport mechanism 16 in the first operation is suspended, for example.

<4-2. Second operation>

[0103] Fig. 10 is a schematic diagram illustrating an example of the second operation in the image forming apparatus 1 according to the second embodiment.

[0104] In the second operation, for example, the transport mechanism 16 transports the base material Bm1, in which the first image Pc1 is formed on the surface Su1

in the first operation, in the second transport direction D2 along the transport path 1Rt in a state where the surface reforming unit 17 does not perform the surface reformation processing on the surface Su1 of the base material Bm1. Considered herein as the state where the surface reforming unit 17 does not perform the surface reformation processing on the surface Su1 of the base material Bm1 is, for example, a state where the actuation of the surface reforming unit 17 is suspended, and the surface reforming unit 17 does not irradiate the surface Su1 of the base material Bm1 with plasma or ion generated by the corona discharge. Alternatively considered is a state where an appropriate shielding material intervenes between the surface reforming unit 17 and the surface Su1 of the base material Bm1 while the surface reforming unit 17 remains actuated.

[0105] Defined as Y2, as illustrated in Fig. 10(a), for example, is a distance from the first region end portion E1a located on the first region Ar1 side of the first processing region Ap1a and the first image end portion E1p located on the first region Ar1 side of the first image Pc1 to an end portion En2 on the first region Ar1 side of the second region Ar2 in the first transport direction D1 along the transport path 1Rt in a state where the transport of the base material Bm1 by the transport mechanism 16 is suspended in accordance with the completion of the first operation. In this case, for example, as illustrated in Fig. 10(b), in the second operation, a distance of the transport of the base material Bm1 in the second transport direction D2 along the transport path 1Rt (also referred to as a backward feed distance) is set to a value of a sum of the distance Y2 and a distance E2. The distance E2 is set to a value equal to or larger than the distance A0 from the first region Ar1 to the second region Ar2 on the transport path 1Rt, for example. The distance E2 needs to be set to be equal to or larger than the distance X1 required to increase the transport speed and stabilize the transport of the base material Bm1 at the time of starting transporting the base material Bm1 in the first transport direction D1, for example. Herein, for example, as the distance E2 becomes larger than the distance A0, the increase in the transport speed and the stabilization of the transport of the base material Bm1 can be achieved more reliably at the time of starting the transport of the base material Bm1 in the first transport direction D1 in the third operation.

[0106] Such a second operation is performed, thus the second image Pc2 can be formed closer to the first image Pc1 on the base material Bm1 in the subsequent third operation, for example. Accordingly, the wasteful use (the waste portion) of the base material Bm1 can be reduced, for example.

<4-3. Third operation>

[0107] Fig. 11 is a schematic diagram illustrating an example of the third operation in the image forming apparatus 1 according to the second embodiment.

[0108] In the third operation, for example, while the transport mechanism 16 transports the base material Bm1 in which the first image Pc1 is formed in the first operation in the first transport direction D1 along the transport path 1Rt, the surface reforming unit 17 performs the surface reformation processing on a region other than the first processing region Ap1a (also referred to as a second processing region) Aplb in the surface Su1 of the base material Bm1 and the image forming unit 18 forms the second image Pc2 on the second processing region Aplb. Accordingly, the base material Bm1 has the second image Pc2 formed on the surface Su1 by the image forming unit 18. Herein, the image forming unit 18 can form the second image Pc2 on the surface Su1 of the base material Bm1 in response to a command of forming the image corresponding to the second image data (for example, the second printing job or the like) transmitted from the control unit 10, for example.

[0109] Herein, for example, after the backward feed of the base material Bm1 in the second operation, the surface reformation processing is performed on the region other than the first processing region Ap1a, on which the surface reformation processing has been already performed, in the surface Su1 of the base material Bm1, and the image forming unit 18 can form the second image Pc2 on the surface Su1 of the base material Bm1. Reduced accordingly is the occurrence of defect that the second image Pc2 is formed on the surface Su1, in the base material Bm1, on which the surface reformation processing has been repetitively performed, and the quality of the second image Pc2 formed on the base material Bm1 is hardly reduced. Accordingly, the quality of the second image Pc2 formed on the base material Bm1 can be improved while reducing the wasteful use (the waste portion) of the base material Bm1, for example.

[0110] Considered herein firstly, for example, is a configuration that the control unit 10 makes the surface reforming unit 17 start the surface reformation processing on the surface Su1 of the base material Bm1 at a timing of when the transport mechanism 16 transports the base material Bm1 by a distance (E2-A0) obtained by subtracting the distance A0 from the distance E2 in the first transport direction D1 along the transport path 1Rt as illustrated in Fig. 11(a), applying a state where the second operation illustrated in Fig. 10(b) is finished as a basis.

[0111] In starting the third operation, it is also applicable the control unit 10 controls the transport mechanism 16, the surface reforming unit 17, and the image forming unit 18 so that an end portion (also referred to as a second region end portion) E2a on a first processing region Ap1a side of the second processing region Aplb and an end portion (also referred to as a second image end portion) E2p on the first image Pc1 side of the second image Pc2 coincide with each other in the first transport direction D1 along the transport path 1Rt, for example, to execute the third operation of forming the second image Pc2 on the surface Su1 of the base material Bm1. This configuration can suppress an excessive extension of the second

processing region Aplb on which the surface reformation processing is performed in relation to the region where the second image Pc2 is formed in the surface Su1 of the base material Bm1, for example. The formation of the second image Pc2 on the surface Su1 of the base material Bm1 can be started in accordance with the second region end portion E2a as a terminal portion of the second processing region Aplb on which the surface reformation processing is performed in the surface Su1 of the base material Bm1 in the first transport direction D1. Reduced accordingly is the occurrence of defect that the second image Pc2 is formed on the surface Su1, in the base material Bm1, on which the surface reformation processing has been repetitively performed, and the quality of the second image Pc2 formed on the base material Bm1 is hardly reduced. Accordingly, the quality of the first image Pc1 and the second image Pc2 formed on the base material Bm1 can be easily improved while reducing the wasteful use of the base material Bm1, for example.

[0112] Considered herein, for example, is a configuration that the control unit 10 makes the image forming unit 18 start forming the second image Pc2 on the surface Su1 of the base material Bm1 at a timing of when the transport mechanism 16 transports the base material Bm1 by the distance E2 in the first transport direction D1 along the transport path 1Rt as illustrated in Fig. 11(b), applying the state where the second operation illustrated in Fig. 10(b) is finished as a basis.

[0113] In finishing the third operation, it is also applicable the control unit 10 controls the transport mechanism 16, the surface reforming unit 17, and the image forming unit 18 so that an end portion (also referred to as a third region end portion) E3a on the first region Ar1 side of the second processing region Aplb and an end portion (also referred to as a third image end portion) E3p on the first region Ar1 side of the second image Pc2 coincide with each other in the first transport direction D1 along the transport path 1Rt, for example, to form the second image Pc2 on the surface Su1 of the base material Bm1. This configuration can suppress an excessive extension of the second processing region Aplb on which the surface reformation processing is performed in relation to the region where the second image Pc2 is formed in the surface Su1 of the base material Bm1, for example. Reduced is an occurrence of defect that the third image is formed on the surface Su1, in the base material Bm1, on which the surface reformation processing has been repetitively performed when the third image is formed on the surface Su1 of the base material Bm1 after the second image Pc2 is formed, for example. As a result, the quality of the third image Pc3 formed on the base material Bm1 is hardly reduced, for example.

[0114] Herein, for example, in the third operation, the length of the second image Pc2 formed on the surface Su1 of the base material Bm1 along the transport path 1Rt in the first transport direction D1 is defined as L2. Considered in this case, as illustrated in Fig. 11(c), for

example, is a configuration that the control unit 10 makes the surface reforming unit 17 finish the surface reformation processing on the surface Su1 of the base material Bm1 at a timing of when the transport distance of the base material Bm1 transported by the transport mechanism 16 in the first transport direction D1 reaches a value (L2-A0) obtained by subtracting the distance A0 from the length L2, applying the timing of when the image forming unit 18 starts forming the second image Pc2 on the surface Su1 of the base material Bm1 as a basis. In this manner, for example, the formation of the second image Pc2 on the surface Su1 of the base material Bm1 can be finished in accordance with the third region end portion E3a as a terminal portion of the second processing region Aplb on which the surface reformation processing is performed in the surface Su1 of the base material Bm1 in the first transport direction D1. Subsequently, in the third operation, as illustrated in Fig. 11(d), the transport of the base material Bm1 by the transport mechanism 16 is suspended, for example.

<4-4. Operation flow according to image forming method>

[0115] Fig. 12 is a flow chart illustrating an example of an operation flow according to an image forming method in the image forming apparatus 1 according to the second embodiment. This operation flow is an example of an operation flow in a case where the second image Pc2 is formed after the first image Pc1 is formed on the elongated band-like base material Bm1 by controlling each unit in the image forming apparatus 1 under control of the control unit 10, for example. In this operation flow, processing of a first step S1b, processing of a second step S2b, and processing of a third step S3b are performed in this order, thus the first image Pc1 and the second image Pc2 may be formed in this order on the surface Su1 of the base material Bm1.

[0116] In the first step S1b, as illustrated in Fig. 8, for example, while the transport mechanism 16 transports the base material Bm1 in the first transport direction D1 along the transport path 1Rt, the surface reforming unit 17 gives the energy to the surface Su1 of the base material Bm1 in the first region Ar1 along the transport path 1Rt to perform the surface reformation processing of reforming the surface Su1 of the base material Bm1 and the image forming unit 18 forms the first image Pc1 on the first processing region Ap1a, in the surface Su1 of the base material Bm1, on which the surface reformation processing is performed in the second region Ar2 along the transport path 1Rt. In other words, the first operation described above is performed.

[0117] In the second step S2b, subsequent to the first step S1b, for example, as illustrated in Fig. 10, the transport mechanism 16 transports the base material Bm1, in which the first image Pc1 is formed on the surface Su1 in the first step S1b, in the second transport direction D2 opposite to the first transport direction D1 along the trans-

port path 1Rt in a state where the surface reforming unit 17 does not perform the surface reformation processing on the surface Su1 of the base material Bm1. In other words, the second operation described above is performed.

[0118] In the third step S3b, subsequent to the second step S2b, as illustrated in Fig. 11, for example, while the transport mechanism 16 transports the base material Bm1, on which the first image Pc1 is formed, in the first transport direction D1 along the transport path 1Rt, the surface reforming unit 17 performs the surface reformation processing on the second processing region Aplb other than the first processing region Ap1a in the surface Su1 of the base material Bm1 and the image forming unit 18 forms the second image Pc2 on the second processing region Ap1b. In other words, the third operation described above is performed.

[0119] According to such an image forming method, reduced is the occurrence of defect that the second image Pc2 is formed on the surface Su1, in the base material Bm1, on which the surface reformation processing has been repetitively performed, and the quality of the second image Pc2 formed on the base material Bm1 is hardly reduced, for example. Accordingly, the quality of the second image Pc2 formed on the base material Bm1 can be improved while reducing the wasteful use (the waste portion) of the base material Bm1, for example.

<5. Outline of second embodiment>

[0120] As described above, the image forming apparatus 1 according to the second embodiment forms the first image Pc1 on the surface Su1 of the base material Bm1 while transporting the base material Bm1 in the first transport direction D1, performs the backward feed of transporting the base material Bm1 in the second transport direction D2 after suspending the transport of the base material Bm1 in the first transport direction D1, then starts the transport of the base material Bm1 in the first transport direction D1, and forms the second image Pc2 on the surface Su1 of the base material Bm1 while transporting the base material Bm1 in the first transport direction D1, for example. Accordingly, the wasteful use of the base material Bm1 can be reduced, for example. For example, after the backward feed of the base material Bm1 without the surface reformation processing, the second image Pc2 is formed on the surface Su1 of the base material Bm1 while the surface reformation processing is performed on the region other than the first processing region Ap1a, on which the surface reformation processing has been already performed, in the surface Su1 of the base material Bm1. Reduced accordingly is the occurrence of defect that the second image Pc2 is formed on the surface Su1, in the base material Bm1, on which the surface reformation processing has been repetitively performed, and the quality of the second image Pc2 formed on the base material Bm1 is hardly reduced. Accordingly, the quality of the second image Pc2 formed on the base

material Bm1 can be improved while reducing the wasteful use (the waste portion) of the base material Bm1, for example.

[0121] For example, in the configuration in which the discharge unit 18h discharging the ink toward the surface Su1 of the base material Bm1 is applied to the image forming unit 18, even when reduced is the quality of the second image Pc2 formed on the base material Bm1 in accordance with the number of executions of the surface reformation processing on the base material Bm1 on which the second image Pc2 has not been formed by the ink, the quality of the second image Pc2 formed on the base material Bm1 can be improved while reducing the wasteful use (the waste portion) of the base material Bm1.

[0122] For example, in the configuration in which the corona discharge unit is applied to the surface reformation unit 17, the timing of performing the surface reformation processing by the corona discharge is controlled, thus the quality of the second image Pc2 formed on the base material Bm1 can be improved while reducing the wasteful use of the base material Bm1.

<6. Modification example>

[0123] The present invention is not limited to the first embodiment and the second embodiment, however, various variations and modifications should be possible without departing from the scope of the invention.

[0124] In the first embodiment described above, the reformation processing unit 17b may be a preprocessing unit applying a preprocessing liquid on the surface Su1 of the base material Bm1 to reform the surface of the base material Bm1, for example. A liquid for promoting the fixing of the ink on the surface Su1 of the base material Bm1 is applied to the preprocessing liquid, for example. Accordingly, also when the surface Su1 of the base material Bm1 is reformed by applying the preprocessing liquid, the portion in which the quality of the image formed in the base material Bm1 is different from that of the surrounding portion in the base material Bm1 can be easily distinguished from the surrounding portion, for example. In such a case, the first region Ar1 is a region being set on the transport path 1Rt and in which the preprocessing liquid can be applied on the base material Bm1 by the surface reformation unit 17. That is to say, the first region Ar1 needs to be a region being set on the transport path 1Rt and in which the surface of the base material Bm1 can be reformed by the surface reformation unit 17.

[0125] In each embodiment described above, for example, when the base material Bm1 has the elongated shape in a longitudinal direction along the transport path 1Rt, it needs not be rolled out from the roll R11 and rolled up by the roll R12. Considered as such a base material Bm1 is a configuration that the image forming apparatus 1 is connected to one or more other devices, and the elongated base material Bm1 is supplied from a first other device and recovered from the image forming apparatus

1 by a second other device. The first other device and the second other device may be the same or different from each other.

[0126] In each embodiment described above, for example, when the ink discharged from the discharge unit 18h in the image forming unit 18 is not the UV cure ink, the image forming unit 18 needs not have the UV lamp 18u.

[0127] In the first embodiment described above, for example, the non-image forming region (for example, the second non-image forming region B2 and the like) with the interval d2 and the specific image region B2A may be formed in at least part of the base material Bm1 in the width direction.

[0128] In the first embodiment described above, for example, a predetermined length which is previously set may be applied to the unit length of one pattern.

[0129] In the first embodiment described above, applicable as the configuration that the multiple surface reformation region Rf3 can be distinguished from the surrounding region, for example, are a configuration that a human can visually recognize, such as a configuration that the width d1 of the first non-image forming region B1 and the width d2 of the second non-image forming region B2 are different from each other and a configuration that the specific image region B2A, for example, is formed, and a configuration that the human cannot visually recognize such as a configuration that a region to which a material such as a magnetic material detectable by a specific sensor is applied or attached is formed.

[0130] In the first embodiment described above, for example, it is applicable to locate a predetermined sensor, which can detect a passing of the second end portion t2 on the uppermost stream side of the second image Pc2 while the base material Bm1 is transported in the first transport direction D1 along the transport path 1Rt, in a predetermined position between the surface reformation unit 17 and the image forming unit 18. In this case, the control unit 10 may make the image forming unit 18 form at least one of the second non-image forming region B2 and the specific image region B2A in accordance with the timing of when the predetermined sensor detects the passing of the second end portion t2, the transport speed of the base material Bm1 and the like. Applicable to the predetermined sensor are an image sensor detecting a position of the second end portion t2 based on an image taken with a camera or the like, an optical sensor detecting a reflection state or a transmission state of light in the base material Bm1, and a specific sensor detecting specific part formed on or in the base material Bm1 in accordance with the second end portion t2, for example. Applied to the specific part is, for example, part where a perforation is formed, part where a punch hole is formed, part where a magnetic material is applied or attached or the like. An optical sensor and a magnetic sensor, for example are applied to the specific sensor.

[0131] In each embodiment described above, for example, a configuration of an offset printing transferring

ink to the base material Bm1 may be applied to the image forming unit 18. In this case, for example, in the first embodiment described above, the second region Ar2 may be a region set on the transport path 1Rt and in which the image can be formed by transferring the ink on the surface Su1 of the base material Bm1 by the image forming unit 18. That is to say, the second region Ar2 needs to be a region being set on the transport path 1Rt and in which the image can be formed on the surface Su1 of the base material Bm1 by the image forming unit 18.

[0132] In the second embodiment described above, for example, it is applicable to locate a predetermined sensor, which can detect a passing of the first image end portion E1p located closest to a feed unit 15 side of the first image Pc1 while the base material Bm1 is transported in the first transport direction D1 along the transport path 1Rt, on an immediate feed unit 15 side of the surface reforming unit 17. In this case, for example, in the third operation, the control unit 10 makes the surface reforming unit 17 start the surface reformation processing on the surface Su1 of the base material Bm1 by the surface reforming unit 17 in response to the detection of the passing of the first image end portion E1p by the predetermined sensor. Applicable to the predetermined sensor are, for example, an image sensor detecting a position of the first image end portion E1p based on an image taken with a digital camera or the like, an optical sensor detecting a reflection state or a transmission state of light in the base material Bm1, a specific sensor detecting a specific part when there is a configuration capable of forming the specific part on the base material Bm1 in accordance with the first image end portion E1p, and the like. Applicable to the specific part are, for example, processing part where a perforation or a punch hole is formed, part where a magnetic material is applied or attached and the like. Applicable to the configuration capable of forming the specific part, for example, are a press machine which can make the perforation or the punch hole, a discharge unit which can spray a magnetic material and the like.

[0133] In the second embodiment described above, for example, the control unit 10 may control an intensity of energy given to the surface Su1 of the base material Bm1 by the surface reforming unit 17 in accordance with the transport speed of the base material Bm1 transported by the transport mechanism 16, for example. Considered herein is, for example, a configuration that the intensity of the energy increases in proportion to the transport speed of the base material Bm1.

[0134] In the second embodiment described above, for example, when post-processing of applying varnish or the like is performed on the first image Pc1 formed on the surface Su1 of the base material Bm1, a defect hardly occurs in applying the varnish or the like in the post-processing when the surface reformation processing is not performed on the first image Pc1 by the surface reforming unit 17. In the meanwhile, for example, when the post-processing of applying the varnish or the like is not

performed on the first image Pc1 formed on the surface Su1 of the base material Bm1, the surface reformation processing may be performed on part of the first image Pc1 by the surface reforming unit 17 in the third operation described above.

[0135] All or some of the configurations described in the above first embodiment, second embodiment, and various modifications can be combined with each other as appropriate unless any contradiction occurs.

[0136] While the invention has been shown and described in detail, the foregoing description is in all aspects illustrative and not restrictive. It is therefore understood that numerous modifications and variations can be devised without departing from the scope of the invention.

Claims

1. An image forming apparatus (1), comprising:

a feed unit (15) configured to supply a base material (Bm1);
 a transport mechanism (16) configured to transport the base material supplied from the feed unit along a transport path (1Rt);
 a recovery unit (19) configured to recover the base material transported by the transport mechanism along the transport path;
 a surface reforming unit (17) configured to perform surface reformation processing of reforming a surface (Su1) of the base material in a first region (Ar1) along the transport path;
 an image forming unit (18) configured to form an image on a surface reformed in the surface reformation processing on the base material in a second region (Ar2) between the surface reforming unit and the recovery unit along the transport path; and
 a control unit (10) configured to make the transport mechanism and the image forming unit form an image on the surface of the base material based on image data, wherein
 the control unit makes the transport mechanism execute a first transport operation of transporting the base material in a first transport direction (D1) toward the recovery unit along the transport path and a second transport operation of transporting the base material in a second transport direction (D2) toward the feed unit opposite to the first transport direction along the transport path, and
 when the control unit makes the transport mechanism perform the first transport operation of transporting the base material having a formation-completed portion in which an image is formed on a surface by the image forming unit in the first transport direction along the transport path after performing the second transport op-

- eration of transporting the base material in the second transport direction along the transport path, the control unit makes the image forming unit form an image on the surface of the base material in such a manner that a multiple surface reformatting region (Rf3), in which a total number of executions of the surface reformation processing in the surface of the base material is larger than a total number of execution of the surface reformation processing in a surrounding region, can be distinguished.
2. The image forming apparatus according to claim 1, wherein the surface reformatting unit includes a corona discharge unit configured to give energy to the surface of the base material by corona discharge to reform the surface of the base material.
 3. The image forming apparatus according to claim 1, wherein the surface reformatting unit includes preprocessing unit configured to apply a preprocessing liquid on the surface of the base material to reform the surface of the base material.
 4. The image forming apparatus according to any one of claim 1 to claim 3, wherein the image forming unit includes a discharge unit (18h) discharging ink toward the surface of the base material.
 5. The image forming apparatus according to any one of claim 1 to claim 4, wherein when the control unit makes the image forming unit form a plurality of images so as to be arranged in the first transport direction on the base material, the control unit makes a width (d1) in the first transport direction of a portion between images on a one-time surface reformatting region (Rf1) on which the surface reformation processing is performed once and a width (d3) in the first transport direction of a portion between images on the multiple surface reformatting region different from each other.
 6. The image forming apparatus according to any one of claim 1 to claim 4, wherein when the control unit makes the image forming unit form a plurality of images so as to be arranged in the first transport direction on the base material, the control unit makes the image forming unit form a specific image region (B2A) in a portion between images on the multiple surface reformatting region.
 7. An image forming method, comprising:
 - (a) performing surface reformation processing of reformatting a surface (Su1) of a base material (Bm1) in a first region (Ar1) along a transport path (IRt) and image forming processing of forming an image on the surface reformed by the surface reformation processing of the base material in a second region (Ar2) along the transport path while transporting the base material in the first transport direction (D1) along the transport path; (b) transporting the base material having a formation-completed portion in which an image is formed on a surface in the (a) in a second transport direction (D2) opposite to the first transport direction along the transport path; and (c) when performing the image reformation processing and the image forming processing while transporting the base material having the formation-completed portion in the first transport direction along the transport path after the (b), forming an image on the surface of the base material in the second region in such a manner that a multiple surface reformatting region (Rf3), in which a total number of executions of the surface reformation processing in the first region in the surface of the base material is larger than a total number of executions of the surface reformation processing in a surrounding region, can be distinguished.
 8. An image forming apparatus (1), comprising:
 - a feed unit (15) configured to supply a base material (Bm1);
 - a transport mechanism (16) configured to transport the base material supplied from the feed unit along a transport path (IRt);
 - a recovery unit (19) configured to recover the base material transported by the transport mechanism along the transport path;
 - a surface reformatting unit (17) configured to give energy to a surface (Su1) of the base material in a first region (Ar1) along the transport path to perform surface reformation processing of reformatting the surface of the base material;
 - an image forming unit (18) configured to form an image on the surface of the base material in a second region (Ar2) between the surface reformatting unit and the recovery unit along the transport path; and
 - a control unit (10) configured to control the transport mechanism, the surface reformatting unit, and the image forming unit based on image data to make the transport mechanism, the surface reformatting unit, and the image forming unit form an image on a surface reformed in the surface reformation processing of the base material, wherein the control unit controls the transport mechanism, the surface reformatting unit, and the image forming unit to make the transport mechanism,

the surface reforming unit, and the image forming unit execute a first operation, a second operation, and a third operation, wherein

the first operation includes an operation of performing the surface reformation processing on the surface of the base material and forming a first image (Pc1) on a first processing region (Ap1a) on which the surface reformation processing is performed in the surface of the base material while transporting the base material in a first transport direction (D1) toward the recovery unit along the transport path, the second operation includes an operation of transporting the base material, in which the first image is formed on the surface in the first operation, in a second transport direction (D2) toward the feed unit opposite to the first transport direction along the transport path in a state where the surface reformation processing is not performed on the surface of the base material after the first operation, and the third operation includes an operation of performing the surface reformation processing on a second processing region (Ap1b) other than the first processing region in the surface of the base material and forming the second image (Pc2) on the second processing region while transporting the base material in which the first image is formed in the first transport direction along the transport path after the second operation.

9. The image forming apparatus according to claim 8, wherein the image forming unit includes a discharge unit (18h) configured to discharge ink toward the surface of the base material.

10. The image forming apparatus according to claim 8 or claim 9, wherein the surface reforming unit includes a corona discharge unit configured to give energy to the surface of the base material by corona discharge to reform the surface of the base material.

11. The image forming apparatus according to any one of claim 8 to claim 10, wherein the control unit controls the transport mechanism, the surface reforming unit, and the image forming unit to make the transport mechanism, the surface reforming unit, and the image forming unit execute the first operation so that a first region end portion (E1a) on a side of the first region in the first processing region and an a first image end portion (E1p) on

the side of the first region in the first image coincide with each other in the first transport direction along the transport path.

12. The image forming apparatus according to any one of claim 8 to claim 11, wherein the control unit controls the transport mechanism, the surface reforming unit, and the image forming unit to make the transport mechanism, the surface reforming unit, and the image forming unit execute the third operation so that a second region end portion (E2a) on a side of the first processing region in the second processing region and an a second image end portion (E2p) on a side of the first image in the second image coincide with each other in the first transport direction along the transport path.

13. An image forming method, comprising:

- (a) giving energy to a surface (Su1) of a base material (Bm1) in a first region (Ar1) along a transport path (1Rt) to perform surface reformation processing of reforming the surface of the base material, and forming a first image (Pc1) on a first processing region (Ap1a), in the surface of the base material, on which the surface reformation processing is performed in a second region (Ar2) along the transport path while transporting the base material in a first transport direction (D1) along the transport path;
- (b) transporting the base material, in which the first image is formed on the surface in the (a), in a second transport direction (D2) opposite to the first transport direction along the transport path in a state where the surface reformation processing is not performed on the surface of the base material; and
- (c) performing the surface reformation processing on a second processing region (Ap1b) other than the first processing region in the surface of the base material and forming a second image (Pc2) on the second processing region while transporting the base material in which the first image is formed in the first transport direction along the transport path after the (b).

14. A program, when executed by a processing unit included in an image forming apparatus, making the image forming apparatus function as an image forming apparatus according to any one of claim 1 to claim 6 and claim 8 to claim 12.

FIG. 1

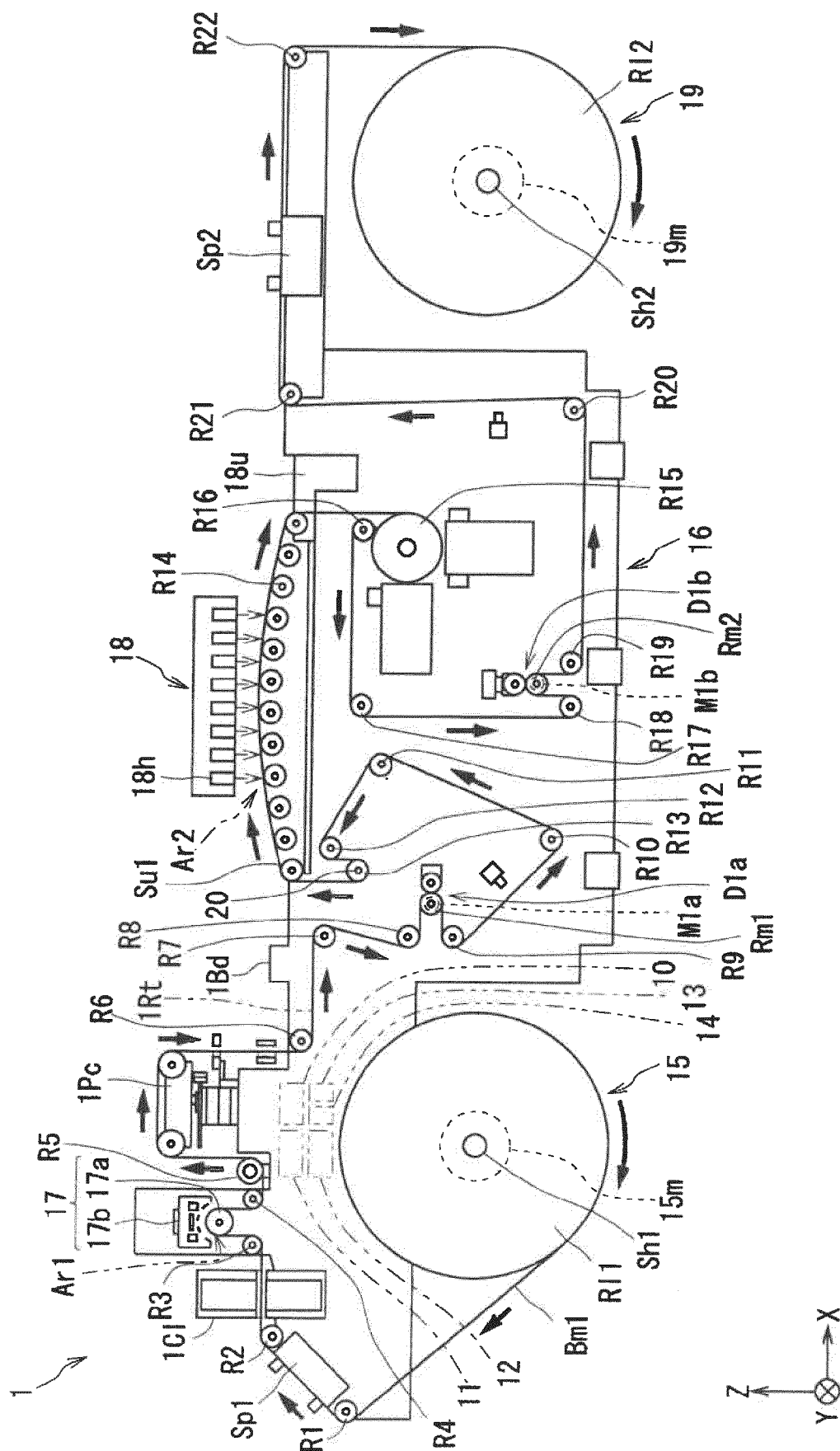


FIG. 2

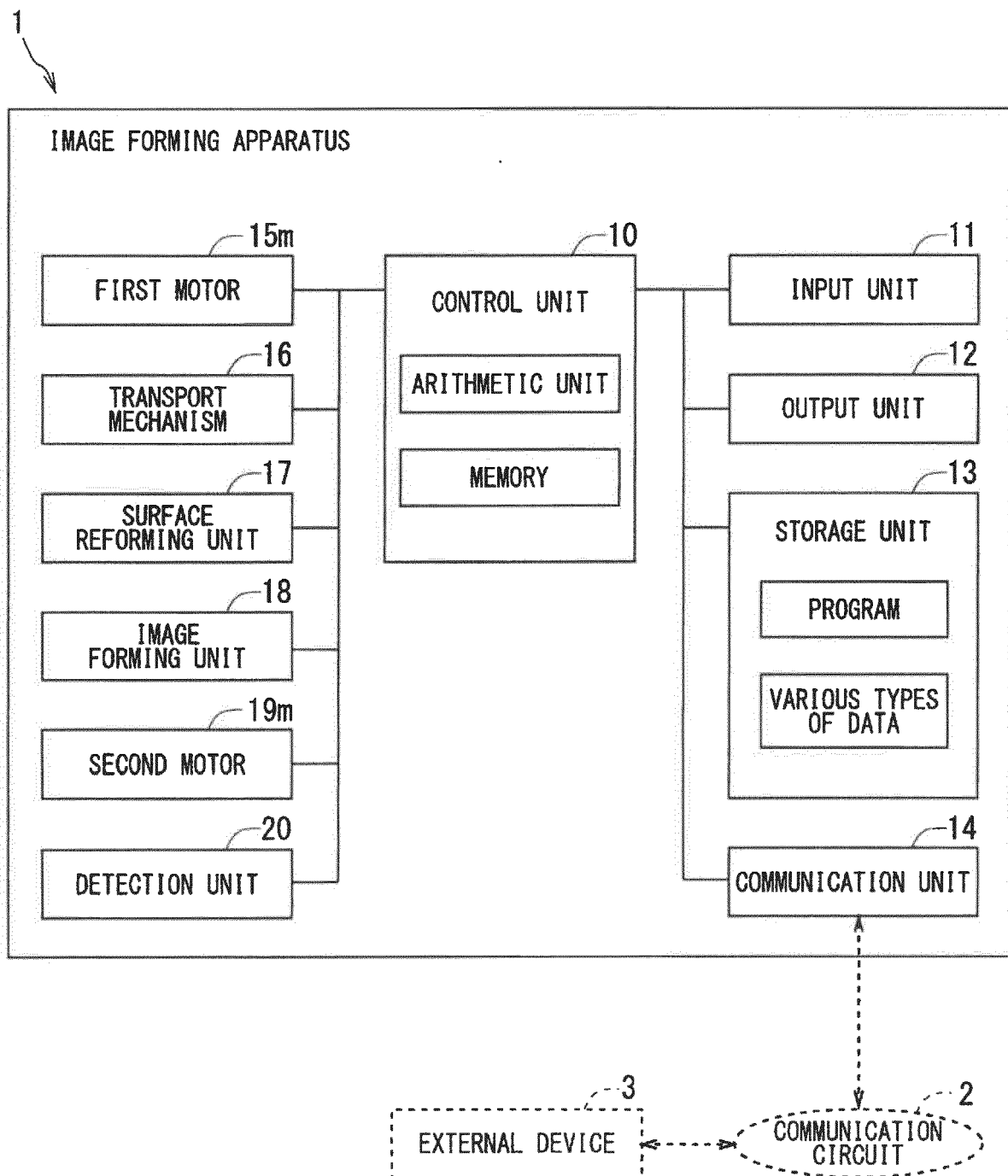


FIG. 3

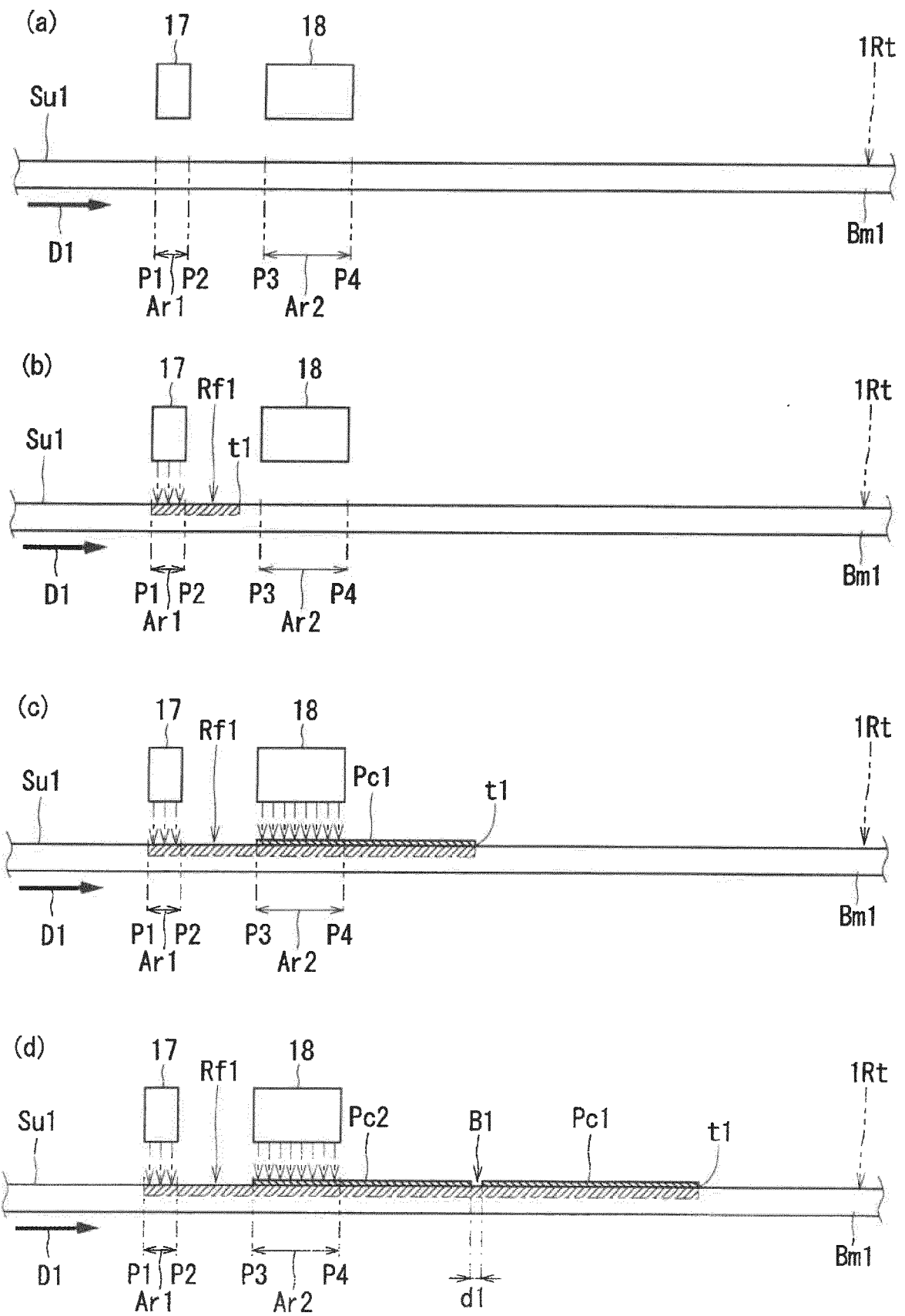


FIG. 4

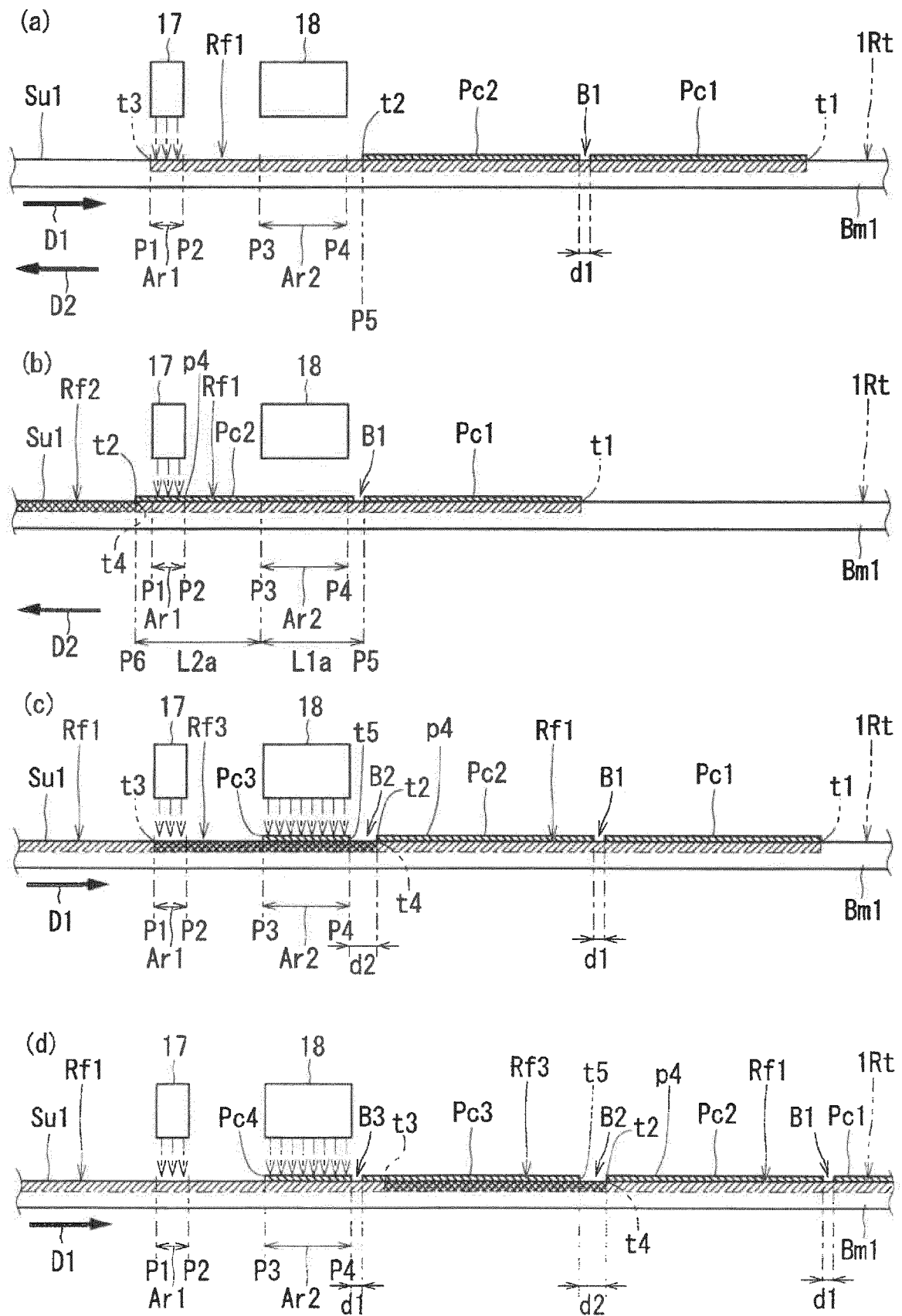


FIG. 5

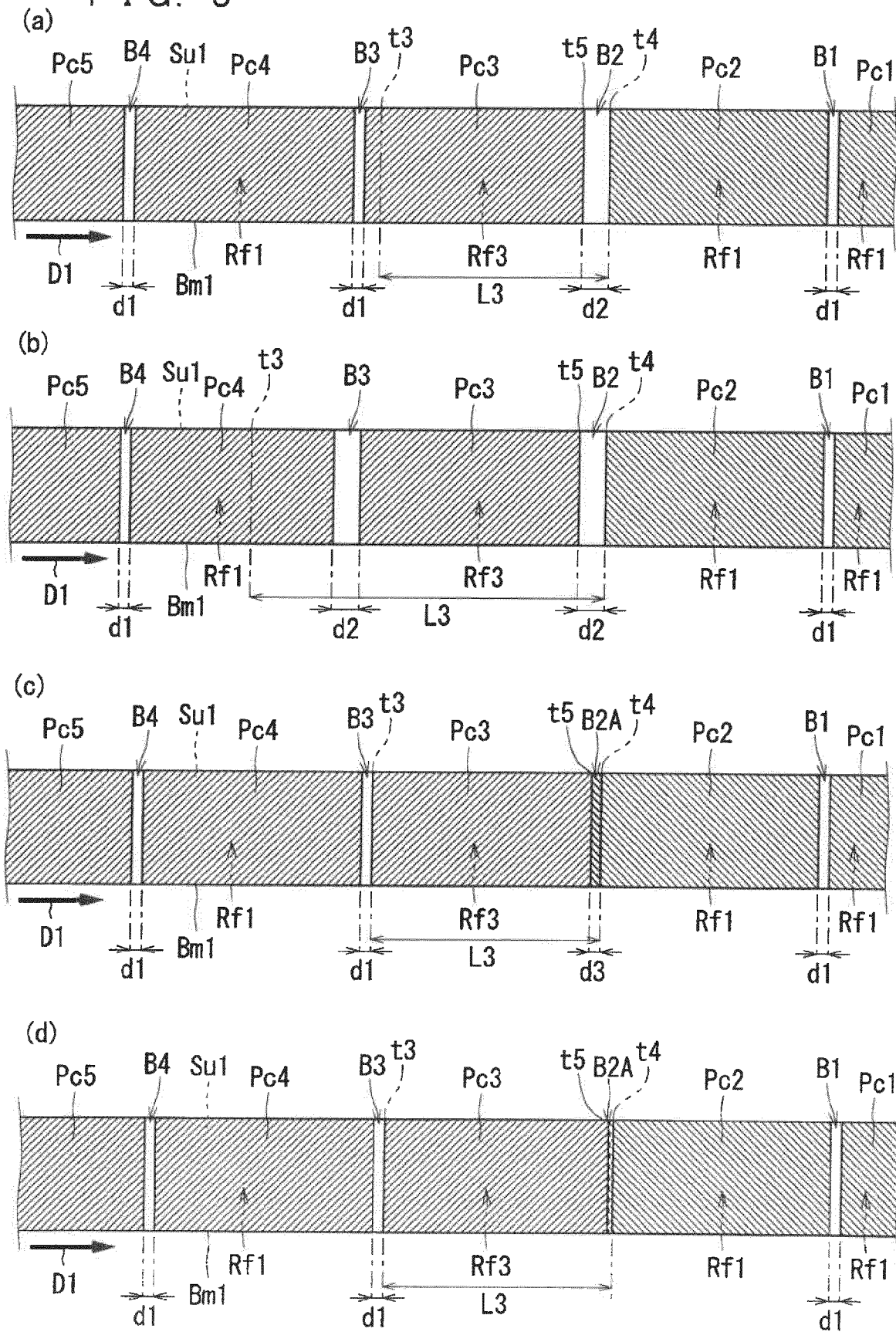


FIG. 6

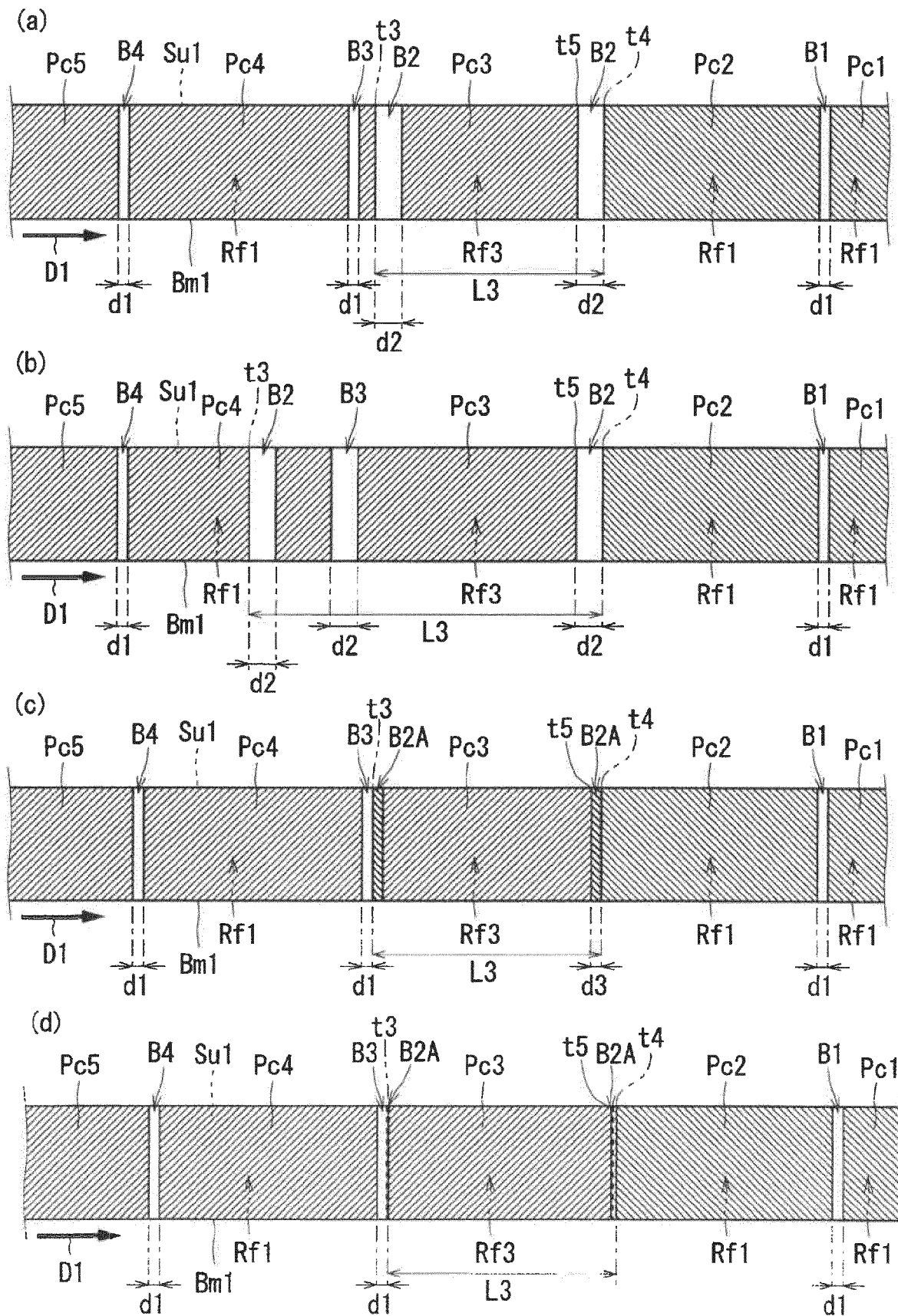


FIG. 7

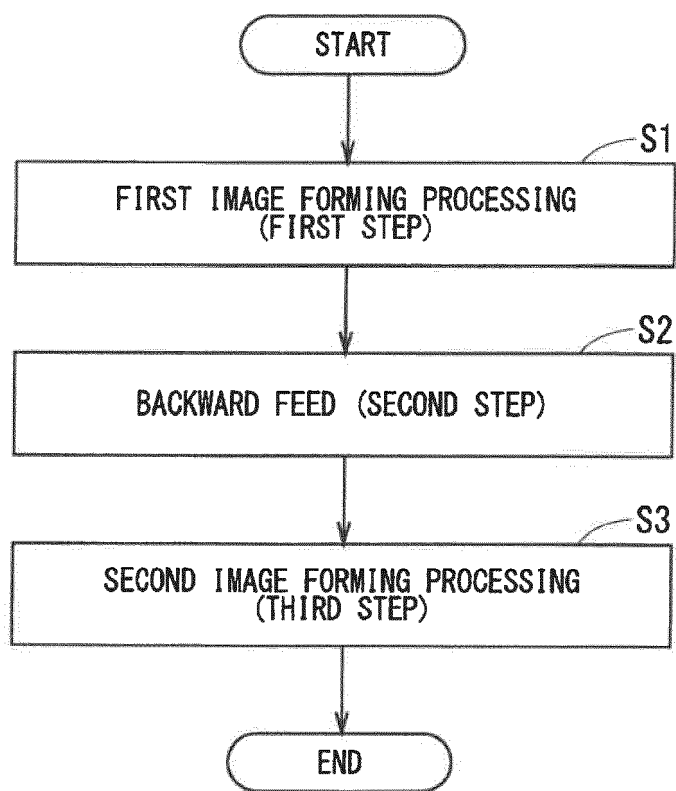


FIG. 8

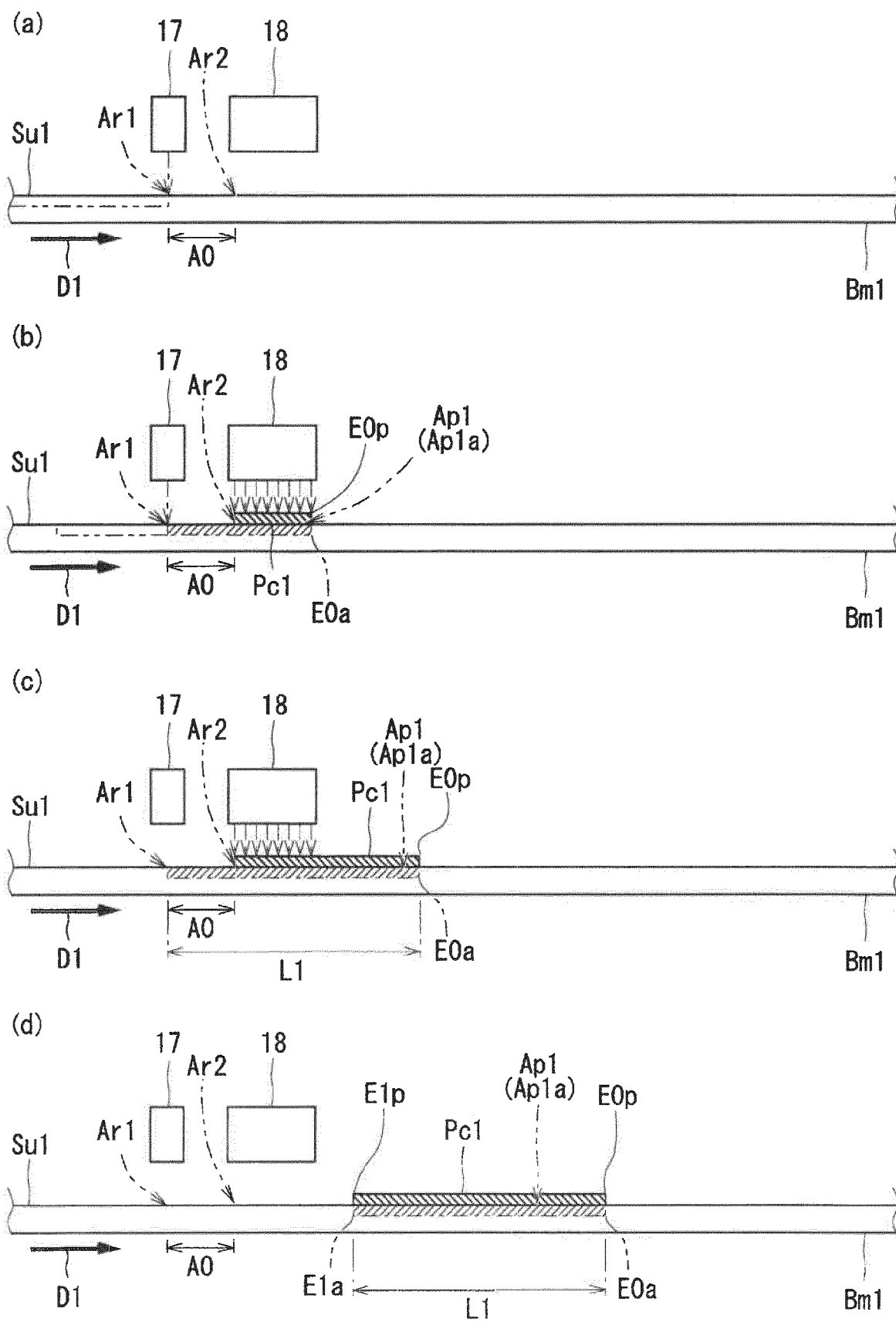
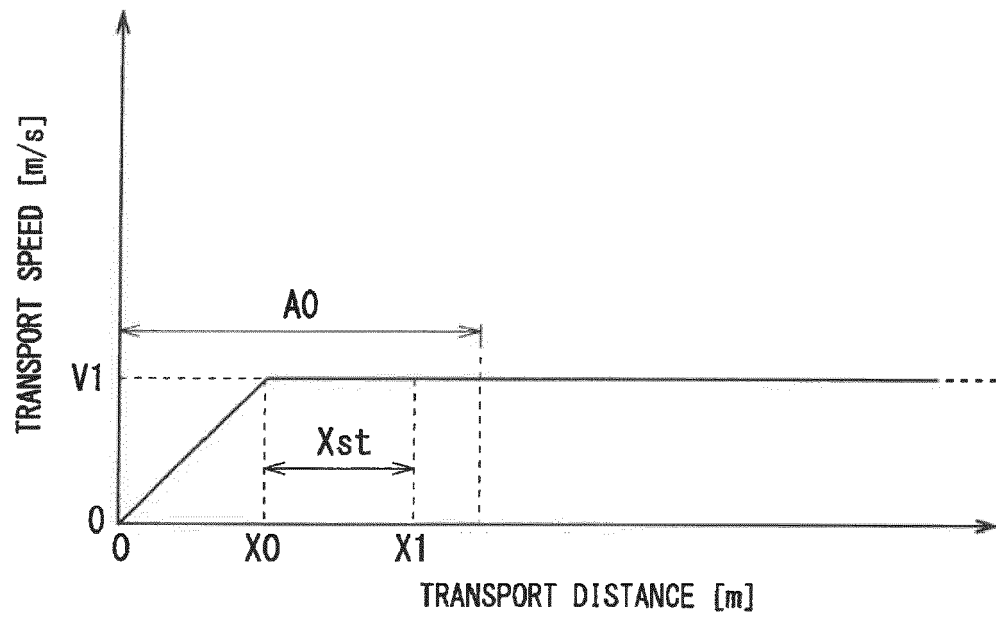


FIG. 9

(a)



(b)

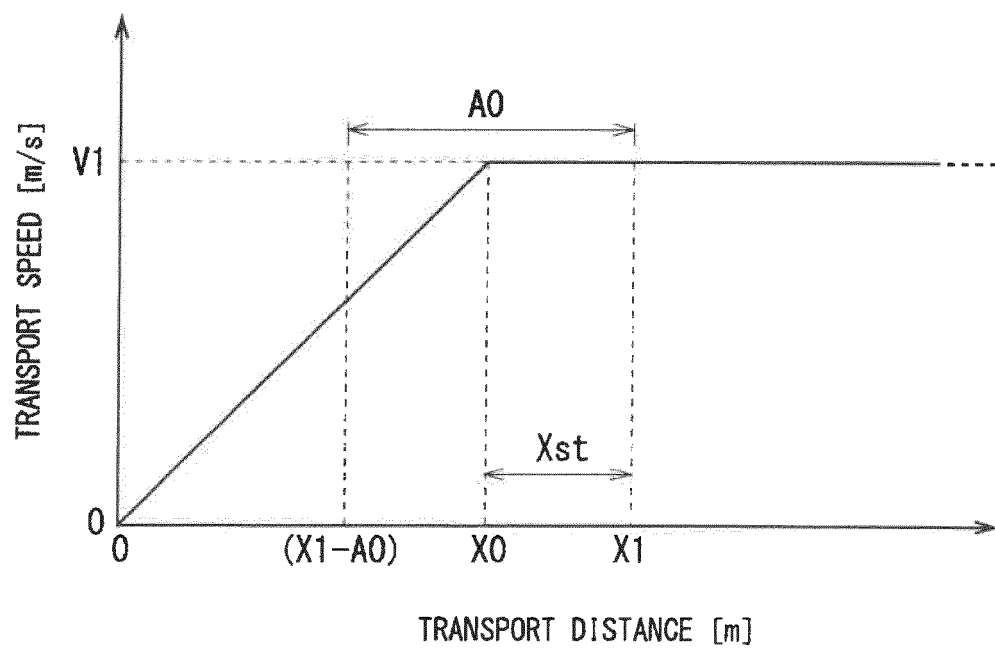
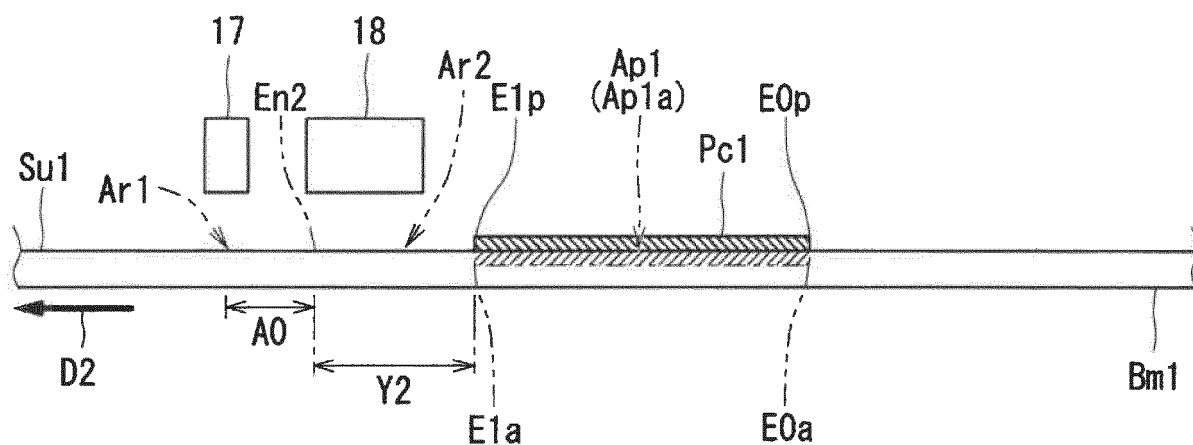


FIG. 10

(a)



(b)

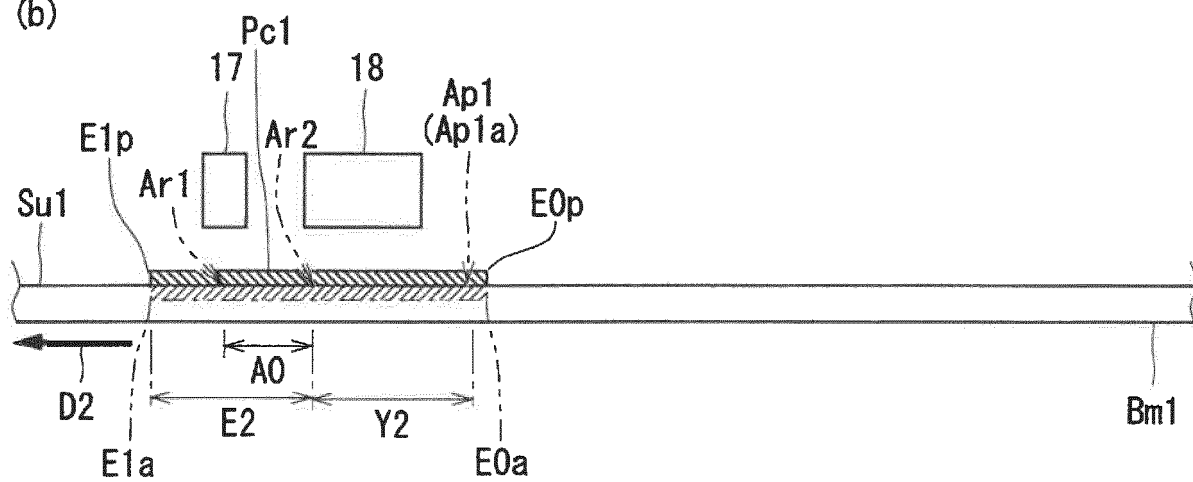


FIG. 11

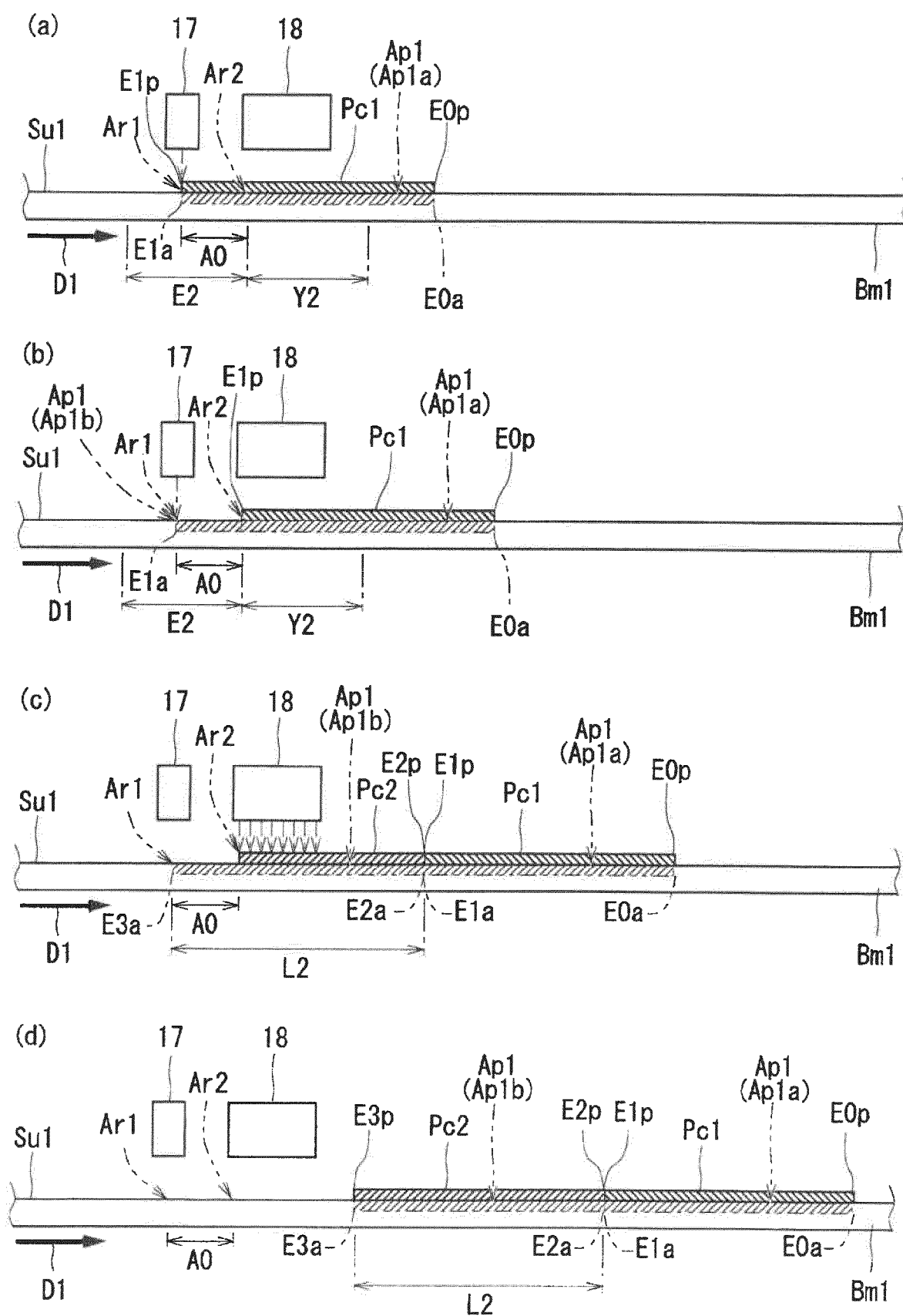


FIG. 12

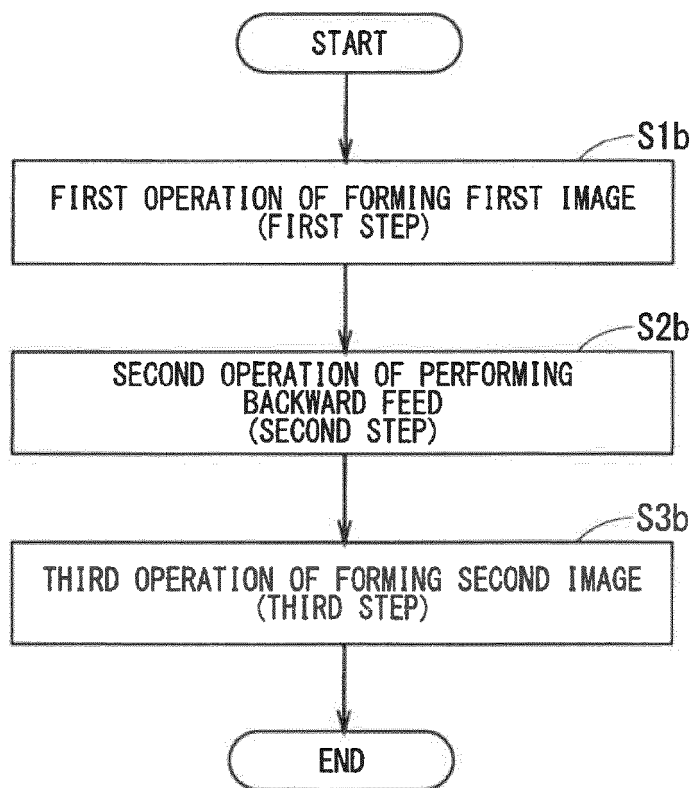


FIG. 13

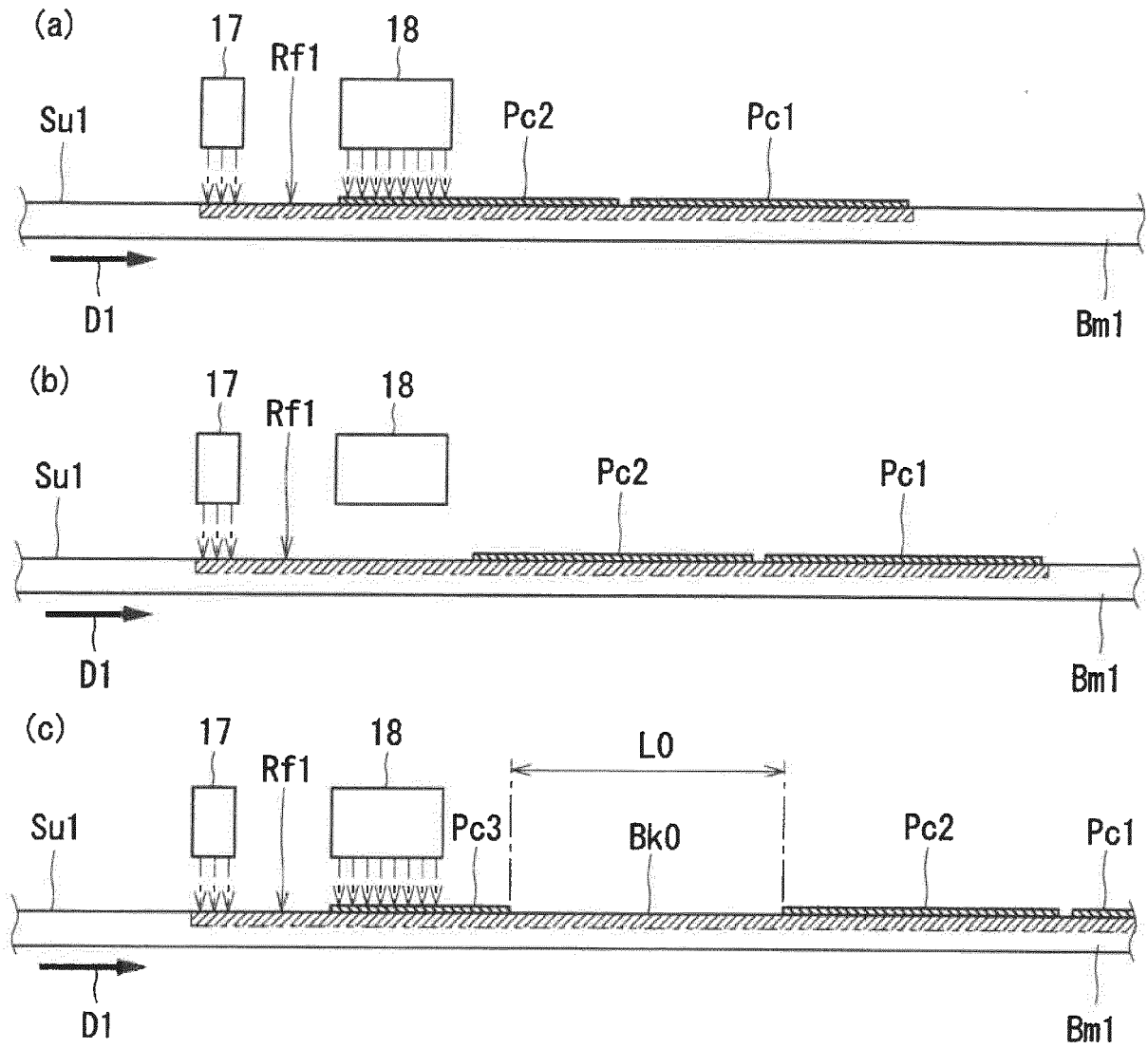


FIG. 14

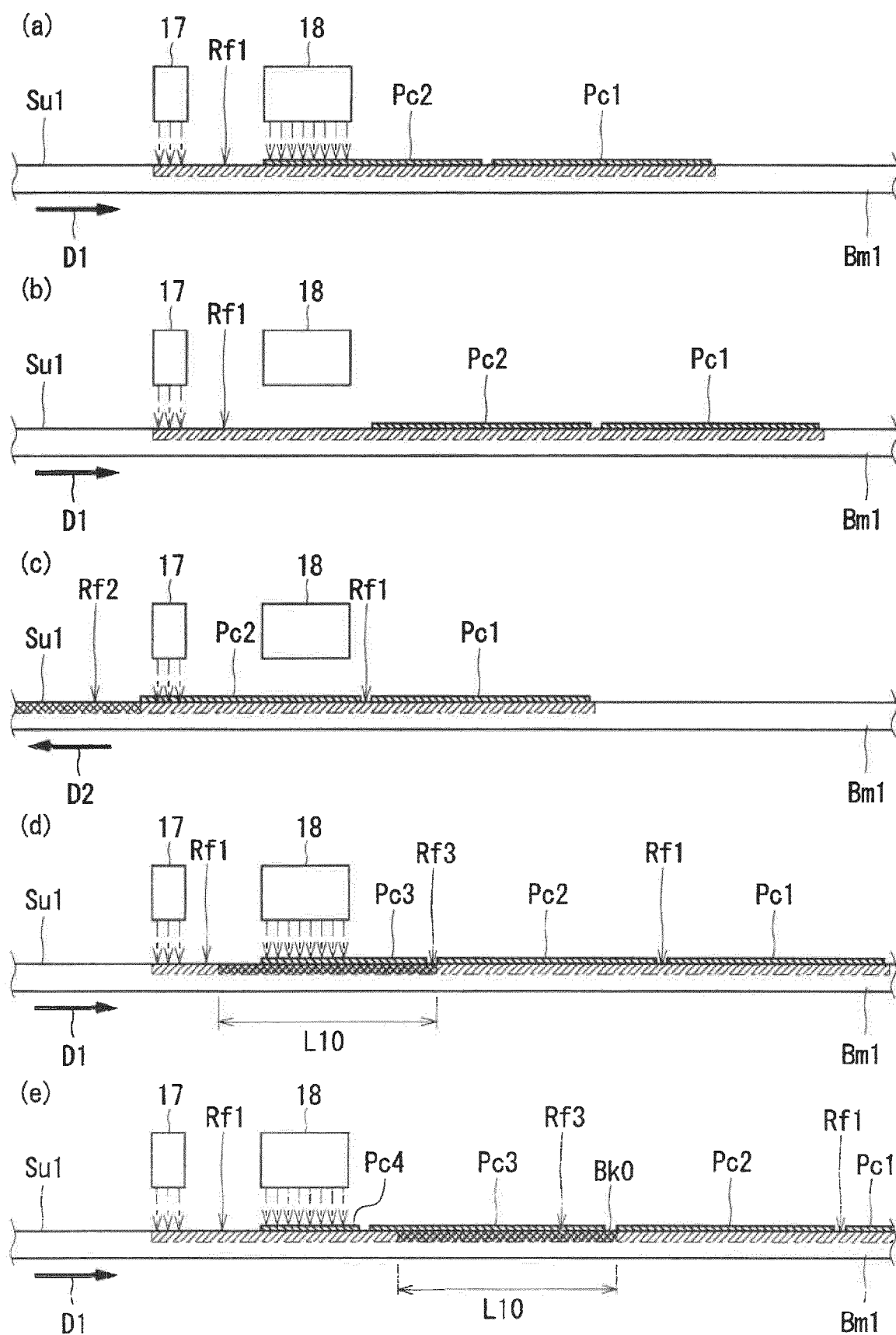


FIG. 15

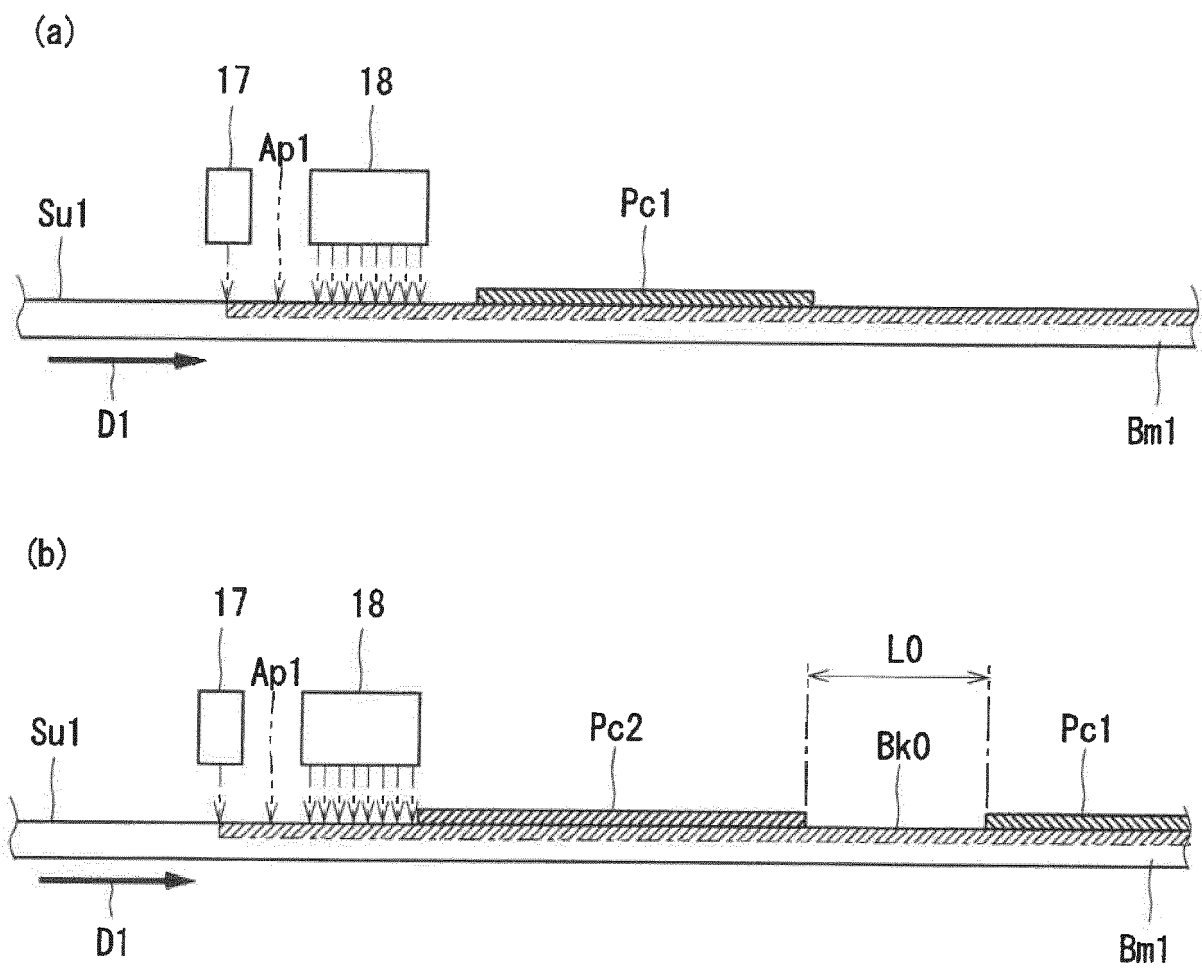
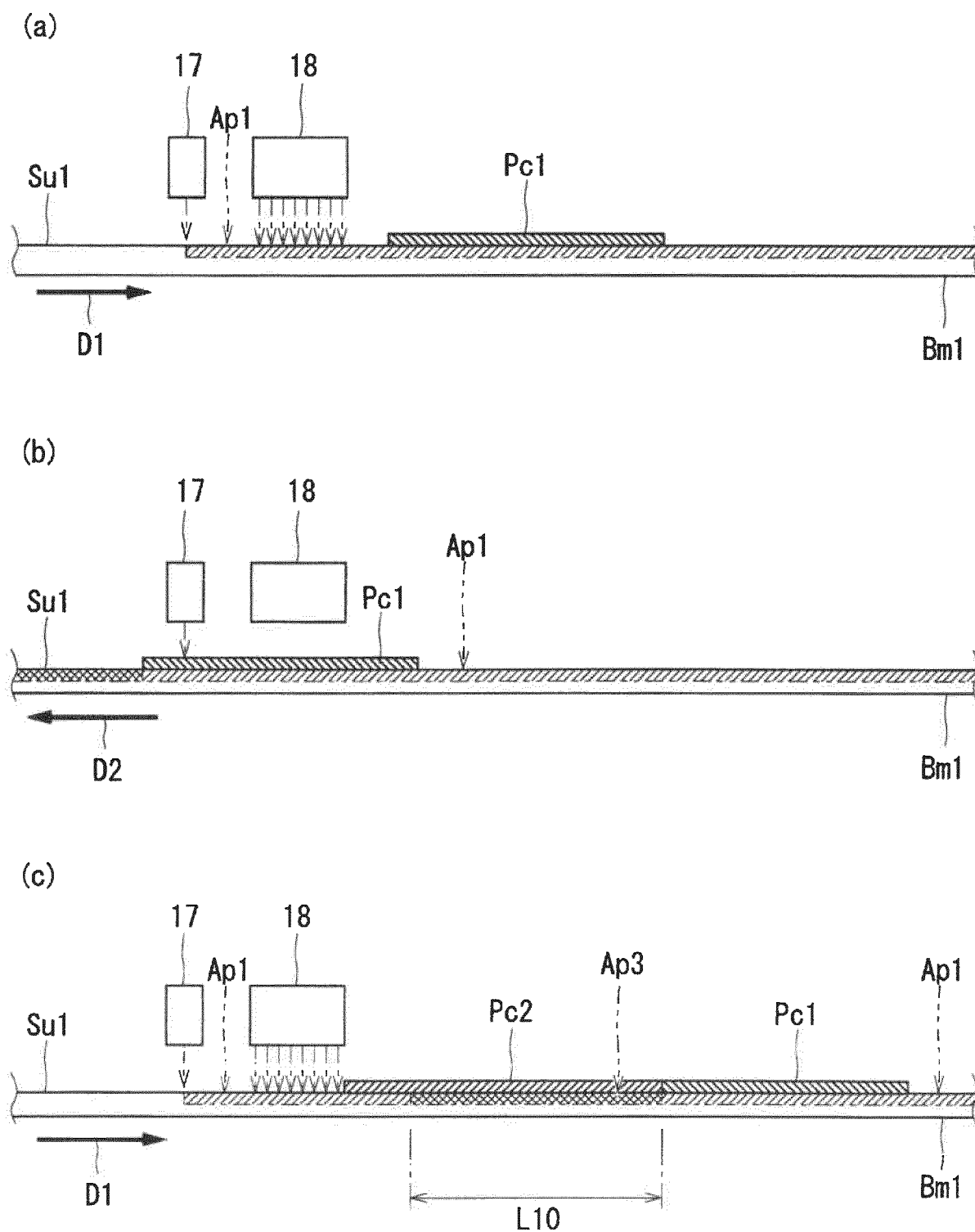


FIG. 16





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Place of search The Hague		Date of completion of the search 17 August 2020	Examiner Curt, Denis
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