

CONVEYING APPARATUS AND CONVEYING METHOD

BACKGROUND

1. Technical Field

The present disclosure relates to a conveying apparatus and conveying method for conveying a strip-shaped thin plate.

2. Description of the Related Art

JP-A-11-240653 discloses a configuration for conveying and winding a base of a lead frame in a production step of a lead frame. Specifically, in JP-A-11-240653, the above base that is a strip-shaped thin plate is clamped by two upper and lower rolls and is conveyed. The base is wound by a winding device. When a configuration in which the base is clamped by rolls is employed, it is possible to convey the base at a constant speed. This makes it possible to uniformly perform various kinds of processes such as an etching process on the base.

CITATION LIST

PATENT LITERATURE

PATENT LITERATURE 1: JP-A-11-240653

SUMMARY

In recent years, a lead frame subjected to half-etching, such as a quad flat no lead package (QFN), has been increased. Such a lead frame has a thin plate thickness and is therefore easily deformed, as compared to a conventional lead frame. Therefore, in an apparatus that clamps a base of a lead frame with rolls and conveys the base, which is disclosed in JP-A-11-240653 cited above, such deformation of the base is

problematic in some cases. Thus, a configuration for conveying a base of a lead frame at a constant speed without deforming the base is demanded.

A method for conveying a base of a lead frame without, for example, clamping the base with rolls (i.e., while restraining deformation of the base of the lead frame) is the following method, for example. In this method, tension is applied to the above base of the lead frame by a motor provided in a winding device. In this state, the base of the lead frame is conveyed. In this method, a portion (portion to be wound) of the base before the winding device is fully stretched (with no hoop). In this case, for example, in a case where the base meanders, the base may be brought into contact with a side plate of the winding device (e.g., PAULOWNIA reel) and dust may be generated in the winding device. Therefore, the portion to be wound of the base is preferably in a loosed state (a state in which a hoop of the base is formed) in conveyance of the base of the lead frame.

In view of this, an object of the present disclosure is to provide a conveying apparatus and conveying method capable of conveying a strip-shaped thin plate at a constant speed while restraining deformation thereof and maintaining a hoop in a portion to be wound of the thin plate.

A conveying apparatus according to a standpoint of the present disclosure includes: an upstream roll provided in a conveyance route of a strip-shaped thin plate and on which the thin plate is wound; a downstream roll positioned on a downstream side of the upstream roll in the conveyance route and on which the thin plate is wound; a winding device positioned on a downstream side of the downstream roll in the conveyance route and configured to wind the thin plate; a first motor configured to rotate at least one of the upstream roll and the downstream roll at a constant speed to move the thin plate wound on the upstream roll and the downstream roll to a

downstream side of the conveyance route; and a tension application device configured to apply constant tension to the thin plate wound on the downstream roll.

A method of conveying a thin plate according to another standpoint of the present disclosure includes: rotating at least one of an upstream roll on which a strip-shaped thin plate is wound and a downstream roll disposed on a downstream side of the upstream roll and on which the thin plate is wound at a constant speed to move the thin plate to a downstream side of a conveyance route; applying constant tension to the thin plate wound on the downstream roll; and winding the thin plate on a downstream side of the downstream roll.

According to the above conveying apparatus and conveying method, it is possible to convey a strip-shaped thin plate at a constant speed while restraining deformation thereof and maintain a hoop in a portion to be wound of the thin plate.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 schematically illustrates an example of a conveying apparatus for a lead frame base.

Figs. 2A and 2B illustrate tension (conveyance force) of S-shaped rolls, and Fig. 2A illustrates a verification image of tension and Fig. 2B is a table showing measurement results of tension.

Fig. 3 is a graph showing correspondence between a winding angle and frictional force.

Fig. 4 schematically illustrates an example of a conveying apparatus according to a comparison example.

Fig. 5 schematically illustrates an example of a conveying apparatus according to a comparison example.

Fig. 6 schematically illustrates an example of a conveying apparatus according to a comparison example.

Fig. 7 schematically illustrates an example of a conveying apparatus according to a modification example.

DESCRIPTION OF THE EMBODIMENTS

In the following detailed description, for purpose of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

An embodiment (this embodiment) according to the present disclosure described below is an example for describing a conveying apparatus and conveying method of the present disclosure. The conveying apparatus and conveying method of the present disclosure are not limited to the following description. In the following description, the same elements or elements having the same function are denoted by the same reference sign, and repeated description thereof will be omitted.

<<Overview of Embodiment>>

A conveying apparatus according to an aspect in this embodiment (this conveying apparatus) includes: an upstream roll provided in a conveyance route of a strip-shaped thin plate and on which the thin plate is wound; a downstream roll positioned on a downstream side of the upstream roll in the conveyance route and on which the thin plate is wound; a winding device positioned on a downstream side of the downstream roll in the conveyance route and configured to wind the thin plate; a first motor configured to rotate at least one of the upstream roll and the downstream roll at a

constant speed to move the thin plate wound on the upstream roll and the downstream roll to a downstream side of the conveyance route; and a tension application device configured to apply constant tension to the thin plate wound on the downstream roll.

In this conveying apparatus, the upstream roll and the downstream roll are provided on an upstream side of the winding device. Then, one of those rolls is rotated by the first motor at a constant speed, and therefore the thin plate wound on the upstream roll and the downstream roll is moved to the downstream side of the conveyance route. Therefore, the thin plate can be conveyed by the roll rotating at a constant speed.

Further, in this conveying apparatus, the tension application device applies constant tension to the thin plate wound on the downstream roll. Herein, for example, it is assumed that the tension applied to the thin plate is decreased for some reason in the route to the downstream roll. In this case, the thin plate may be loosened in the route to the downstream roll. Further, it is assumed that the tension applied to the thin plate is increased for some reason in the route to the downstream roll. In this case, the thin plate may be moved to slide on the roll.

As described above, even if a rotational speed of the roll is constant, the thin plate may not be conveyed at a constant speed in a state in which the tension to the thin plate is not controlled. Regarding this point, in this conveying apparatus, the tension application device applies constant tension to the thin plate wound on the downstream roll. This makes it possible to restrain the tension applied to the thin plate from being decreased and increased. Consequently, it is possible to convey the thin plate at a constant speed.

As described above, this conveying apparatus can convey the thin plate at a constant speed without clamping the thin plate with two upper and lower rolls, i.e.,

without deforming the thin plate. Further, the thin plate is conveyed by the upstream roll and the downstream roll without depending on tension from the winding device. This makes it possible to provide a hoop in the thin plate in a section between the downstream roll and the winding device.

Thus, according to this conveying apparatus, it is possible to convey the strip-shaped thin plate at a constant speed while restraining deformation thereof and maintain a hoop in a portion to be wound of the thin plate.

In this conveying apparatus, the first motor may be configured to rotate the upstream roll at a constant speed. Further, the tension application device may be a second motor that controls torque of the downstream roll to apply constant tension to the thin plate. With this, rotational force of the downstream roll is adjusted by the second motor. Therefore, constant tension to be applied to the thin plate can be easily and appropriately kept constant.

In this conveying apparatus, the downstream roll may be configured so that the thin plate is wound on an upper side of the roll. In a case where the thin plate is loosened for some reason, the thin plate wound on the roll may hang down toward a position below the roll due to gravity. In this case, even in a case where torque control is performed by the second motor, tension may not be appropriately applied to the hanging thin plate. Regarding this point, in the above configuration, the thin plate is wound on an upper portion of the downstream roll whose torque is controlled by the second motor. With this, even if the thin plate is loosened, hanging down of the thin plate due to gravity does not easily occur (the thin plate is not easily separated from the roll). This makes it possible to appropriately apply tension to the thin plate.

In this conveying apparatus, the upstream roll and the downstream roll may be configured so that the thin plate is wound by a half or more turn on each roll. With

this, the rolls and the thin plate are in contact with each other in a wide range, and therefore frictional force caused by this contact is increased. Consequently, it is possible to increase tension to be applied to the thin plate. With this, this conveying apparatus can secure conveyance force with a simple configuration.

This conveying apparatus may further include an intermediate roll that is positioned on a downstream side of the upstream roll and on an upstream side of the downstream roll and on which the thin plate is wound. Because not only the upstream roll and the downstream roll but also the roll (intermediate roll) positioned between those rolls is provided, the rolls and the thin plate are in contact with each other in a wide range. This makes it possible to increase tension based on frictional force caused by the contact. Consequently, this conveying apparatus can secure conveyance force with a simple configuration.

In this conveying apparatus, the intermediate roll may be configured to rotate to follow the thin plate moving through the conveyance route. For example, in a case where a motor for rotating the intermediate roll is provided, it is necessary to completely synchronize the motor for rotating the intermediate roll with the first motor in order to rotate the intermediate roll and the roll to which rotational force is applied by the first motor at the same speed. In a case where those motors are not synchronized, for example, the thin plate may be moved to slide on the roll. Regarding this point, because the intermediate roll is configured to rotate to follow the thin plate, the intermediate roll and the roll to which rotational force is applied by the first motor are easily rotated at the same speed. Consequently, it is possible to restrain the above slide or the like of the thin plate.

A method of conveying a thin plate according to another aspect in this embodiment includes: rotating at least one of an upstream roll on which a strip-shaped

thin plate is wound and a downstream roll disposed on a downstream side of the upstream roll and on which the thin plate is wound at a constant speed to move the thin plate to a downstream side of a conveyance route; applying constant tension to the thin plate wound on the downstream roll; and winding the thin plate on a downstream side of the downstream roll.

<<Example of Embodiment>>

[Conveying Apparatus for Lead Frame Base]

A conveying apparatus 1 for a lead frame base LF (strip-shaped thin plate) will be described with reference to Fig. 1. A lead frame is thin-plate metal and is used as internal wiring of a semiconductor package such as an integrated circuit (IC) or a large scale integration (LSI). The lead frame is used to be connected to external wiring. The lead frame is produced by a method such as etching or stamping. Etching is a method of dissolving metal with chemicals. Stamping is a method of performing stamping from metal with a mold. The lead frame base LF is a base processed to produce a lead frame. The conveying apparatus 1 is provided in a production line (not illustrated) of a lead frame and is an apparatus for conveying the lead frame base LF in a production step of a lead frame.

For example, when a lead frame shape is formed by etching, the following steps are performed in the production line (not illustrated) of the lead frame. First, a surface conditioning step is performed. In this step, a surface of a metal material is delipidated and washed. Then, a resist coating step is performed. In this step, the metal material is subjected to, for example, application of a photosensitive resist, attachment of a dry film resist, formation of a resist by electrodeposition, or a soak in a resist solution and dry. Then, a printing and exposure step is performed. In this step, a lead frame pattern is transferred to the metal material. Then, a developing step is

performed. In this step, a resist unexposed portion of the metal material is washed away. Then, an etching step is performed. In this step, an etching process for corroding metal is performed. Then, a resist peeling step is performed. In this step, the resist is peeled. Finally, a washing step is performed. In this step, the metal material is washed and dried.

The conveying apparatus 1 is, for example, an apparatus for conveying the lead frame base LF that is metal material when the above washing step is completed. In this embodiment, description will be made by considering the conveying apparatus 1 to be an apparatus for conveying the lead frame base LF when the above washing step is completed. However, the conveying apparatus 1 is not limited thereto and may be an apparatus for conveying the lead frame base in another step included in the production step of a lead frame.

As illustrated in Fig. 1, the conveying apparatus 1 includes an upstream roll 20, a speed control motor 21 (first motor), intermediate rolls 25 and 26, a downstream roll 30, a torque control motor 31 (tension application device, second motor), a winding device 50, a winding motor 55, detection sensors 61, 62, 63, and 64, and a controller 100. The conveying apparatus 1 conveys the lead frame base LF along a predetermined conveyance route TR. In the conveyance route TR, the upstream roll 20, the intermediate rolls 25 and 26, the downstream roll 30, and the winding device 50 are disposed in this order from an upstream side to a downstream side. That is, the lead frame base LF is conveyed by the upstream roll 20, the intermediate rolls 25 and 26, and the downstream roll 30 in order and is wound by the winding device 50.

In the following description, expressions "up" and "down" mean "up" and "down" in a direction vertical to a surface on which the conveying apparatus is provided. Note that expressions "upstream" and "downstream" mean "upstream" and

"downstream" in the conveyance route TR.

The upstream roll 20 is a roll that is provided in the conveyance route TR of the lead frame base LF and on which the lead frame base LF is wound. A rotation axis of the upstream roll 20 extends substantially in parallel to a rotation axis of the winding device 50. The lead frame base LF is wound by a half or more turn on the upstream roll 20. More specifically, the lead frame base LF conveyed from an upstream side and from a position above the upstream roll 20 is wound on the upstream roll 20. The lead frame base LF is wound by at least a half or more turn on a lower portion of the upstream roll 20 (a side surface of lower half of the upstream roll 20). The upstream roll 20 rotates at a constant speed on the basis of driving force (rotational force) applied by the speed control motor 21, thereby conveying the lead frame base LF downstream.

The speed control motor 21 is a motor that applies driving force (rotational force) to the upstream roll 20 to rotate the upstream roll 20 at a constant speed. With such rotation, the speed control motor 21 moves the lead frame base LF wound on the upstream roll 20, the intermediate rolls 25 and 26, and the downstream roll 30 to a downstream side of the conveyance route TR. The speed control motor 21 applies driving force to the upstream roll 20 under control of the controller 100. The speed control motor 21 can be various motors capable of controlling speed. The speed control motor 21 can be, for example, a synchronous motor or a servomotor.

The intermediate rolls 25 and 26 are rolls that are positioned on a downstream side of the upstream roll 20 and on an upstream side of the downstream roll 30 and on which the lead frame base LF is wound. Rotation axes of the intermediate rolls 25 and 26 extend substantially in parallel to the rotation axis of the winding device 50.

The intermediate roll 25 is disposed on the downstream side of the upstream roll 20 and above (immediately above) the upstream roll 20. The lead frame base LF

is wound by a half or more turn on the intermediate roll 25. More specifically, the lead frame base LF conveyed by the upstream roll 20 from the upstream side and from a position below the intermediate roll 25 is wound on the intermediate roll 25. The lead frame base LF is wound by at least a half or more turn on an upper portion of the intermediate roll 25 (a side surface of upper half of the intermediate roll 25). The intermediate roll 25 rotates at a constant speed to follow the lead frame base LF conveyed from the upstream roll 20 (the lead frame base LF moving through the conveyance route TR), thereby conveying the lead frame base LF downstream.

The intermediate roll 26 is disposed on a downstream side of the intermediate roll 25 and is below the intermediate roll 25. More specifically, the intermediate roll 26 is not disposed immediately below the intermediate roll 25 but is disposed below the intermediate roll 25 and at a position closer to the winding device 50 than the intermediate roll 25. The position closer to the winding device 50 than the intermediate roll 25 is a position at which a separation distance between the winding device 50 and the intermediate roll 26 is shorter than a separation distance between the winding device 50 and the intermediate roll 25. The lead frame base LF is wound by a half or more turn on the intermediate roll 26. More specifically, the lead frame base LF conveyed by the intermediate roll 25 from the upstream side and from a position above the intermediate roll 26 is wound on the intermediate roll 26. The lead frame base LF is wound by at least a half or more turn on a lower portion of the intermediate roll 26 (a side surface of lower half of the intermediate roll 26). The intermediate roll 26 rotates at a constant speed to follow the lead frame base LF conveyed from the intermediate roll 25 (the lead frame base LF moving through the conveyance route TR), thereby conveying the lead frame base LF downstream.

The downstream roll 30 is a roll that is positioned on the downstream side of

the upstream roll 20 in the conveyance route TR and on which the lead frame base LF is wound. More specifically, the downstream roll 30 is disposed on a downstream side of the intermediate roll 26 and above (immediately above) the intermediate roll 26. A rotation axis of the downstream roll 30 extends substantially in parallel to the rotation axis of the winding device 50. The lead frame base LF is wound by a half or more turn on the downstream roll 30. More specifically, the lead frame base LF conveyed by the intermediate roll 26 from the upstream side and from a position below the downstream roll 30 is wound on the downstream roll 30. The lead frame base LF is wound by at least a half or more turn on an upper portion of the downstream roll 30 (a side surface of upper half of the downstream roll 30). The downstream roll 30 rotates with constant torque on the basis of driving force (rotational force) applied by the torque control motor 31, thereby conveying the lead frame base LF downstream.

The torque control motor 31 is a motor that applies driving force (rotational force) to the downstream roll 30 to rotate the downstream roll 30 with constant torque. The torque control motor 31 performs control so that the downstream roll 30 rotates with constant torque, thereby applying constant tension to the lead frame base LF wound on the downstream roll 30. The torque control motor 31 applies driving force to the downstream roll 30 under control of the controller 100. The torque control motor 31 can be various motors capable of controlling torque.

The winding device 50 is a roll that is positioned on a downstream side of the downstream roll 30 in the conveyance route TR and winds the lead frame base LF and is, for example, a PAULOWNIA reel. The winding device 50 rotates on the basis of driving force (rotational force) applied by the winding motor 55, thereby winding the lead frame base LF. Note that the lead frame base LF hangs down in a hoop shape in a section between the downstream roll 30 and the winding device 50 in the conveyance

route TR.

The winding motor 55 is a motor that applies driving force (rotational force) to the winding device 50 to rotate the winding device 50. The winding motor 55 applies driving force to the winding device 50 under control of the controller 100 based on detection results of the detection sensors 61, 62, 63, and 64 (details will be described below).

The detection sensors 61, 62, 63, and 64 are provided in the section between the downstream roll 30 and the winding device 50 in the conveyance route TR. The detection sensors 61, 62, 63, and 64 detect a hanging state of the lead frame base LF that hangs down in a hoop shape in the section. The detection sensors 61, 62, 63, and 64 can be, for example, optical electronic sensors. The detection sensors 61 and 63 are, for example, projectors. In this case, the detection sensor 62 is an optical receiver that receives a light beam from the detection sensor 61. Further, the detection sensor 64 is an optical receiver that receives a light beam from the detection sensor 63. The pair of detection sensors 61 and 62 is disposed, for example, below the pair of detection sensors 63 and 64. The pair of detection sensors 61 and 62 is disposed at a first height. The first height is a height at which the lead frame base LF does not desirably hang down toward a position below the first height. That is, the first height is a lower limit of a desired range of hanging down of the lead frame base LF. Winding is started by the winding device 50 at a timing at which the detection sensors 61 and 62 detect the lead frame base LF (details will be described below). Further, the pair of detection sensors 63 and 64 is disposed at a second height in order to maintain a hoop of the lead frame base LF. The second height is a minimum height at which the lead frame base LF desirably hangs down. That is, the second height is an upper limit of the desired range of hanging down of the lead frame base LF. Winding is terminated by the

winding device 50 at a timing at which the detection sensors 63 and 64 do not detect the lead frame base LF (details will be described below).

The controller 100 generates, for example, an instruction signal for operating the speed control motor 21 and the torque control motor 31 on the basis of a program recorded on a recording medium (not illustrated) or operation input from an operator and transmits the instruction signal to the speed control motor 21 and the torque control motor 31. That is, the controller 100 transmits an instruction signal for starting and terminating application of driving force to the speed control motor 21 and also transmits an instruction signal for specifying a rotational speed to the speed control motor 21. Further, the controller 100 transmits an instruction signal for starting and terminating application of driving force to the torque control motor 31 and also transmits an instruction signal for specifying torque to the torque control motor 31.

Further, the controller 100 generates, for example, an instruction signal for operating the winding motor 55 on the basis of a program recorded on a recording medium (not illustrated), operation input from an operator, or detection results from the detection sensors 61, 62, 63, and 64 and transmits the instruction signal to the winding motor 55. That is, in a case where the controller 100 receives detection results showing that the lead frame base LF has been detected from the detection sensors 61 and 62, the controller 100 transmits an instruction signal for instructing that operation be started to the winding motor 55. Further, in a case where the controller 100 receives detection results showing that the lead frame base LF has not been detected from the detection sensors 63 and 64, the controller 100 transmits an instruction signal for instructing that the operation be terminated to the winding motor 55.

Next, conveyance of the lead frame base LF in the conveyance route TR will be described.

The lead frame base LF, which has been washed and dried in the washing step, first arrives at the upstream roll 20. Specifically, the lead frame base LF is conveyed downward along a guide roll 10 disposed on the upstream side of and above the upstream roll 20. Thereafter, the lead frame base LF is wound on the upstream roll 20 from a side surface of the upstream roll 20, the side surface being further from the winding device 50. The lead frame base LF is conveyed while being wound by at least a half or more turn on the lower portion of the upstream roll 20 (the side surface of the lower half of the upstream roll 20). The lead frame base LF separates from the upstream roll 20 on a side surface of the upstream roll 20, the side surface being closer to the winding device 50.

Then, the lead frame base LF is conveyed toward a side surface of the intermediate roll 25, the side surface being further from the winding device 50. The lead frame base LF is wound on the intermediate roll 25 from the side surface of the intermediate roll 25, the side surface being further from the winding device 50. The lead frame base LF is conveyed while being wound by at least a half or more turn on the upper portion of the intermediate roll 25 (the side surface of the upper half of the intermediate roll 25). The lead frame base LF separates from the intermediate roll 25 on a side surface of the intermediate roll 25, the side surface being closer to the winding device 50.

As described above, the lead frame base LF is conveyed while being wound on a lower portion of the upstream roll 20 from the side surface of the upstream roll 20, the side surface being further from the winding device 50, to the side surface thereof, the side surface being closer to the winding device 50. Thereafter, the lead frame base LF is conveyed while being wound on an upper portion of the intermediate roll 25 from the side surface of the intermediate roll 25, the side surface being further from the winding

device 50, to the side surface thereof, the side surface being closer to the winding device 50. That is, the lead frame base LF is conveyed to draw an S-shaped track in a route regarding the upstream roll 20 and the intermediate roll 25 in the conveyance route TR.

Then, the lead frame base LF is conveyed toward a side surface of the intermediate roll 26, the side surface being further from the winding device 50. The lead frame base LF is wound on the intermediate roll 26 from the side surface of the intermediate roll 26, the side surface being further from the winding device 50. The lead frame base LF is conveyed while being wound by at least a half or more turn on the lower portion of the intermediate roll 26 (the side surface of the lower half of the intermediate roll 26). The lead frame base LF separates from the intermediate roll 26 on a side surface of the intermediate roll 26, the side surface being closer to the winding device 50. As described above, the lead frame base LF is conveyed to draw an S-shaped track also in a route regarding the intermediate roll 25 and the intermediate roll 26 in the conveyance route TR.

Then, the lead frame base LF is conveyed toward a side surface of the downstream roll 30, the side surface being further from the winding device 50. The lead frame base LF is wound on the downstream roll 30 from the side surface of the downstream roll 30, the side surface being further from the winding device 50. The lead frame base LF is conveyed while being wound by at least a half or more turn on the upper portion of the downstream roll 30 (the side surface of the upper half of the downstream roll 30). The lead frame base LF separates from the downstream roll 30 on a side surface of the downstream roll 30, the side surface being closer to the winding device 50. As described above, the lead frame base LF is conveyed to draw an S-shaped track also in a route regarding the intermediate roll 26 and the downstream roll 30 in the conveyance route TR.

The lead frame base LF that has separated from the downstream roll 30 is conveyed toward the winding device 50. In the section between the downstream roll 30 and the winding device 50, the lead frame base LF hangs down in a hoop shape. Note that a guide roll 40 is provided in the section. The guide roll 40 guides the hoop-shaped lead frame base LF (performs positioning of the lead frame base LF).
[Effects]

Next, effects of the conveying apparatus 1 according to this embodiment will be described while being compared with conveying apparatuses according to comparison examples.

A conveying apparatus 200 according to a comparison example, which is illustrated in Fig. 4, has been conventionally known as a conveying apparatus for conveying a lead frame base. In the conveying apparatus 200, two upper and lower rolls 201 and 202 clamp a lead frame base LF to convey the lead frame base LF. When a configuration in which the lead frame base LF is clamped by the two upper and lower rolls 201 and 202 is employed, it is possible to convey the lead frame base LF at a constant speed. This makes it possible to uniformly perform various kinds of processes such as an etching process on the lead frame base LF. Meanwhile, the configuration in which the lead frame base LF is clamped by the two upper and lower rolls 201 and 202 may deform the lead frame base LF.

A conveying apparatus 300 according to a comparison example, which is illustrated in Fig. 5, is, for example, a conveying apparatus for conveying a lead frame base LF without deforming the lead frame base LF. The conveying apparatus 300 includes guide rolls 301, 302, and 303, a winding device 304, and a weight 305. In the conveying apparatus 300, a lead frame base LF is wound on the guide rolls 301, 302, and 303. The weight 305 is provided between the guide roll 303 and the winding

device 304. When the weight 305 applies force to the lead frame base LF in a downward direction due to gravity, frictional force (tension) between the guide rolls 302 and 303 and the lead frame base LF is increased. In this state, the lead frame base LF is conveyed. With such a configuration, it is possible to convey the lead frame base LF without using a configuration in which the lead frame base LF is clamped by rolls.

However, in the conveying apparatus 300, tension is applied to the lead frame base LF by the weight 305 provided between the guide roll 303 and the winding device 304. Therefore, a portion (portion to be wound) of the lead frame base LF before the winding device 304 is in a fully stretched state (in which no hoop is formed). In a case where no hoop is formed, the lead frame base LF may be brought into contact with a side plate of the winding device 304 and dust may be generated in the winding device 304 in a case where, for example, the lead frame base LF meanders. Further, lead frame bases LF are connected in a lot unit via a tape. Therefore, when winding is completed, it is necessary to cut apart the lead frame bases LF at portions connected via the tape. Regarding this, in a case where no hoop is formed in the lead frame base LF, the cutting operation becomes difficult.

Further, a conveying apparatus 400 according to a comparison example, which is illustrated in Fig. 6, is, for example, a conveying apparatus for conveying a lead frame base LF without deforming the lead frame base LF. The conveying apparatus 400 includes guide rolls 401, 402, 403, and 405 and a winding device 404. In the conveying apparatus 400, a lead frame base LF is wound on the guide rolls 401, 402, 403, and 405. The winding device 404 winds the lead frame base LF by using driving force from a torque motor or the like. With this, tension is applied to the lead frame base LF, and the lead frame base LF is conveyed by this tension. Also with such a configuration, it is possible to convey the lead frame base LF without using a

configuration in which the lead frame base LF is clamped by rolls. However, in the conveying apparatus 400, the lead frame base LF is conveyed by tension from the winding device 404. Therefore, a portion (portion to be wound) of the lead frame base LF before the winding device 404 is in a fully stretched state (in which no hoop is formed), which is similar to the case of the conveying apparatus 300. Therefore, the conveying apparatus 400 has a problem similar to that of the conveying apparatus 300.

Thus, in each of the conveying apparatuses 200, 300, and 400 according to the comparison examples, it is difficult to achieve both conveying the lead frame base LF at a constant speed while restraining deformation thereof and maintaining a hoop in a portion to be wound.

On the contrary, the conveying apparatus 1 according to this embodiment includes the upstream roll 20, the downstream roll 30, the winding device 50, the speed control motor 21, and the torque control motor 31. The upstream roll 20 is provided in the conveyance route TR of the lead frame base LF, and the lead frame base LF is wound thereon. The downstream roll 30 is positioned on the downstream side of the upstream roll 20 in the conveyance route TR. The lead frame base LF is wound on the downstream roll 30. The winding device 50 is positioned on the downstream side of the downstream roll 30 in the conveyance route TR and winds the lead frame base LF. The speed control motor 21 rotates the upstream roll 20 at a constant speed, thereby moving the lead frame base LF wound on the upstream roll 20 and the downstream roll 30 toward the downstream side of the conveyance route TR. The torque control motor 31 controls torque of the downstream roll 30 to apply constant tension to the lead frame base LF wound on the downstream roll 30.

In such a conveying apparatus 1, the upstream roll 20 and the downstream roll 30 are provided on an upstream side of the winding device 50. Then, the upstream roll

20 is rotated by the speed control motor 21 at a constant speed, and therefore the lead frame base LF wound on the upstream roll 20 and the downstream roll 30 is moved to the downstream side of the conveyance route TR. Therefore, the lead frame base LF can be conveyed by the upstream roll 20 rotating at a constant speed.

Further, in the conveying apparatus 1, the torque control motor 31 applies constant tension to the lead frame base LF wound on the downstream roll 30. Herein, for example, it is assumed that the tension applied to the lead frame base LF is decreased for some reason in the route to the downstream roll 30. In this case, the lead frame base LF may be loosened in the route to the downstream roll 30. Further, it is assumed that the tension applied to the lead frame base LF is increased for some reason in the route to the downstream roll 30. In this case, the lead frame base LF may be moved to slide on the roll.

As described above, even if a rotational speed of the roll is constant, the lead frame base LF may not be conveyed at a constant speed in a state in which the tension to the lead frame base LF is not controlled. Regarding this point, in the conveying apparatus 1, the torque control motor 31 applies constant tension to the lead frame base LF wound on the downstream roll 30. This makes it possible to restrain the tension applied to the lead frame base LF from being decreased and increased. Consequently, it is possible to convey the lead frame base LF at a constant speed.

As described above, the conveying apparatus 1 can convey the lead frame base LF at a constant speed without clamping the lead frame base LF with two upper and lower rolls, i.e., without deforming the lead frame base LF. Further, the lead frame base LF is conveyed by the upstream roll 20 and the downstream roll 30 without depending on tension from the winding device 50. This makes it possible to provide a hoop in the lead frame base LF in the section between the downstream roll 30 and the

winding device 50.

Thus, according to the conveying apparatus 1, it is possible to convey the lead frame base LF at a constant speed while restraining deformation thereof and maintain a hoop in a portion to be wound of the lead frame base LF.

Herein, a chemical solution used in a prior process remains on, for example, the above connection portion between the lead frame bases LF in a lot unit in some cases. For example, in a case where the configuration in which the lead frame base LF is clamped by the two upper and lower rolls 201 and 202 is employed as in the conveying apparatus 200 according to the comparison example, a chemical solution remaining on the above connection portion may be squeezed and the chemical solution may be attached to the rolls, and therefore the chemical solution may be transferred from the rolls to the lead frame base LF. Regarding this point, transfer of a chemical solution to the lead frame base LF is not problematic in the conveying apparatus 1 that does not employ the configuration in which the lead frame base LF is clamped by the two upper and lower rolls 201 and 202.

Further, in the conveying apparatus 1, the lead frame base LF is wound on the upper side of the downstream roll 30. In a case where the lead frame base LF is loosened for some reason, the lead frame base LF wound on the roll may hang down toward a position below the roll due to gravity. In this case, even in a case where torque control is performed, tension may not be appropriately applied to the hanging lead frame base LF. Regarding this point, in the conveying apparatus 1, the lead frame base LF is wound on the upper portion of the downstream roll 30 whose torque is controlled by the torque control motor 31. With this, even if the lead frame base LF is loosened, hanging down of the lead frame base LF due to gravity does not easily occur (the lead frame base LF is not easily separated from the downstream roll 30). This

makes it possible to appropriately apply tension to the lead frame base LF.

As described above, in the conveying apparatus 1, it is possible to restrain the lead frame base LF wound on the roll (the downstream roll 30) whose torque is controlled from being hanging down due to gravity. However, in some cases, tension is not appropriately applied to the lead frame base LF wound on the upper portion of the downstream roll 30 for some reason. In this case, when the torque control motor 31 rotates the roll at a high speed in order to obtain a set torque, the lead frame base LF may slide from the roll (tension may not be appropriately applied to the lead frame base LF). In order to avoid the above state, in the conveying apparatus 1, a predetermined speed limit (an upper limit value of a speed) may be set in the torque control motor 31. In this case, in a case where tension is not applied to the lead frame base LF from the downstream roll 30, a rotational speed of the torque control motor 31 is controlled to be gradually increased but be less than a predetermined upper limit value. Then, in a case where the rotational speed of the torque control motor 31 becomes the upper limit value, the rotational speed of the torque control motor 31 is controlled to be gradually decreased. With such a control, it is possible to apply tension to the lead frame base LF from the downstream roll 30 again. Thereafter, the rotational speed of the torque control motor 31 is controlled to be gradually increased, and normal torque control is restarted.

Further, the conveying apparatus 1 further includes the intermediate rolls 25 and 26. The intermediate rolls 25 and 26 are positioned on the downstream side of the upstream roll 20 and on the upstream side of the downstream roll 30. The lead frame base LF is wound on the intermediate rolls 25 and 26.

Fig. 2 is diagrams illustrating tension applied to the lead frame base LF wound on the rolls in an S shape (tension of S-shaped rolls). The inventors prepared two rolls

71 and 72 as illustrated in Fig. 2A. The inventors wound the lead frame base LF on those rolls 71 and 72 in an S shape. Further, the inventors measured tension applied to the lead frame base LF while changing a load applied to a hoop shape of the lead frame base LF on a downstream side.

As illustrated in Fig. 2B, even in a case where the load was set to 0 (only hoop's own weight), tension of 0.9 kgf was generated by frictional force between the lead frame base LF and the rolls 71 and 72. Further, in a case where a load 80 of 0.6 kg was applied to the hoop portion, the above frictional force was increased and tension of 6 kgf was generated. Furthermore, in a case where the load 80 of 1.05 kg was applied to the hoop portion, the above frictional force was further increased and tension of 9.5 kgf was generated. From this, the inventors found that tension that is about ten times as much as an applied load is obtained by frictional force of the S-shaped rolls.

Two sets of S-shaped rolls are provided in the conveying apparatus 1 including the intermediate rolls 25 and 26. As described above, even in a case where a load is set to 0, tension of 0.9 kgf is generated by frictional force of a single set of S-shaped rolls. Therefore, in a case where two sets of S-shaped rolls are provided, a load of 0.9 kgf is applied to the second set of S-shaped rolls. Thus, it is considered that tension of $0.9 \text{ kgf} \times 10 = 9.0 \text{ kgf}$ is generated.

In the above conveying apparatus 1 for conveying the lead frame base LF, when tension of, for example, 7.5 kgf or more is applied to the lead frame base LF, it is possible to appropriately convey the lead frame base LF. Therefore, the conveying apparatus 1, which includes two sets of S-shaped rolls because the intermediate rolls 25 and 26 are provided, can obtain sufficient tension to convey the lead frame base LF. That is, because the intermediate rolls 25 and 26 are provided, the rolls and the lead frame base LF are in contact with each other in a wide range, and therefore frictional

force generated by this contact is increased. Consequently, the conveying apparatus 1 can obtain necessary conveyance force with a simple configuration.

Further, in the conveying apparatus 1, the lead frame base LF is wound by a half or more turn on the upstream roll 20 and the downstream roll 30.

Fig. 3 is a diagram illustrating a relationship between a winding angle of the lead frame base LF on a roll and frictional force (conveyance force) between the roll and the lead frame base LF. When the winding angle is set to θ , the frictional force is denoted by $\epsilon\mu\theta$. A relationship between the winding angle θ and the frictional force $\epsilon\mu\theta$ is shown by a graph of Fig. 3. The frictional force is exponentially increased as the winding angle is increased. Therefore, for example, it is possible to sufficiently increase frictional force by sufficiently increasing the winding angle to, for example, 180° or more (winding the lead frame base LF by a half or more turn on the roll). Consequently, it is possible to obtain desired conveyance force.

Further, in the conveying apparatus 1, the intermediate rolls 25 and 26 rotate to follow the lead frame base LF moving through the conveyance route TR. For example, in a case where a motor for rotating the intermediate rolls 25 and 26 is additionally provided, it is necessary to completely synchronize the motor for rotating the intermediate rolls 25 and 26 and the speed control motor 21 in order to rotate the intermediate rolls 25 and 26 and the upstream roll 20 at the same speed. In a case where those motors are not synchronized, for example, the lead frame base LF may be moved to slide on the roll. Regarding this point, in the conveying apparatus 1, the intermediate rolls 25 and 26 are configured to rotate to follow the lead frame base LF. With this, the intermediate rolls 25 and 26 and the upstream roll 20 are easily rotated at the same speed. Consequently, it is possible to restrain the above slide or the like of the lead frame base LF.

[Modification examples]

Hereinabove, the embodiment has been described. However, the conveying apparatus according to the present disclosure is not limited to the above embodiment. For example, in the above embodiment, the torque control motor 31 for controlling torque of the downstream roll has been described as a tension application device. However, the tension application device is not limited to the torque control motor 31. Specifically, as in a conveying apparatus 1A illustrated in Fig. 7, a roll 99 provided on a downstream roll 30A may function as the tension application device. The lead frame base LF is interposed between the roll 99 and the downstream roll 30A. With this, the roll 99 applies constant tension to the lead frame base LF wound on the downstream roll 30A.

Further, in the above embodiment, the intermediate rolls 25 and 26 are provided in the conveyance route TR. However, for example, as in the conveying apparatus 1A illustrated in Fig. 7, sufficient conveyance force can be obtained by frictional force between the upstream roll 20A and the downstream roll 30A and the lead frame base LF in some cases. In this case, no intermediate roll may be provided.

Further, the conveying apparatus may be configured to convey a thin plate (e.g., resin gauge) other than the lead frame base LF. Further, the first motor serving as a speed control motor may be configured to rotate not only the upstream roll but also the downstream roll at a constant speed. Alternatively, the first motor may be configured to rotate the downstream roll at a constant speed instead of the upstream roll. Further, for example, in the conveying apparatus 1 illustrated in Fig. 1, the intermediate roll 25 is positioned above the upstream roll 20 in the vertical direction, and the lead frame base LF is wound on the upper side of the intermediate roll 25. A speed control motor may be provided in this intermediate roll 25. When the lead frame base is wound on

the upper portion of the intermediate roll 25 whose speed is controlled by the speed control motor, hanging down of the lead frame base LF due to gravity does not easily occur (the lead frame base LF is not easily separated from the roll).

The foregoing detailed description has been presented for the purposes of illustration and description. Many modifications and variations are possible in light of the above teaching. It is not intended to be exhaustive or to limit the subject matter described herein to the precise form disclosed. Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims appended hereto.

CLAIMS

1. A conveying apparatus, comprising:
 - an upstream roll provided in a conveyance route of a strip-shaped thin plate and on which the thin plate is wound;
 - a downstream roll positioned on a downstream side of the upstream roll in the conveyance route and on which the thin plate is wound;
 - a winding device positioned on a downstream side of the downstream roll in the conveyance route and configured to wind the thin plate;
 - a first motor configured to rotate at least one of the upstream roll and the downstream roll at a constant speed to move the thin plate wound on the upstream roll and the downstream roll to a downstream side of the conveyance route; and
 - a tension application device configured to apply constant tension to the thin plate wound on the downstream roll.
2. The conveying apparatus according to claim 1, wherein:
 - the first motor is configured to rotate the upstream roll at a constant speed; and
 - the tension application device is a second motor that controls torque of the downstream roll to apply constant tension to the thin plate.
3. The conveying apparatus according to claim 2, wherein
 - the downstream roll is configured so that the thin plate is wound on an upper side of the roll.
4. The conveying apparatus according to any one of claims 1 to 3, wherein
 - the upstream roll and the downstream roll are configured so that the thin plate

is wound by a half or more turn on each roll.

5. The conveying apparatus according to any one of claims 1 to 4, further comprising

an intermediate roll positioned on the downstream side of the upstream roll and on an upstream side of the downstream roll and on which the thin plate is wound.

6. The conveying apparatus according to claim 5, wherein
the intermediate roll is configured to rotate to follow the thin plate moving through the conveyance route.

7. A method of conveying a thin plate, comprising:

rotating at least one of an upstream roll on which a strip-shaped thin plate is wound and a downstream roll disposed on a downstream side of the upstream roll and on which the thin plate is wound at a constant speed to move the thin plate to a downstream side of a conveyance route;

applying constant tension to the thin plate wound on the downstream roll; and
winding the thin plate on a downstream side of the downstream roll.