

Description

Title of Invention:

DUST COLLECTION APPARATUS, RESIN MOLDING APPARATUS, AND
RESIN MOLDED PRODUCT MANUFACTURING METHOD

Technical Field

[0001]

The present invention relates to a dust collection apparatus, a resin molding apparatus, and a resin molded product manufacturing method.

Background Art

[0002]

Hitherto, as shown in Patent Literature 1, dust has been collected by a dust collection apparatus in a resin molding apparatus using a transfer molding method. The resin molding apparatus has a configuration in which a dust collection port is provided in a resin supplying module that supplies a resin tablet and dust is collected from the dust collection port.

Citation List

Patent Literature

[0003]

Patent Literature 1: Japanese Patent Laid-Open No. 2019-202495

Summary of Invention

Technical Problem

[0004]

The proportion of the power consumption of the dust collection apparatus in the power consumption of the resin molding apparatus is not small.

[0005]

However, an air moving apparatus of the dust collection apparatus in the related-art resin molding apparatus is operated at a constant rotation speed regardless of the section dust of which is collected, the dust collection timing, or the like.

[0006]

Thus, the present invention has been made in order to solve the problem described above, and a main object thereof is to reduce power consumption of a dust collection apparatus used in a resin molding apparatus.

Solution to Problem

[0007]

In other words, a dust collection apparatus according to the present invention is configured to collect dust from one or a plurality of dust collection ports provided in a resin molding apparatus. The dust

collection apparatus includes an air moving apparatus driven by a motor, and an inverter configured to control the rotation speed of the motor. The dust collection apparatus is configured to collect dust from a dust collection port provided in a molding die cleaner portion configured to clean a molding die of the resin molding apparatus. In the dust collection apparatus, the inverter is configured to control the rotation speed of the motor to be a first rotation speed when the molding die is cleaned by the molding die cleaner portion, and allow inertial rotation of the motor by releasing electrical connection with the motor after the cleaning of the molding die by the molding die cleaner portion.

Advantageous Effect of Invention

[0008]

According to the present invention configured as above, it becomes possible to reduce the power consumption of the dust collection apparatus used in the resin molding apparatus.

Brief Description of Drawings

[0009]

[Figure 1] Figure 1 is a plan view schematically illustrating a configuration of a resin molding apparatus according to one embodiment of the present invention.

[Figure 2] Figure 2 is a schematic diagram illustrating a configuration of a dust collection apparatus of the same embodiment.

[Figure 3] Figure 3 is a schematic diagram showing control content of a motor of an air moving apparatus in the same embodiment.

[Figure 4] Figure 4 is a schematic diagram showing motor rotation speed and power consumption in each mode.

[Figure 5] Figure 5 is a schematic diagram showing a dust collection operation, motor rotation speed, and power consumption in a resin molding operation of the resin molding apparatus in the same embodiment.

Description of Embodiment

[0010]

Next, technologies according to the present invention are described in more detail by means of examples. It is to be noted that the present invention is not limited to the following technologies.

[0011]

A dust collection apparatus of Technology 1 according to the present invention is configured to collect dust from one or a plurality of dust collection ports provided in a resin molding apparatus. The dust collection apparatus includes an air moving apparatus driven by a motor, and an inverter configured to control the rotation speed of the motor. The dust collection

apparatus is configured to collect dust from a dust collection port provided in a molding die cleaner portion configured to clean a molding die of the resin molding apparatus. In the dust collection apparatus, the inverter is configured to control the rotation speed of the motor to be a first rotation speed when the molding die is cleaned by the molding die cleaner portion, and allow inertial rotation of the motor by releasing electrical connection with the motor after the cleaning of the molding die by the molding die cleaner portion. [0012]

With this dust collection apparatus, inertial rotation of the motor is allowed by releasing the electrical connection with the motor when the rotation speed is to be dropped from the first rotation speed. Therefore, it becomes possible to reduce the power consumption of the dust collection apparatus used in the resin molding apparatus. In particular, when the molding dies are cleaned by the molding die cleaner portion, a large amount of dust is formed. Thus, when the molding dies are cleaned, the inverter controls the rotation speed of the motor to be the first rotation speed. Therefore, it becomes possible to exhibit a high dust collection capability and efficiently collect dust. Deceleration control is unnecessary when the rotation speed is to be dropped from the first rotation speed by the inverter, and it becomes possible to alleviate or

eliminate handling of regenerative energy generated in the deceleration control. As a result, it becomes possible to downsize or eliminate components such as a resistor for absorbing regenerative energy.

[0013]

Some resin molding apparatuses include an unnecessary-resin removing mechanism that removes unnecessary resin included in resin molded products. Some resin molding apparatuses have a molded product cleaner portion that cleans the resin molded products before or after unnecessary resin is removed by the unnecessary-resin removing mechanism. Therefore, in a dust collection apparatus of Technology 2 according to the present invention, in addition to the configuration of Technology 1 described above, the dust collection apparatus is desired to be configured to collect dust from a dust collection port provided in a molded product cleaner portion configured to clean a resin molded product. In the dust collection apparatus, the inverter is desired to be configured to control the rotation speed of the motor to be the first rotation speed when the resin molded product is cleaned by the molded product cleaner portion, and allow inertial rotation of the motor by releasing the electrical connection with the motor after the cleaning of the resin molded product by the molded product cleaner portion.

A large amount of dust may be formed when the resin molded product is cleaned by the molded product cleaner portion, and the inverter controls the rotation speed of the motor to be the first rotation speed when the resin molded product is cleaned. Therefore, it becomes possible to exhibit a high dust collection capability and efficiently collect dust. As a result, it becomes possible to improve the quality of the resin molded products from which unnecessary resin has been removed.

[0014]

In a dust collection apparatus of Technology 3 according to the present invention, in addition to the configuration of Technology 1 or 2 described above, the inverter is desired to be configured to switch the rotation speed of the motor between the first rotation speed and a second rotation speed that is a rotation speed lower than the first rotation speed and allow inertial rotation of the motor by releasing the electrical connection with the motor when the first rotation speed is switched to the second rotation speed.

With this configuration, it becomes possible to rotate the motor at the first rotation speed when a high dust collection capability is required and rotate the motor at the second rotation speed when a high dust collection capability is not required. As a result, it becomes possible to suitably collect dust in accordance with the section dust of which is collected, the dust

collection timing, or the like and reduce the power consumption of the dust collection apparatus. When the first rotation speed is switched to the second rotation speed, the electrical connection with the motor is released, and inertial rotation of the motor is allowed. Therefore, it becomes possible to reduce the power consumption at the time of switching to the second rotation speed.

[0015]

In a dust collection apparatus of Technology 4 according to the present invention, in addition to the configuration of Technology 3 described above, the inverter is desired to be configured to control the rotation speed of the motor to be the second rotation speed after the rotation speed of the motor reaches the second rotation speed by inertial rotation.

With this configuration, it is unnecessary to perform deceleration control from the first rotation speed to the second rotation speed by the inverter, and it becomes possible to alleviate or eliminate handling of regenerative energy generated in the deceleration control. As a result, it becomes possible to downsize or eliminate components such as a resistor for absorbing regenerative energy.

[0016]

A dust collection apparatus of Technology 5 according to the present invention, in addition to the

configuration of any one of Technologies 1 to 4 described above, is desired to be configured to collect dust from a dust collection port provided in a resin supplying module of the resin molding apparatus. In the dust collection apparatus, the inverter is desired to be configured to allow inertial rotation of the motor by releasing the electrical connection with the motor or control the rotation speed of the motor to be the second rotation speed when the inverter collects dust from the dust collection port provided in the resin supplying module.

The resin supplying module includes a resin send-out portion that accommodates a tablet-form resin material, for example, on the inside and sends out the tablet-form resin material, and a resin supplying portion that supplies the resin material sent out from the resin send-out portion to the resin convey mechanism, and a dust collection port is provided in each of those portions. When dust is collected with a high dust collection capability when dust is collected from the dust collection ports, there is a fear that the supply of the resin material may be hindered. Therefore, by allowing inertial rotation of the motor or controlling the rotation speed of the motor to be the second rotation speed when dust is collected from the dust collection ports of the resin supplying module, it becomes possible to collect dust without hindering the supply of the

resin material and to reduce the power consumption of the dust collection apparatus.

[0017]

A dust collection apparatus of Technology 6 according to the present invention, in addition to the configuration of any one of Technologies 1 to 5 described above, is desired to include a connecting pipe that connects a plurality of the dust collection ports and the air moving apparatus to each other, and a switching mechanism that is provided in the connecting pipe and configured to switch the dust collection port that collects dust by the air moving apparatus.

With this configuration, it becomes possible to use a shared air moving apparatus for a plurality of dust collection ports and reduce the number of the air moving apparatuses. As a result, it becomes possible to reduce the power consumption of the dust collection apparatus.

[0018]

In a dust collection apparatus of Technology 7 according to the present invention, in addition to the configuration of Technology 6 described above, the rotation speed of the motor is desired to be set in correspondence with the dust collection port switched by the switching mechanism.

With this configuration, it becomes possible to control the rotation speed of the motor to be the first rotation speed when switching is performed to the dust

collection port of the molding die cleaner portion, the dust collection port of the unnecessary-resin removing portion, and the like, for example. When switching is performed to the dust collection ports of other parts, it is possible to allow inertial rotation of the motor or control the rotation speed of the motor to be the second rotation speed. Another rotation speed such as a third rotation speed may be set in addition to the first rotation speed and the second rotation speed.

[0019]

In a dust collection apparatus of Technology 8 according to the present invention, in addition to the configuration of any one of Technologies 1 to 7 described above, the inverter is desired to be configured to detect the rotation speed of the motor and restart energization of the motor based on the detected rotation speed when the inverter performs control of setting the motor to be at the first rotation speed from a state of inertial rotation.

With this configuration, the inverter detects the rotation speed of the motor in an inertial rotation state. Therefore, there is no need to separately provide a rotation sensor, and it becomes possible to simplify the configuration of the dust collection apparatus. Here, the inverter is conceived to have a current-detecting speed search function.

[0020]

A resin molding apparatus of Technology 9 according to the present invention includes a resin molding module configured to perform transfer molding of a resin material with respect to a molding target by a pair of molding dies, a molding die cleaner portion configured to clean the molding dies, and the dust collection apparatus according to any one of Technologies 1 to 8.

With this resin molding apparatus, it becomes possible to reduce the power consumption of the dust collection apparatus, and hence it becomes possible to reduce the power consumption in the resin molding apparatus in transfer molding. It becomes possible to suitably collect dust in accordance with the section dust of which is collected, the dust collection timing, or the like, and hence it becomes possible to improve the quality of the resin molded product.

[0021]

A resin molded product manufacturing method of Technology 10 according to the present invention is a resin molded product manufacturing method using the resin molding apparatus according to Technology 9. The resin molded product manufacturing method includes supplying a molding target and a resin material to the molding die, performing resin molding with respect to the molding target, and conveying a resin molded product that is resin-molded from the molding die.

With this resin molded product manufacturing method, it becomes possible to reduce the power consumption of the dust collection apparatus, and hence it becomes possible to reduce the manufacturing cost of the resin molded product. It becomes possible to suitably collect dust in accordance with the section dust of which is collected, the dust collection timing, or the like, and hence it becomes possible to improve the quality of the resin molded product.

[0022]

<One Embodiment of Present Invention>

Hereinafter, one embodiment of a resin molding apparatus according to the present invention is described with reference to the drawings.

It is to be noted that each of the figures described below is also schematically illustrated with appropriate omission or exaggeration for ease of understanding. The same components are denoted by the same reference symbols and description thereof is omitted, as appropriate.

[0023]

<1. Basic Configuration of Resin Molding Apparatus 100>

A resin molding apparatus 100 of the present embodiment manufactures resin molded products P by resin-sealing electronic components (not shown) mounted to substrates W that are molding targets by transfer molding using thermosetting resin materials J.

[0024]

Here, examples of the substrate W include a metal substrate, a resin substrate, a glass substrate, a ceramic substrate, a circuit board, a semiconductor substrate, a lead frame, a silicon wafer, and a glass wafer. Examples of the electronic component include electronic elements such as a semiconductor chip, a resistor element, and a capacitor element, or an electronic component in a form in which at least one of those electronic elements is resin sealed. The resin materials J is tablet-form resin in the present embodiment, but may be liquid resin, sheet-form resin, or powder-form resin (including granular resin), for example. The resin materials J may be a material having thermal plasticity.

[0025]

Specifically, as illustrated in Figure 1, the resin molding apparatus 100 includes, as components, a supplying module 2 that supplies the substrates W before resin molding (hereinafter referred to as "pre-molding substrates W") and the resin materials J, a resin molding module 3 that performs resin molding, and a conveying module 4 for conveying the substrates W after resin molding (hereinafter referred to as "resin molded products P"). Each of the supply module 2, the resin molding module 3, and the conveying module 4 that are components can be attached to and detached from other components and can be replaced.

[0026]

The resin molding apparatus 100 includes a conveying mechanism 5 (hereinafter referred to as a "loader 5") that conveys the pre-molding substrates W and the resin materials J supplied by the supplying module 2 to the resin molding module 3, and a conveying mechanism 6 (hereinafter referred to as an "unloader 6") that conveys the resin molded products P resin-molded by the resin molding module 3 to the conveying module 4.

[0027]

The supplying module 2 of the present embodiment is obtained by integrating a substrate supplying module 7 and a resin supplying module 8 with each other. The substrate supplying module 7 and the resin supplying module 8 may be separately provided.

[0028]

The substrate supplying module 7 has a substrate send-out portion 71 and a substrate supplying portion 72. The substrate send-out portion 71 sends out the pre-molding substrates W in a magazine to the substrate supplying portion 72. The substrate supplying portion 72 receives the pre-molding substrates W from the substrate send-out portion 71, aligns the received pre-molding substrates W in a predetermined direction, and transfers the pre-molding substrates W to the loader 5.

[0029]

The resin supplying module 8 has a resin send-out portion 81, a resin arranging portion 82, and a resin supplying portion 83. The resin send-out portion 81 is a so-called parts feeder and receives the resin materials J from a resin accommodating portion 84 such as a stocker and sends out the resin materials J to the resin arranging portion 82 by vibration. The resin arranging portion 82 receives the resin materials J from the resin send-out portion 81 and arranges the resin materials J in a line. The resin supplying portion 83 aligns a plurality of the arranged resin materials J at a time by the resin arranging portion 82 and transfers those arranged resin materials J to a resin holding portion 51 of the loader 5. The resin holding portion 51 of the loader 5 is provided in correspondence with a plurality of pots 11b formed in a lower molding die 11.

[0030]

Each resin molding module 3 has a press portion 1. Each press portion 1 has the lower molding die 11 that can be raised and lowered, an upper molding die 12 that is fixed above the lower molding die 11 so as to face the lower molding die 11, and a clamping mechanism 13 for clamping the lower molding die 11 and the upper molding die 12.

[0031]

In the lower molding die 11, a loading portion 11a on which the pre-molding substrates W conveyed by the

loader 5 are loaded is formed. In the lower molding die 11, a plurality of pots 11b in which the resin materials J conveyed by the loader 5 are loaded is formed. In each of the pots 11b of the lower molding die 11, a plunger (not shown) for injecting the melted resin materials J into cavities (not shown) formed in the lower molding die 11 and the upper molding die 12 is provided.

[0032]

The conveying module 4 has an unnecessary-resin removing mechanism 41, and a resin molded product housing portion 42. The unnecessary-resin removing mechanism 41 removes (performs a degating process of) unnecessary resin K from the resin molded products P (each including a product portion and the unnecessary resin K connected to the product portion). Specifically, the unnecessary-resin removing mechanism 41 has a stage portion 41a on which the resin molded products P are placed, and an unnecessary-resin removing portion 41b that removes the unnecessary resin K from the resin molded products P placed on the stage portion 41a. The resin molded product housing portion 42 houses the resin molded products P (product portions) unnecessary resin K of which has been removed by the unnecessary-resin removing mechanism 41.

[0033]

<2. Collection of Dust in Resin Molding Apparatus 100>

In the resin supplying module 8 of the present embodiment, as illustrated in Figure 1 and Figure 2, dust collection ports H1, H2, H3 for collecting dust are provided in the resin send-out portion 81, the resin arranging portion 82, and the resin accommodating portion 84, respectively. The dust collection apparatus 30 is connected to those dust collection ports H1, H2, H3 (see Figure 2).

[0034]

As illustrated in Figure 1 and Figure 2, a loader cleaner portion 85 that cleans the resin holding portion 51 of the loader 5 is provided in the resin supplying module 8. The loader cleaner portion 85 has a cleaning member 851 such as a brush that cleans the resin holding portion 51, and a dust collection port H4 for collecting dust caused by cleaning. The dust collection apparatus 30 is connected to the dust collection port H4 (see Figure 2).

[0035]

As illustrated in Figure 1 and Figure 2, the resin molding apparatus 100 of the present embodiment has a molding die cleaner portion 9 that cleans molding die surfaces of the lower molding die 11 and the upper molding die 12 after resin molding. The molding die cleaner portion 9 is provided in the unloader 6, for example, and cleans the molding die surfaces of the lower molding die 11 and the upper molding die 12 when the

resin molded products P are conveyed from the lower molding die 11 and the upper molding die 12 that are opened. The molding die cleaner portion 9 has a cleaning member 91 such as a brush that cleans the molding die surfaces of the lower molding die 11 and the upper molding die 12, and a dust collection port H5 for collecting dust caused by cleaning. The dust collection apparatus 30 is connected to the dust collection port H5 (see Figure 2). Regarding the molding die cleaner portion 9, a molding die cleaner portion for the lower molding die 11 and a molding die cleaner portion for the upper molding die 12 may be separately provided, or a molding die cleaner portion may be shared between the lower molding die 11 and the upper molding die 12.

[0036]

In addition, as illustrated in Figure 1 and Figure 2, a molded product cleaner portion 10 that cleans the resin molded products P before the unnecessary resin K is removed or after the unnecessary resin K is removed by the unnecessary-resin removing mechanism 41 is provided in the conveying module 4. The molded product cleaner portion 10 has a cleaning member 101 such as a brush that cleans the resin molded products P, and a dust collection port H6 for collecting dust caused by cleaning. The dust collection apparatus 30 is connected to the dust collection port H6 (see Figure 2).

[0037]

Other than the configuration in which the dust collection ports H1 to H6 are provided in the portions 81, 82, 84, 85, 9, 10, respectively, a configuration in which the dust collection ports H1 to H6 are provided on the periphery of the portions 81, 82, 84, 85, 9, 10, respectively, in correspondence with those portions may be employed.

[0038]

<3. Specific Configuration of Dust Collection Apparatus 30>

Next, a specific configuration of a dust collection apparatus 30 in the present embodiment is described below.

[0039]

As illustrated in Figure 1 and Figure 2, the dust collection apparatus 30 collects dust from one or a plurality of the dust collection ports H1 to H6 provided in the modules. The dust collection apparatus 30 of the present embodiment is provided in the conveying module 4 but may be provided in another module or on the outside.

[0040]

Specifically, as illustrated in Figure 2, the dust collection apparatus 30 includes an air moving apparatus 31 driven by a motor 31a, and an inverter 32 that controls the rotation speed of the motor 31a.

[0041]

The air moving apparatus 31 includes blades (not shown) and the motor 31a that rotary drives the blades. The air moving apparatus 31 of the present embodiment is a concept including a fan, a blower, or a compressor. The motor 31a is a three-phase induction motor, for example.

[0042]

The inverter 32 controls the rotation speed of the motor 31a by controlling the frequency of AC voltage output to the motor 31a.

[0043]

Specifically, the inverter 32 has a converter circuit 32a that converts AC voltage of an AC power supply 40 to DC voltage, a capacitor 32b that smoothenes the DC voltage from the converter circuit 32a, an inverter circuit 32c that converts the DC voltage smoothened by the capacitor 32b to AC voltage, and an inverter control portion 32d that controls the inverter circuit 32c. The inverter control portion 32d controls the inverter circuit 32c based on a control command from control equipment CTL described later.

[0044]

The inverter circuit 32c of the present embodiment converts DC voltage to three-phase AC voltage and is configured with use of a plurality of switching elements (not shown). The inverter control portion 32d outputs AC voltage at a predetermined frequency to the motor 31a by

controlling the plurality of switching elements of the inverter circuit 32c.

[0045]

As illustrated in Figure 2, the air moving apparatus 31 is connected to a connecting pipe 33 connected to the plurality of dust collection ports H1 to H6. In the connecting pipe 33, switching mechanisms 34 that switch the dust collection ports H1 to H6 that collect dust by the air moving apparatus 31 are provided. In other words, a plurality of branch pipe portions 331 connected to the plurality of dust collection ports H1 to H6, respectively, and a shared confluence pipe portion 332 connected to the air moving apparatus 31 are connected to the switching mechanisms 34. The switching mechanisms 34 switch the dust collection ports H1 to H6 that collect dust by the air moving apparatus 31 by switching the plurality of branch pipe portions 331 that communicate with the confluence pipe portion 332. The switching mechanisms 34 can be configured with use of on-off valves such as solenoid valves.

[0046]

The rotation speed of the motor 31a is set in correspondence with the plurality of dust collection ports H1 to H6 switched by the switching mechanisms 34. In the present embodiment, either a first rotation speed R_H or a second rotation speed R_L that is lower than the

first rotation speed R_H is set in correspondence with the plurality of dust collection ports H1 to H6.

[0047]

Here, the first rotation speed R_H is a rotation speed for collecting dust with a high dust collection capability (powerful dust collection mode) and is from 90 rpm to 120 rpm, for example. The second rotation speed R_L is a rotation speed for collecting dust with a normal dust collection capability (intermediate dust collection mode) and is from 50 rpm to 60 rpm, for example.

[0048]

As shown in Figure 3, the inverter 32 controls the rotation speed of the motor 31a to be the first rotation speed R_H and allows inertial rotation of the motor 31a by releasing the electrical connection with the motor 31a when the rotation speed is to be reduced from the first rotation speed R_H . Here, inertial rotation means a case in which the motor 31a rotates by inertia when power supply from the inverter 32 is cut off in a state in which the motor 31a is rotating, and inertial rotation is also called free running or idling.

[0049]

Specifically, as shown in Figure 3, the inverter 32 switches the rotation speed of the motor 31a between the first rotation speed R_H and the second rotation speed R_L . The inverter 32 allows inertial rotation of the motor 31a by releasing the electrical connection with the motor 31a

when the first rotation speed R_H is to be switched to the second rotation speed R_L . The inverter 32 controls the rotation speed of the motor 31a to be the second rotation speed R_L after the motor 31a reaches the second rotation speed R_L by inertial rotation.

[0050]

The inverter 32 performs switching between a first dust collection state (powerful dust collection mode) of collecting dust from the dust collection ports H1 to H6 by controlling the rotation speed of the motor 31a to be the first rotation speed R_H and a second dust collection state (intermediate dust collection mode) of collecting dust from the dust collection ports H1 to H6 by controlling the rotation speed of the motor 31a to be the second rotation speed R_L .

[0051]

Specifically, the inverter 32 controls the rotation speed of the motor 31a to be the first rotation speed R_H when the lower molding die 11 and the upper molding die 12 are cleaned by the molding die cleaner portion 9 or the resin molded products P are cleaned by the molded product cleaner portion 10. As a result, the first dust collection state (powerful dust collection mode) in which dust is collected from the dust collection port H5 of the molding die cleaner portion 9 or the dust collection port H6 of the molded product cleaner portion 10 is obtained.

[0052]

The inverter 32 allows inertial rotation of the motor 31a or controls the rotation speed of the motor 31a to be the second rotation speed R_L after the inertial rotation of the motor 31a when the resin supplying module 8 supplies resin materials to the loader 5 at times other than the cleaning of the lower molding die 11 and the upper molding die 12 and the cleaning of the resin molded products P. As a result, the second dust collection state (intermediate dust collection mode) in which dust is collected from each of the dust collection ports H1 to H4 of the resin supplying module 8 is obtained. Other than the above, the inverter 32 constantly controls the rotation speed of the motor 31a to be the second rotation speed R_L at times other than the cleaning of the lower molding die 11 and the upper molding die 12, the cleaning of the resin molded products P, and the supplying of the resin materials to the loader 5 by the resin supplying module 8.

[0053]

<4-1. Control from Inertial Rotation to Second Rotation Speed R_L >

Here, a case in which the motor 31a is controlled to be set to the second rotation speed R_L from a state of inertial rotation is described.

[0054]

When the inverter 32 controls the motor 31a to be set to the second rotation speed R_L from a state of

inertial rotation, the inverter 32 is conceived to restart the energization of the motor 31a and control the rotation speed to be the second rotation speed R_L after predetermined inertial time elapses from the release of the electrical connection with the motor 31a controlled at the first rotation speed R_H as indicated by a time point "E1" in Figure 3. Here, the predetermined inertial time can be set by obtaining an amount of time it takes for the motor 31a rotated at the first rotation speed R_H to be decelerated to the second rotation speed R_L by inertial rotation after the release of the electrical connection with the motor 31a by calculation or a test in advance.

[0055]

When the inverter 32 controls the motor 31a to be set to the second rotation speed R_L from an inertial rotation state, the inverter 32 detects the rotation speed of the motor 31a in an inertial rotation state with use of a speed search function after the predetermined inertial time elapses from the release of the electrical connection with the motor 31a controlled at the first rotation speed R_H as indicated by the time point "E1" in Figure 3. Then, the inverter 32 is conceived to control the rotation speed to be the second rotation speed R_L by restarting the energization of the motor 31a based on the detected rotation speed.

[0056]

The speed search function of the inverter 32 is a current-detecting speed search function built in the inverter 32 and is performed before the energization of the motor 31a is restarted. The current-detecting speed search function is a known function that sweeps the frequency of the AC voltage to be supplied to the motor 31a, detects current that flows through the motor 31a at that time, and identifies (estimates) the rotation speed of the motor 31a based on the detected current.

[0057]

<4-2. Control from Inertial Rotation to First Rotation Speed R_H >

Here, a case in which the motor 31a is controlled to be set to the first rotation speed R_H from a state of inertial rotation is described.

[0058]

When the inverter 32 controls the rotation speed of the motor 31a to be the first rotation speed R_H from a state of inertial rotation, the inverter 32 detects the rotation speed of the motor 31a, and restarts the energization of the motor 31a based on the detected rotation speed as indicated by a time point "E2" and the time point "E3" in Figure 3.

[0059]

Specifically, when the inverter 32 receives a control command for obtaining the first rotation speed R_H in a state in which the motor 31a is rotating by inertia,

the inverter 32 detects the rotation speed of the motor 31a in an inertial rotation state with use of the speed search function. Then, the inverter 32 controls the rotation speed of the motor 31a to be the first rotation speed R_H by restarting the energization of the motor 31a based on the detected rotation speed.

[0060]

<4-3. Control from Second Rotation Speed R_L to First Rotation Speed R_H >

When the inverter 32 receives a control command for obtaining the first rotation speed R_H in a state in which the rotation speed of the motor 31a is controlled to be the second rotation speed R_L , the inverter 32 controls the rotation speed of the motor 31a to be the first rotation speed R_H by gradually raising the rotation speed without using the current-detecting speed search function as indicated by a time point "E4" and a time point "E5" in Figure 3.

[0061]

<5. Rotation Speed and Power Consumption in Each Mode>

Next, the rotation speed and the power consumption in three operation modes are described with reference to Figure 4.

[0062]

Here, a first operation mode (see Figure 4(a)) is a related-art operation mode and controls the rotation speed of the motor 31a of the air moving apparatus 31 to

be a constant rotation speed (first rotation speed R_H). A second operation mode (see Figure 4(b)) performs rotation control of the motor 31a of the air moving apparatus 31 by the inverter 32 and performs acceleration control and deceleration control of the motor 31a of the air moving apparatus between the first rotation speed R_H (powerful dust collection mode) and the second rotation speed R_L (intermediate dust collection mode). A third operation mode (see Figure 4(c)) is an operation mode of the present embodiment and performs rotation control of the motor 31a of the air moving apparatus 31 by the inverter 32 and allows inertial rotation of the motor 31a of the air moving apparatus 31 when the motor 31a of the air moving apparatus 31 is switched from the first rotation speed R_H (powerful dust collection mode) to the second rotation speed R_L (intermediate dust collection mode).

[0063]

The first operation mode consumes constant power regardless of the position of dust collection. The second operation mode can reduce the power consumption of the dust collection apparatus 30 as compared to the first operation mode. This leads to the reduction of the power consumption of the resin molding apparatus 100. The third operation mode can further reduce the power consumption at the time of deceleration and downsize or eliminate components such as a resistor for consuming

regenerative energy at the time of deceleration as compared to the second operation mode.

[0064]

<6. Resin Molding Operation of Resin Molding Apparatus 100>

Next, an example of the operation of the resin molding apparatus 100 is described with reference to Figure 1 and Figure 5. The operation described below is performed by controlling each unit of the resin molding apparatus 100 by the control equipment CTL provided in the supply module 2, for example. The control equipment CTL is a dedicated or general-purpose computer including a CPU, an internal memory, an input/output interface, an AD converter, and the like. The operation of the resin molding apparatus 100 is simplified in Figure 5. In actuality, a pre-molding substrate and resin material supplying process ("loading" in Figure 5), a resin molding process ("molding" in Figure 5), a resin molded product conveying process, an unnecessary-resin removing process, and a resin molded product housing process ("unloading" in Figure 5) are performed in parallel.

[0065]

In a dust collection operation in a resin molding operation below, dust is constantly collected from the dust collection port H1 of the resin send-out portion 81 and the dust collection port H3 of the resin accommodating portion 84, and dust collection from the

dust collection port H1 of the resin send-out portion 81 and the dust collection port H3 of the resin accommodating portion 84 is turned off when dust is collected from the other dust collection ports H2, H4 to H6.

[0066]

(1) Pre-molding Substrate and Resin Material Supplying Process

The substrate send-out portion 71 sends out the pre-molding substrates W in the magazine to the substrate supplying portion 72. The substrate supplying portion 72 aligns the received pre-molding substrates W in a predetermined direction and transfers the pre-molding substrates W to the loader 5. In parallel with the above, the resin send-out portion 81 sends out the resin materials J received from the stocker 84 to the resin arranging portion 82. The resin supplying portion 83 transfers a necessary number (four in Figure 1) of the resin materials J arranged by the resin arranging portion 82 to the loader 5.

[0067]

Next, the loader 5 simultaneously conveys the two pre-molding substrates W and the four resin materials J that have been received to the press portion 1. The loader 5 supplies the pre-molding substrates W to the loading portion 11a of the lower molding die 11 and

supplies the resin materials J into the pots 11b formed in the lower molding die 11.

[0068]

In the pre-molding substrate and resin material supplying process, the inverter 32 controls the rotation speed of the motor 31a to be the second rotation speed R_L and sets the mode to be the intermediate dust collection mode. The switching mechanisms 34 perform switching such that dust is collected from the dust collection ports H1 to H4 of the resin supplying module 8. Specifically, the switching mechanisms 34 perform switching such that dust is collected from the dust collection port H4 of the loader cleaner portion 85 when the resin holding portion 51 of the loader 5 is cleaned by the loader cleaner portion 85. When the resin materials are arranged in a line by the resin arranging portion 82, switching is performed such that dust is collected from the dust collection port H2 of the resin arranging portion 82. At timings other than the above, the switching mechanisms 34 perform switching such that dust is collected from the dust collection port H1 of the resin send-out portion 81 and the dust collection port H3 of the resin accommodating portion 84 until the loader 5 supplies the resin materials J to the lower molding die 11.

[0069]

(2) Resin Molding Process

Then, the upper molding die 12 and the lower molding die 11 are clamped with use of the clamping mechanism 13. Fluid resin is generated by heating and melting the resin materials J in each of the pots 11b, and the fluid resin is pushed by the plunger. As a result, the fluid resin is injected into the cavities formed between the upper molding die 12 and the lower molding die 11.

Subsequently, by heating the fluid resin for a required amount of time necessary for curing, the fluid resin is cured, and cured resin is formed. As a result, electronic components in the cavities and substrates in the vicinity thereof are sealed in the cured resin (sealing resin) molded in correspondence with the shapes of the cavities.

[0070]

In the resin molding process, the inverter 32 controls the rotation speed of the motor 31a to be the second rotation speed R_L and sets the mode to be the intermediate dust collection mode. The switching mechanisms 34 perform switching such that dust is collected from the dust collection ports H1 to H4 of the resin supplying module 8. Specifically, the switching mechanisms 34 perform switching such that dust is collected from the dust collection port H1 of the resin send-out portion 81 and the dust collection port H3 of the resin accommodating portion 84.

[0071]

(3) Resin Molded Product Conveying Process

Next, after the required amount of time necessary for curing elapses, the upper molding die 12 and the lower molding die 11 are opened, and the resin molded products P that are molded substrates are removed from the dies. Then, by the unloader 6, the resin molded products P are conveyed from the upper molding die 12 and the lower molding die 11 that are opened. The unloader 6 that has received the resin molded products P conveys the resin molded products P to the conveying module 4.

[0072]

Here, when the unloader 6 conveys the resin molded products P, the molding die cleaner portion 9 provided in the unloader 6 cleans the lower molding die 11 and the upper molding die 12.

[0073]

At this time, the inverter 32 controls the rotation speed of the motor 31a to be the first rotation speed R_H and sets the mode to the powerful dust collection mode. The switching mechanisms 34 perform switching such that dust is collected from the dust collection port H5 of the molding die cleaner portion 9. The dust collection by the dust collection port H5 is started before or at the same time as the cleaning by the molding die cleaner portion 9 is started. When the cleaning by the molding die cleaner portion 9 is ended, the inverter 32 transitions to the intermediate dust collection mode by

releasing the electrical connection with the motor 31a and allowing inertial rotation of the motor 31a.

[0074]

(4) Unnecessary-Resin Removing Process

Then, the unloader 6 places the conveyed resin molded products P to the stage portion 41a of the unnecessary-resin removing mechanism 41. When the resin molded products P are placed on the stage portion 41a, the unnecessary resin K on the resin molded products P is removed. In at least one of before and after the removal of the unnecessary resin K, the resin molded products P are cleaned by the molded product cleaner portion 10.

[0075]

At this time, the inverter 32 controls the rotation speed of the motor 31a to be the first rotation speed R_H and sets the mode to the powerful dust collection mode. The switching mechanisms 34 perform switching such that dust is collected from the dust collection port H6 of the molded product cleaner portion 10. The dust collection by the dust collection port H6 is started before or at the same time as the cleaning by the molded product cleaner portion 10 is started. When the cleaning by the molded product cleaner portion 10 is ended, the inverter 32 transitions to an intermediate dust collection mode by releasing the electrical connection with the motor 31a and allowing inertial rotation of the motor 31a.

[0076]

(5) Resin Molded Product Housing Process

Then, the resin molded products (product portions) from which the unnecessary resin K has been removed are accommodated in the resin molded product housing portion 42 of the conveying module 4 by the unloader 6.

[0077]

<7. Effects of Present Embodiment>

According to the resin molding apparatus 100 of the present embodiment, the rotation speed of the motor 31a is controlled to be the first rotation speed R_H , and inertial rotation of the motor 31a is allowed by releasing the electrical connection with the motor 31a when the rotation speed is to be dropped from the first rotation speed R_H . Therefore, it becomes possible to reduce the power consumption of the dust collection apparatus 30 used in the resin molding apparatus 100.

[0078]

In particular, when the lower molding die 11 and the upper molding die 12 are cleaned by the molding die cleaner portion 9, a large amount of dust is formed. Thus, when the lower molding die 11 and the upper molding die 12 are cleaned, the inverter 32 controls the rotation speed of the motor 31a to be the first rotation speed R_H . Therefore, it becomes possible to exhibit a high dust collection capability and efficiently collect dust. Deceleration control is unnecessary when the rotation speed is to be dropped from the first rotation speed R_H .

by the inverter 32, and it becomes possible to alleviate or eliminate handling of regenerative energy generated in the deceleration control. As a result, it becomes possible to downsize or eliminate components such as a resistor for absorbing regenerative energy.

[0079]

A large amount of dust may be formed when the resin molded products P are cleaned by the molded product cleaner portion 10, and the inverter 32 controls the rotation speed of the motor 31a to be the first rotation speed R_H when the resin molded products P are cleaned. Therefore, it becomes possible to exhibit a high dust collection capability and efficiently collect dust. As a result, it becomes possible to improve the quality of the resin molded products P from which unnecessary resin has been removed.

[0080]

<8. Other Modification Embodiments>

It is to be noted that the present invention is not limited to the embodiment.

[0081]

For example, in the embodiment, a configuration of performing switching between two stages, that is, the first rotation speed R_H and the second rotation speed R_L is employed, but a configuration of switching between three or more stages by adding other rotation speeds may be employed.

[0082]

A method of detecting the rotation speed of the motor 31a in an inertial rotation state may be performed by providing a rotation sensor in the motor 31a and the like and detecting the rotation speed of the motor 31a besides the speed search function of the inverter 32.

[0083]

In the embodiment, a configuration in which one resin molding module 3 is connected to a place between the supply module 2 and the conveying module 4 has been employed, but a configuration in which two or more resin molding modules 3 are connected may be employed. The resin molding apparatus does not necessarily need to be modularized for each module as in the embodiment.

[0084]

In addition, the present invention is not limited to the embodiment, and it is needless to say that various modifications can be made thereto without departing from the gist thereof.

Industrial Applicability

[0085]

According to the present invention, it becomes possible to reduce power consumption of a dust collection apparatus used in a resin molding apparatus.

Reference Signs List

[0086]

100 ... Resin molding apparatus

3 ... Resin molding module

8 ... Resin supplying module

W ... Molding target

J ... Resin material

P ... Resin molded product

K ... Unnecessary resin

11, 12 ... Molding die

H1 to H6 ... Dust collection port

9 ... Molding die cleaner portion

10 ... Molded product cleaner portion

30 ... Dust collection apparatus

31 ... Air moving apparatus

31a ... Motor

R_H ... First rotation speed

R_L ... Second rotation speed

32 ... Inverter

33 ... Connecting pipe

34 ... Switching mechanism

Claims

[Claim 1]

A dust collection apparatus configured to collect dust from one or a plurality of dust collection ports provided in a resin molding apparatus, the dust collection apparatus comprising:

an air moving apparatus driven by a motor; and

an inverter configured to control a rotation speed of the motor, the dust collection apparatus being configured to collect dust from a dust collection port provided in a molding die cleaner portion configured to clean a molding die of the resin molding apparatus, wherein the inverter is configured to control the rotation speed of the motor to be a first rotation speed when the molding die is cleaned by the molding die cleaner portion, and allow inertial rotation of the motor by releasing electrical connection with the motor after the cleaning of the molding die by the molding die cleaner portion.

[Claim 2]

The dust collection apparatus according to claim 1, the dust collection apparatus being configured to collect dust from a dust collection port provided in a molded product cleaner portion configured to clean a resin molded product, wherein the inverter is configured to control the rotation speed of the motor to be the first

rotation speed when the resin molded product is cleaned by the molded product cleaner portion, and allow inertial rotation of the motor by releasing the electrical connection with the motor after the cleaning of the resin molded product by the molded product cleaner portion.

[Claim 3]

The dust collection apparatus according to claim 1 or 2, wherein the inverter is configured to switch the rotation speed of the motor between the first rotation speed and a second rotation speed that is a rotation speed lower than the first rotation speed and allow inertial rotation of the motor by releasing the electrical connection with the motor when the first rotation speed is switched to the second rotation speed.

[Claim 4]

The dust collection apparatus according to claim 3, wherein the inverter is configured to control the rotation speed of the motor to be the second rotation speed after the rotation speed of the motor reaches the second rotation speed by inertial rotation.

[Claim 5]

The dust collection apparatus according to claim 3 or 4, the dust collection apparatus being configured to collect dust from a dust collection port provided in a resin supplying module of the resin molding apparatus, wherein the inverter is configured to allow inertial rotation of the motor by releasing the electrical

connection with the motor or control the rotation speed of the motor to be the second rotation speed when the inverter collects dust from the dust collection port provided in the resin supplying module.

[Claim 6]

The dust collection apparatus according to any one of claims 1 to 5, comprising:

a connecting pipe that connects a plurality of the dust collection ports and the air moving apparatus to each other; and

a switching mechanism that is provided in the connecting pipe and configured to switch the dust collection port that collects dust by the air moving apparatus.

[Claim 7]

The dust collection apparatus according to claim 6, wherein the rotation speed of the motor is set in correspondence with the dust collection port switched by the switching mechanism.

[Claim 8]

The dust collection apparatus according to any one of claims 1 to 7, wherein the inverter is configured to detect the rotation speed of the motor and restart energization of the motor based on the detected rotation speed when the inverter performs control of setting the motor to be at the first rotation speed from an inertial rotation state.

[Claim 9]

A resin molding apparatus, comprising:

a resin molding module configured to perform transfer molding of a resin material with respect to a molding target by a pair of molding dies;

a molding die cleaner portion configured to clean the molding dies; and

the dust collection apparatus according to any one of claims 1 to 8.

[Claim 10]

A resin molded product manufacturing method using the resin molding apparatus according to claim 9, comprising:

supplying a molding target and a resin material to the molding die;

performing resin molding with respect to the molding target; and

conveying a resin molded product that is resin-molded from the molding die.