DESCRIPTION

CONVEYING SYSTEM HAVING ENDLESS DRIVE MEDIUM, METHOD FOR IDENTIFYING CARRIER THEREOF, AND CARRIER

Field of the Invention

[0001]

The present invention relates to a transport system for transporting semiconductor substrates or the like by a carrier attached to an endless driving medium. In particular, the present invention relates to a technique of identifying a carrier holding articles such as semiconductor substrates or the like.

Background Art

[0002]

According to the disclosure of Patent Reference 1 (US7234584), a plurality of carriers are attached to an endless belt, and the endless belt rotates in a circulating manner. Each of the carriers has a support surface for supporting a flange or the like of a semiconductor cassette, and the cassette is loaded or unloaded using a hand of a station. Transport systems have controllers for controlling positions of the carriers. Carriers as targets of loading and unloading are designated in stations. For identification of a carrier at the station, an ID should be attached to the carrier, and an ID reader should be provided at the station. However, in this case, the ID reader is required for carrier identification.

Related Art Reference

[0003]

Patent Reference 1: US7234584

Summary of the Invention

Problems to be solved by the Invention

[0004]

An object of the present invention is to make it possible to identify a carrier using a sensor for position detection of the sensor in a transport system using an endless driving medium and a plurality of carriers.

Means for solving the Problems

[0005]

A transport system of the present invention includes:

an endless driving medium configured to rotate in a circulating manner;

a plurality of carriers each having an identification target (mark) for carrier identification, configured to hold articles, and attached to the endless driving medium; and

a plurality of stations each having a hand configured to load articles to or unload articles from the carriers, and a sensor configured to detect the identification target at a predetermined position upstream of the hand along a rotation direction of the endless driving medium for outputting a detection signal of the carrier and an identification signal of the carrier.

[0006]

A method of identifying a carrier in a transport system of the present invention includes the steps of:

attaching a plurality of carriers configured to hold articles and each having an identification target (mark) for carrier identification, to an endless driving medium configured to rotate in a circulating manner;

providing a plurality of stations each having a hand configured to load articles to or unloading articles from the carriers and a sensor configured to detect the identification target at a predetermined position upstream of the hand along a rotation direction of the

endless driving medium; and

identifying a carrier and recognizing appearance of the carrier at a predetermined position based on a signal from the sensor for operating the hand for a desired carrier.

[0007]

A carrier of the present invention includes:

a carrier body for supporting an article; and

an attachment provided at an upper portion of the carrier body for attachment to an endless driving medium.

The carrier is identifiable based on a width of the attachment along a moving direction of the endless driving medium.

[0008]

Preferably, the detection signal of the carrier is used as a timing signal for starting unloading or unloading operation of the hand.

More preferably, the identification target is an attachment configured to attach the carrier to the endless driving medium, and for identification of the carrier, attachments having different widths are provided for the plurality of carriers along the rotation direction of the endless driving medium.

Particularly preferably, the attachment is attached to a lower end of the endless driving medium, and a carrier body of the carrier is provided with a gap in a height direction between the lower end of the endless driving medium and the carrier body of the carrier.

The sensor is configured to detect the attachment at a height position between the lower end of the endless driving medium and an upper portion of the carrier body.

[0009]

Further, preferably, an identification target that is different from other identification targets is provided for every predetermined number of carriers, and the carrier is detected by counting a number of identification targets detected after detection

of the different identification target. In this regard, as for counting of the identification targets, any method can be adopted. For example, the different identification target is counted as "0" and the next identification target is counted as "1" or the different identification target is counted as "1" and the next identification target is counted as "2".

[0010]

In this specification, description regarding the transport system is directly applicable to the transport method and the carrier used in the transport system.

Advantages of the Invention

[0011]

In the present invention, appearance of a carrier at a predetermined position can be recognized, and the carrier can be identified by detecting an identification target (mark) by a sensor. In this manner, a single sensor can be used for both of carrier identification and detection of the carrier position. Further, it is not essential to use different signals for the identification signal of the carrier and the detection signal of the carrier. For example, the identification signal may be added to the detection signal to form one signal.

[0012]

By identifying the carrier using different widths of attachments for attaching the carriers to the endless driving medium, carrier identification can be performed easily.

In particular, by providing a gap in a height direction between the lower end of the endless driving medium and a carrier body of the carrier to detect the width of the attachment along the rotation direction of the endless driving medium at the height of the gap, the identification target can be detected without being obstructed by articles during transportation.

[0013]

By providing an identification target that is different from other identification

targets for every predetermined number of carriers, and counting a number of identification targets after detection of the different identification target, whether carrier identification can be performed correctly or not can be checked at intervals of the predetermined number of carriers.

Brief Description of the Drawings

[0014]

[FIG. 1]

FIG. 1 is a plan view showing a layout of a transport system in an embodiment.

[FIG. 2]

FIG. 2 is a block diagram showing a control system in the embodiment.

[FIG. 3]

FIG. 3 is a block diagram showing a control system of a station in the embodiment.

[FIG. 4]

FIG. 4 is a side view showing main components of a carrier and a hand of the station in the embodiment.

[FIG. 5]

FIG. 5 is a plan view showing main components of the carrier and the hand of the station in the embodiment.

[FIG. 6]

FIG. 6 is a rear view showing main components of the station in the embodiment.

[FIG. 7]

FIG. 7 is a view showing identification of a carrier in the embodiment.

[FIG. 8]

FIG. 8 is a view showing carriers in a modified embodiment.

[FIG. 9]

FIG. 9 is a view showing a carrier in a second modified embodiment.

[FIG. 10]

FIG. 10 is a timing chart at the time of loading in the embodiment.

[FIG. 11]

FIG. 11 is a timing chart at the time of unloading in the embodiment.

[FIG. 12]

FIG. 12 is a flow chart showing the former half of an algorithm of loading and unloading in the embodiment.

[FIG. 13]

FIG. 13 is a flow chart showing the latter half of the algorithm of loading and unloading in the embodiment.

[Embodiment for carrying out the Invention]

[0015]

Hereinafter, an embodiment in the most preferred form for carrying out the present invention will be described.

[Embodiments]

[0016]

FIGS. 1 to 11 show an embodiment and its modification. In the drawings, a reference numeral 2 denotes a transport system for rotating an endless belt 4 in a circulating manner. Reference numerals 6 denote pulleys for driving the endless belt 4. Reference numerals 6a, 6b denote individual pulley parts. Instead of the belt 4, a chain, a wire, a rope or the like may be used. The belt 4 is rotated in a fixed direction, and a plurality of stations 8 are provided along the belt 4. Buffers (not shown) and processing tools 10 or the like are connected to each station 8. For example, carriers 12 are attached to the belt 4 at constant intervals for transportation of cassettes 14 containing semiconductor substrates or the like. Any type of articles can be transported.

[0017]

FIG. 2 shows a control system of the transport system. A reference numeral 20 denotes a manufacturing execution controller. The manufacturing execution controller 20 controls processing tools or the like, and requests a material handling controller 22 to transport the cassettes. The material handling controller 22 controls an endless belt driver 24 and station controllers 26. The station controller 26 is provided for each station. The endless belt driver 24 drives the endless belt 4 at a constant velocity. Inputs to the station controller 26 are transportation instructions from the material handling controller 22. The transportation instructions are issued to load cassettes from, or unload cassettes to a carrier at a predetermined address. A unique address is assigned to each of the carriers along a rotation direction in which the endless belt is rotated. In the embodiment, the address is data having a bit length in a range of 10 to 16 bits, and the address is expressed using a binary value. Loading is a motion to allow the carrier to support the articles, and unloading is a motion to take out the articles from the carrier using a hand.

[0018]

Detection signals indicating detection of carriers are inputted from two photoelectric sensors s1, s2, to the station controller 26. Among the photoelectric sensors s1, s2, the photoelectric sensor s1 additionally inputs identification signals indicating identification of the carriers to the station controller 26. The travel displacement of the endless belt is inputted from an encoder enc to the station controller 26. The station controller 26 recognizes appearance of a carrier at a predetermined position upstream of the station by the signal from the photoelectric sensor s1, and recognizes a type of the carrier, e.g., based on duration of the signal from the photoelectric sensor s1.

[0019]

The data of the encoder when the carrier is detected by the photoelectric sensor s1 is latched. The difference from the latch value is considered, and the position of watching the photoelectric sensor s1 is regarded as a reference point to recognize the position of the carrier. Further, validity of the data of the encoder is checked by the

photoelectric sensor s2 as described later. Based on the data of the encoder, a hand driver 27 is operated, and a hand 28 provided at the station is operated for loading cassettes from, and unloading cassettes to the carrier.

[0020]

A dedicated hand for loading and a dedicated hand for unloading may be used. Alternatively, one hand may be used for both of loading and unloading. The hand 28 is an end effector of transfer means, and any shape and structure can be adopted for the hand 28. For example, occupation sensors 29R, 29L are provided on both of left and right sides of the hand 28. In the case of loading a cassette on a carrier, it is checked whether the carrier supports another cassette or not. In the case of unloading a cassette from a carrier, it is checked whether any cassettes are loaded on the carrier or not. The hand 28 and the endless belt move at the same velocity. Since the hand 28 moves toward the carrier from a position on the front side of the carrier or from a position on the back side of the carrier, a pair of left and right occupation sensors 29R, 29L are used selectively depending on the direction in which the hand 28 moves toward the carrier.

[0021]

FIG. 3 shows structure of the station controller 26. Reference numerals 31, 32 denote shaping circuits. Shaping of signals from the sensors s1, s2 is performed, and a counter 33 counts the output pulses from the encoder. A reference numeral e0 denotes the output from the counter 33. A signal from a carrier counter 34 indicates an address of the carrier. In response to the detection signal indicating detection of the carrier from the sensor s1, the carrier counter 34 increments the carrier number by 1, and checks the validity of the value of the carrier counter 34 based on a check signal which appears at intervals of every eight sensors. If there is any error in the data of the carrier counter 34 for some reasons, the check signal does not match the output from the carrier counter 34.

[0022]

A comparator 35 compares the address of the carrier designated to perform

loading or unloading of articles and the output from the carrier counter 34. If the address of the carrier matches the output from the carrier counter 34, the output from the counter 33 at this time point is stored in a latch 36. The output from the latch 36 is denoted by L0. The output from the counter 33 at the moment when the signal of the sensor s1 is turned on is stored. In the case where processing in the carrier counter 34 and the comparator 35 is slow, processing is modified to allow the latching operation to be performed at the rising edge of the output from the shaping circuit 31. A reference numeral 37 denotes an adder for adding calibrated transfer parameters K0 to K2, P1 to P7 stored in a parameter memory 41. When the comparator 38 founds that the signal from the adder 37 matches the signal from the counter 33, the hand is operated by the hand driver 27 accordingly.

[0023]

In the embodiment, the hand is operated by three motors M1, M2, and M3. Among these motors M1, M2, and M3, the motors M1, M2 are used for elevating or lowering the hand in the height direction. The motor M3 is used for moving the hand in the rotation direction in which the endless belt is rotated as indicated by an arrow Y. In the following description, it is assumed that height direction is a direction indicated by an arrow Z. In the embodiment, the hand is driven along two axes, i.e., in the Y direction and in the Z direction. Further, the hand may be driven additionally in a direction, e.g., indicated by an arrow X, i.e., to move along three axes. Moreover, numbers of rotations of the motors M1 to M3 are monitored by the encoders 43 to 45, and feedback control of the hand is implemented by the hand driver 27. The outputs from the encoders 43 to 45 are reset each time the hand returns to its home position after loading or unloading of articles is finished.

[0024]

The signals from the latch 36 and the counter 33 are inputted to an encoder checker 40 to examine validity of the encoder enc. That is, the interval between the

detection positions of the photoelectric sensor s1 and the photoelectric sensor s2 is known, and the number of output pulses of the encoder corresponding to this interval is stored in the parameter memory 41. The validity of the encoder enc can be checked based on whether the difference between the signal from the counter 33 at the time point when the sensor s2 is operated and the output from the latch 36 corresponds to the interval between the sensors s1, s2. Further, as described later, when the sensor s2 is operated, operation of the hand is started. If the hand is operated according to a target operating pattern, the outputs from the encoders 43 to 45 at this time point must be in a predetermined range. Therefore, operation of the hand is checked based on the signals from the encoders 43 to 45 when the sensor s2 is turned on. If there is any error (difference) beyond an allowable value or more in these items of data, a trouble signal Trouble is outputted from the checker 40, and operation of the hand is stopped.

[0025]

A communication interface (I/F) 42 communicates with the material handling controller 22, and an address of a carrier which requires loading or unloading of cassettes, and a type indicating loading or unloading are inputted. Then, transportation results are transmitted from the communication interface 42 to the material handling controller 22. Further, the trouble signal Trouble is outputted from the checker 40. When the transfer operation is interrupted, information to this effect is reported to the material handling controller 22.

[0026]

FIGS. 4 to 6 show the relationship between the hand 28 and the endless belt 4 at the station 8. As shown in FIG. 4, it is assumed that the rotation direction of the belt 4 is the Y direction, the direction perpendicular to the Y direction in a horizontal plane is the X direction, and the height direction is the Z direction. Further, the hand 28 is operated in the Y direction and the Z direction. The pulley 6 is operated by a driving motor 46 or the like. The carrier 12 has a pair of front and back attachments 48. Among the

attachments 48, an attachment on the front side is denoted by a reference numeral 48f, and an attachment on the back side is denoted by a reference numeral 48r. The carrier 12 includes a carrier body 51 and the attachments 48. A gap between a lower end of the endless belt 4 and an upper end of the carrier body 51 is a watching line 60. At this height, the photoelectric sensors s1, s2 watch the attachments 48f, 48r. The flange 50 of the cassette 14 is placed on a supporting surface 49 of the carrier body 51. A pair of columns 52 are provided on both of left and right sides of the station 8. An elevating and lowering rail 56 is elevated and lowered along a guide groove 54 by motors M1, M2 (not shown). A motor M3 is provided at an upper portion of a hand base 58, and wheels 59 travel within the elevating and lowering rail 56 in the Y direction.

[0027]

FIG. 7 shows detection and identification of the carrier 12. It is assumed that the endless belt 4 travels from the left side to the right side in FIG. 7 at a constant velocity. The carrier 12 has the attachment 48f on the front side, and the attachment 48r on the back side. The attachments 48f, 48r have different widths along the travel direction of the belt 4. Further, for example, attachments 48f' having a different width along the travel direction of the belt 4 are provided at intervals of every eight carriers. In this embodiment, when the attachments 48f, 48r are detected by the photoelectric sensor s1, a signal shown on the lower side in FIG. 7 is obtained. A reference numeral 70 denotes a baseline of detection signals, and reference numerals 71 to 73 denote the detection signals. Since the attachments 48f and 48r have different widths, the signals 71, 73 have different widths. Next, since the attachments 48f and 48f' have different widths, if the signals 71, 72 have different widths, and the attachment 48f' can be detected. For example, the attachments 48f' are provided at intervals of every eight carriers, the lower three bits of the address of the carrier 12 can be checked. As can be seen from an enlarged view at a lower right position in FIG. 7, the watching line 60 for the attachments 48f, 48r or the like is positioned in a gap in the height direction between the lower end of

the belt 4 and the carrier body 51.

[0028]

FIG. 8 shows carriers 80 in a modified embodiment. Two types of attachments 48f, 48f' having different widths are provided on the front side of the carriers 80, and two types of attachments 48r, 48r' having different widths 48r, 48r' are provided on the back side of the carriers 80. Since the interval between the carriers 80 is larger than the interval between the attachments on the front and back sides, it is possible to identify which attachments are the attachments 48f, 48f' on the front side and which attachments are the attachments 48r, 48r' on the back side based on signals from the photoelectric sensor. In this manner, four types of carriers 80 can be identified. By increasing the types of attachments to have three or more different widths, it becomes possible to further increase the number of identifiable types of carriers. In other respects, the carrier 80 of the modified embodiment is the same as that of the embodiment shown in FIGS. 1 to 7.

[0029]

FIG. 9 shows a carrier 90 in a second embodiment. For example, an optical mark 94 is provided at a front end of the carrier 90 in the travel direction. The attachments 91, 92 are not used as targets of detection. The carrier 90 is detected, e.g., at the first edge of the optical mark 94, and the type of the carrier 90 is detected at the subsequent edge. Also in this approach, the type of the carrier can be identified using the photoelectric sensor without being obstructed by the cassettes 14. However, the optical mark needs to be provided in addition to the attachment. In other respect, the carrier 90 of the second modified embodiment is the same as that of the embodiment shown in FIGS. 1 to 7.

[0030]

FIGS. 10 to 13 show loading motion (FIG. 10) and unloading motion (FIG. 11) in the embodiment, and an algorithm for the loading motion and the unloading motion (FIGS. 12 and 13). When the carrier is detected by the photoelectric sensor s1, the count value of the encoder output at this time point is latched. The latched output is denoted by

a reference numeral L0. After latching, a preparation period is provided before starting operation of the hand. In the case of loading, a stand by period of K0 in terms of the number of pulses of the encoder's output is provided, and in the case of unloading, a stand by period of K2 in terms of the number of pulses is provided. Since acceleration at the time of loading is smaller than acceleration at the time of unloading, the number of pulses K0 is smaller than the number of pulses K2. As a result, loading motion and unloading motion as described later can be started at the same position relative to the station. Then, before turning on the photoelectric sensor s2, travel of the hand in the Y direction is started in both of loading and unloading.

[0031]

At the time point when the photoelectric sensor s2 is turned on, the number of the encoder's output pulses after the photoelectric sensor s1 is turned on is determined, and this number is compared with a predetermined value K1. If the error (difference) from the predetermined value K1 is large, it is considered that sliding or the like occurs in the encoder, and transfer is stopped. Further, at the time point when the photoelectric sensor s2 is turned on, values of the encoders 43, 44 for the driving motor of the hand are checked to confirm whether the hand is operated in accordance with a predetermined operating pattern. After the photoelectric sensor s2 is turned on, at the time when a number of output pulses common to both of loading and unloading is obtained, operation of elevating or lowering the hand is started. Loading motion or unloading motion herein means operation from the start to the end of elevating or lowering the hand. The count value of the encoder's output pulses at the time of starting loading motion or unloading motion is larger than the latched value L0 by P1. P1 is common to both of loading and unloading. When the carrier comes to a position which is the same as the position of the station, loading motion or unloading motion is started. For this purpose, the area where unloading movement is performed and the area where loading movement is performed are substantially the same with respect to the station.

[0032]

In the case of loading, the hand is elevated, and when the output value from the counter is increased by P2, the hand is accelerated in the Y direction. The hand and the carrier are overlapped with each other vertically along the Y direction. When the counter value of the encoder's output becomes L0 + P3, the hand is started to be lowered. While the hand is being lowered, when the velocity in the Z direction becomes 0, the cassette is loaded from the hand to the carrier. When the counter value of the encoder's output becomes L0 + L4, elevating and lowering operation of the hand is stopped, and the hand is decelerated along the Y direction to escape to the back side of the carrier. When the count value becomes L0 + L7, the carrier returns to a predetermined position of the station.

[0033]

In the case of unloading, elevation of the hand is started when the counter value of the encoder's output becomes L0 + L1. While the hand is being elevated, the velocity in the Z direction is once regulated to zero. At this time point, the cassette is unloaded from the carrier to the hand. Then, when the count value becomes L0 + P5, the hand is decelerated to escape to the back side of the carrier, and when the count value becomes L0 + L6, the hand is lowered. Then, when the counter value becomes L0 + L7, the carrier returns to a predetermined position of the station.

[0034]

In the embodiment, the following advantages are obtained.

(1) The validity of the address of the carrier can be checked using a photoelectric sensor for detection of the carrier.

(2) By positioning the detection line at the height of a gap between the carrier body and the endless bolt, the attachment for the carrier can be used also as a mark for identification. Further, the mark can be detected without being obstructed by the carrier body or the like.

(3) Identification of the carrier is not obstructed by transported articles such as cassettes.

[0035]

In the embodiment, though the photoelectric sensors and optical marks are used in combination, magnetic marks may be used instead of the optical marks. In this case, for example, the magnetic mark may be attached to an upper part of the carrier body, and the magnetic mark may be detected by the magnetic sensor for detecting the position and the type of the carrier. Though the photoelectric sensors are used in the embodiment, reflective type photoelectric sensors may be used. Further, alternatively, laser sensors or the like may be used.

Description of reference numerals

[0036]

2: transport system

4: endless belt

6, 6a, 6b: pulley

8: station

10: processing tool

12: carrier

14: cassette

20: manufacturing execution controller

22: material handling controller

24: endless belt driver

26: station controller

27: hand driver

28: hand

29R, 29L: occupation sensor

31, 32: shaping circuit

33: counter

34: carrier counter

35: comparator

36: latch

37: adder

38: comparator

40: encoder checker

41: parameter memory

42: communication I/F

43 to 45: encoder

46: driving motor

48, 48f, 48r: attachment

49: supporting surface

50: flange

51: carrier body

52: column

54: guide groove

56: elevating and lowering rail

58: hand base

59: wheel

60: watching line

70: baseline

71 to 73: detection signal

80, 90: carrier

91, 92: attachment

94: optical mark

S1, s2: photoelectric sensor

enc: encoder

M1 to M3: motor

P1 to P7: parameter

K0 to K2: parameter

WHAT IS CLAIMED IS:

1. A transport system comprising:

an endless driving medium configured to rotate in a circulating manner;

a plurality of carriers each having an identification target for carrier identification, configured to hold articles, and attached to the endless driving medium; and

a plurality of stations each having a hand configured to load articles to or unload articles from the carriers, and a sensor configured to detect the identification target at a predetermined position upstream of the hand along a rotation direction of the endless driving medium for outputting a detection signal of the carrier and an identification signal of the carrier.

2. The transport system according to claim 1, the transport system being configured to use the detection signal of the carrier as a timing signal for starting unloading or unloading operation of the hand.

3. The transport system according to claim 2, the identification target comprising an attachment configured to attach the carrier to the endless driving medium;

for identification of the carrier, attachments having different widths being provided for the plurality of carriers along the rotation direction of the endless driving medium.

4. The transport system according to claim 3, the attachment being attached to a lower end of the endless driving medium, a carrier body of the carrier being provided below the attachment with a gap in a height direction between the lower end of the endless driving medium and the carrier body of the carrier, the sensor being configured to detect the attachment at a height position between the lower end of the endless driving

medium and an upper portion of the carrier body.

5. The transport system according to claim 1, an identification target different from other identification targets being provided for every predetermined number of carriers, and the carriers being detected by detecting a number of identification targets detected after detection of the different identification target.

6. A method of identifying a carrier in a transport system, the method comprising the steps of:

attaching a plurality of carriers each having an identification target and configured to hold articles for transportation, to an endless driving medium configured to rotate in a circulating manner;

providing a plurality of stations each having a hand configured to load articles to or unloading articles from the carriers and a sensor configured to detect the identification target at a predetermined position upstream of the hand along a rotation direction of the endless driving medium; and

identifying a carrier and recognizing appearance of the carrier at a predetermined position based on a signal from the sensor for operating the hand for a desired carrier.

7. A carrier comprising:

a carrier body for supporting an article; and

an attachment provided at an upper portion of the carrier body for attachment to an endless driving medium,

the carrier being identifiable based on a width of the attachment along a moving direction of the endless driving medium.