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(54) **Separation method**

Trennverfahren

Procédé de séparation

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a separation method for separating small pieces consisting of a specific constituent substance from a group of the small pieces in which plural small pieces obtained by crushing the used household electric appliances and the like are mixed.

Related art of the Invention

[0002] In recent years, economic activities represented by mass production, mass consumption, and mass disposal have been causing environmental problems on a global scale, such as global warming and depletion of resources.

[0003] Under such circumstance, it is obliged to recycle the used air conditioners, televisions, refrigerators/freezers, and washing machines by paying attention to the recycling household electric appliances so as to build a recycling society.

[0004] The unneeded household electric appliances become small pieces by crushing and then these crushed small pieces are separated for the constituent substance by using magnetism, wind, oscillation, and the like in household electric appliance-recycling plants, so as to reuse them.

[0005] As to metal materials, the high recycling rate is realized because these small pieces are separated for the constituent substance such as iron, copper, aluminum and the like at high purity by using a specific gravity separation device or a magnetism separation device.

[0006] As to resin materials, polypropylene (hereinafter denoted as PP), which has a low specific gravity, is separated from a component having a high specific gravity through specific gravity segregation using water and thus recovered with a relatively high degree of purity.

[0007] However, in the case of the specific gravity segregation using water, an enormous amount of wastewater is produced and it is difficult to separate with high accuracy, for example, polystyrene (hereinafter denoted as PS), acrylonitrile-butadiene-styrene (hereinafter denoted as ABS) and the like, which have similar specific gravities, from each other.

[0008] Further, the separation apparatus, which can separate the resin materials at high accuracy by using a jet of air and is useful for the recycling of the resin materials, has been known (see, for example, Japanese Patent Laid-Open No. 2009-279553).

[0009] In the following, such conventional separation apparatus 100 will be described, referring to Fig. 5.

[0010] Here, FIG. 5 is a schematic side view of the conventional separation apparatus 100.

[0011] In the case of the conventional separation apparatus 100, the constituent substance of the resin small piece 101 conveyed by the conveyor 104 is distinguished by the distinguishing device 106 when the resin small piece 101 passes the front of the distinguishing device 106.

[0012] According to the distinguishing result of the distinguishing device 106, air is jetted from the jetting nozzle 110 in the direction intersecting for a flight direction of the resin small piece 101 which falls from the lower end of the shooter 105, when constant time passes after the resin small piece 101 passes through a detection position of the passing detection sensor 111

[0013] By means of this, it is decided into which side of separation board 130 the resin small piece 101 falls depending on the constituent substance, so that the resin small pieces 101 are separated from each other.

[0014] US 5,887,073 describes a high speed mass flow food sorting apparatus and method comprises a product conveyor for receiving and conveying a laterally-distributed stream of bulk food articles past a product diverter. A camera is positioned to view the stream of food articles upstream of a product diverter. A sorting system downstream of the camera including a product diverter is configured to divert undesirable product in response to optically detected undesirable characteristics pursuant to an automated control system. The automated control system connects to the optical inspection system and the sorting system and includes an operator control console having a display and a screen-adjustable graphical slider usable for altering sorting characteristics corresponding to an undesirable optically detected characteristic so as to direct sorting of the undesirable food article during processing. Preferably, the operator control console displays a graphical user interface via a computer on which the control system is implemented and includes a software application pack specifically configured for processing a particular type of food article having corresponding desirable features, at least one having a corresponding screen-adjustable scaling image.

[0015] DE 197 36 567 C1 specifies an arrangement which has a first proximity zone through which the products pass into a second zone containing a separation element rotated by a stepper motor and with peripheral fingers at equal intervals. The separation elements transfers the products into three or more further zones. A real-time imaging following system detects the entire path of the products through the zones. The system places information associated with the

individual products, e.g. vol., speed, shape, centre of gravity, damage points, etc. into individual microprocessors or address regions and passes the data to a main coordinate processor whose outputs control the stepper motor and separating element with individual product related rotation direction and acceleration.

SUMMARY OF THE INVENTION

[0016] The inventors of the present invention, however, have noticed that the conventional separation apparatus 100 cannot separate the resin small pieces 101 at accuracy high enough.

[0017] Then the inventors think that the cause is that the air is jetted from the jetting nozzle 110, when constant time which is decided uniformly passes after the resin small piece 101 passes through a detection position of the passing detection sensor 111.

[0018] That is to say, in the case of the conventional separation apparatus 100, many resin small pieces 101 are continuously supplied to the conveyor 104, the constituent substances of the resin small pieces 101 are distinguished, respectively, and air is jetted according to the distinguishing result.

[0019] The shapes and sizes of the resin small pieces 101 are various. When the size of the resin small piece 101 is large for the detection resolution (the minimum size of the detectable resin small piece) of the passing detection sensor 111, plural detection positions exist for the single resin small piece 101. Therefore, plural detection results corresponding to the plural detection positions, respectively, can be obtained with respect to the single resin small piece 101.

[0020] Under such a situation, in many cases, the air jetted first hits only the edge part of the resin small piece 101.

[0021] As a result, the resin small piece 101 which should be separated may not be blown off successfully, because a posture of the resin small piece 101 is changed by rotation due to the shape and size of the resin small piece 101.

[0022] Next, more concrete explanation will be described, referring to Figs. 6(a) to 6(c).

[0023] Here, Fig. 6(a) is a schematic perspective view of the other conventional separation apparatus 150. Figs. 6(b) and 6(c) are explanation views of plural distinguishing results (hereinafter referred to as the group of distinguishing results) by the distinguishing device 3 of the other conventional separation apparatus 150.

[0024] As shown in Fig. 6(a), a small piece 2A as a separation target is conveyed by the conveyor 1, and the constituent substance of the small piece 2A is distinguished when the small piece 2A passes under the distinguishing device 3.

[0025] As shown in Fig. 6(b), when the size of the small piece 2A is large for the detection resolution of the distinguishing device 3, plural distinguishing results 9 are obtained with respect to the single small piece 2A.

[0026] As shown in Fig. 6(b), the plural distinguishing results 9 denoted by black round marks are distinguishing results of the constituent substances distinguished at a constant interval when the small piece 2A passes under the distinguishing device 3, and the group of distinguishing results is formed by the plural distinguishing results 9. Further, these positions of the black round marks denote the distinguishing positions on the small piece 2A.

[0027] The small piece 2A which is conveyed in a conveying direction X (see Fig. 6(a)) by the conveyor 1 is thrown out the conveying end portion 4 of the conveyor 1 and flies.

[0028] The group of nozzles 5 provided in order to separate the small piece 2A, which is made from the specific constituent substance, from the flying path of the small piece 2B made from the other constituent substance is allowed to jet air according to the distinguishing results 9, and the small piece 2A made from the specific constituent substance is shot down into the side near the conveyor 1 with reference to the separation board 7, so as to be separated from the small piece 2B made from the other constituent substance.

[0029] However, it is thought that the air jetted from the group of nozzles 5 hits only an edge part 2A1 of the board-shaped small piece 2A, because the air is jetted from the group of nozzles 5, based on the distinguishing results 9 (that is, the distinguishing results 9 located in the right end in Fig. 6(b)) obtained at the first timing in the group of the distinguishing results for the small piece 2A obtained by the distinguishing device 3.

[0030] As a result, a posture of the small piece 2A is changed by rotation due to the influence of the air that has hit the edge part 2A1 of the small piece 2A.

[0031] In this case, the air is jetted continuously or intermittently based on the other distinguishing results 9 in the group of the distinguishing results, however, the air from the group of nozzles 5 does not hit the small piece 2A correctly, because the posture of the small piece 2A has been changed already.

[0032] As a result, the small piece 2A, which should be shot down into the side near the conveyor 1 with reference to the separation board 7, is not shot down into the side, flies the course denoted by the arrow, and falls to a place distant from the conveyor 1 with reference to the separation board 7 as shown in Fig. 6(a) .

[0033] By the way, there is a case where erroneous decision, in which the distinguishing results which are obtained on the same small piece 2A differ, occurs. That is, as shown in Fig. 6(c), the distinguishing result 9B which should be the same as the distinguishing result 9A may be obtained as a distinguishing result which is different from the distinguishing result 9A by the erroneous decision due to an electric noise or a shape of material. Here, it is supposed that the distinguishing result 9A denotes a correct distinguishing result and the distinguishing result 9B denotes an incorrect distinguishing result.

[0034] In this case, the air is jetted based on the incorrect distinguishing result 9B. Therefore, the small piece 2A, which should be separated from the small piece 2B made from the other constituent substance, is not separated correctly, and as a result, the small piece 2A made from the specific constituent substance, which should be separated, is mixed in the group of the small piece 2B made from the other constituent substance.

[0035] An object of the present invention is, in view of the above-mentioned conventional problems, to provide a separation method, which can recover the separation target at higher accuracy.

[0036] In accordance with the present invention, this object is achieved by the features of independent claim 1. A preferred embodiment is defined in the dependent claim.

Advantageous Effects of the Invention

[0037] According to the present invention, it is possible to provide a a separation method, which can recover the separation target at higher accuracy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038]

Figs. 1(a), 1(b) and 1(c) are schematic side views of a separation apparatus usable with the present invention;
Fig. 2 is a schematic plan view of a separation apparatus usable with the present invention;
Figs. 3(a) and 3(b) are schematic perspective views of a further separation apparatus;
Figs. 3(c) and 3(d) are explanation views of the group of distinguishing results by the distinguishing device;
Figs. 4(a), 4(b), 4(c) and 4(d) are further explanation views of the groups of distinguishing results obtained by the distinguishing device of the separation apparatus;
Fig. 4(e) is an explanation view of a distinguishing application area shown in Fig. 4(d);
Fig. 5 is a schematic side view of the conventional separation apparatus;
Fig. 6(a) is a schematic perspective view of the other conventional separation apparatus; and Figs. 6(b) and 6(c) are explanation views of group of distinguishing results by the distinguishing device of the other conventional separation apparatus.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0039] In the following, an embodiment of the present invention will be described, referring to drawings.

[0040] A configuration and operation of a separation apparatus 200 will be described, mainly referring to Figs. 1(a) to 1(c) and Fig. 2.

[0041] Here, Figs. 1(a), 1(b) and 1(c) are schematic side views of a separation apparatus 200 according to the present Embodiment 1 of the present invention. Fig. 2 is a schematic plan view of the separation apparatus 200 according to the present Embodiment 1 of the present invention.

[0042] By the way, the following embodiment is merely one example of a separation apparatus, and the present invention is not limited to this embodiment.

[0043] One example of the separation method according to the present invention will also be described, while describing the operation of the separation apparatus 200.

[0044] Since the constituent substances of small pieces 2A, 2B, 2C and 2D are analyzed by a distinguishing device 3 having an optical device which analyzes the constituent substances of the small pieces 2A to 2D, based on the distributions of intensity of reflected light which are detected by irradiating the small pieces 2A to 2D with light, it is possible to separate the small pieces 2A to 2D consisting of the resin material, which cannot be separated by the conventional specific gravity separation device.

[0045] The optical device of the distinguishing device 3 has plural light emitting/light receiving elements (not shown) which are disposed in the direction perpendicular to the conveyance direction X of the conveyor 1 (see Fig. 2). Since the conveyor 1 is allowed to have another distribution of intensity of reflected light that is different from each of the unique distributions of intensity of reflected light of the resin materials, it becomes possible to distinguish whether the small pieces 2A to 2D exist or not and analyze the constituent substances thereof as described below.

[0046] More specifically, the distinguishing device 3 analyzes the constituent substances of the small pieces 2A to 2D as the separation targets which are conveyed by the conveyor 1, and the analyzed small piece 2A made from the specific constituent substance is separated from the flying paths of the other small pieces 2B to 2D which are thrown out the conveying end portion 4 of the conveyor 1.

[0047] That is, the separation apparatus 200 specifies the small piece 2A which should be separated, based on information about the constituent substances analyzed by the distinguishing device 3, determines the timing at which

air is allowed to jet pulsingly from nozzles which are disposed above or below the flying path, and blows off the small piece 2A made from the specific constituent substance by jetting the air pulsingly based on the timing in order to separate the small piece 2A from the other small pieces 2B to 2D.

[0048] As described below, the air is jetted at least to a position of a center of gravity of the small piece 2A.

[0049] In Figs. 1(a) to 1(c), the small pieces 2A, 2B, 2C and 2D denote the small pieces before passing under the distinguishing device 3, and the small pieces 2A', 2B', 2C' and 2D' denote the small pieces after passing under the distinguishing device 3. Here, the small pieces 2A' to 2D' are the same as the small pieces 2A to 2D, respectively.

[0050] First, a configuration of a separation apparatus 200 will be described more concretely, referring to Fig. 1(a) and Fig. 2.

[0051] A group of nozzles 5 is provided with plural nozzles which jet air in order to separate the small piece 2A made from the specific constituent substance from the flying path of the small pieces 2A to 2D as separation targets which are conveyed and are thrown out the conveying end portion 4 of the conveyor 1, and the plural nozzles are disposed in a width direction of the conveyor 1.

[0052] A calculation part 6 specifies the small piece 2A which should be separated, based on information about the constituent substances analyzed by the distinguishing device 3, and determines the timing at which the air is allowed to jet pulsingly from the group of nozzles 5.

[0053] A separation board 7 is a member which is disposed so as to separate the small piece 2A made from the specific constituent substance, which has been separated from the flying paths of the other small pieces 2B to 2D.

[0054] Each size of the small pieces 2A to 2D is about 10 to 100 mm with respect to a lengthwise direction and a lateral direction, and is about 0.5 to 2 mm with respect to a thickness direction.

[0055] A conveyance speed of the conveyor 1 is about 2 to 3 m/sec.

[0056] The interval between the nozzles of the group of nozzles 5, which are disposed in the direction perpendicular to the conveyance direction X of the conveyor 1, is about 5 to 10 mm.

[0057] Next, operation of the separation apparatus 200 will be described more concretely, referring to Figs. 1(a) to 1(c).

[0058] As shown in Fig. 1(b), the distinguishing device 3 distinguishes whether the small piece 2A' as one of the separation targets, which passed under the distinguishing device 3, exists or not, and analyzes the constituent substance of the small piece 2A' when the distinguishing device 3 judges that the small piece 2A' exists.

[0059] As shown in Fig. 1(c), the small pieces 2A' to 2D' which have been distinguished by the distinguishing device 3 are thrown out the conveying end portion 4 of the conveyor 1.

[0060] When the small piece 2A' made from the specific constituent substance, which should be separated, passes under the group of nozzles 5, the air is jetted pulsingly from the nozzle corresponding to the position of the small piece 2A'.

[0061] Then, the small piece 2A' made from the specific constituent substance, which should be separated, is blown off and separated from the flying paths of the other small pieces 2B' to 2D'.

[0062] The typical flying paths of the small pieces 2B' to 2D' which have been thrown out the conveying end portion 4 of the conveyor 1 are indicated by a solid line, a dotted line and a chain line.

[0063] Next, it will be described more concretely how the small piece 2A made from the specific constituent substance, which should be separated, is specified, based on information about the constituent substances analyzed by the distinguishing device 3, and how the timing, at which the air is allowed to jet pulsingly from the group of nozzles 5, is determined.

[0064] When the small pieces 2A to 2D as the separation targets which are conveyed by the conveyor 1 pass under the distinguishing device 3, the distinguishing device 3 distinguishes whether the small pieces 2A to 2D exist or not and analyzes the constituent substances thereof.

[0065] That is, the distinguishing device 3 distinguishes whether the small pieces 2A to 2D exist or not and analyzes the constituent substances thereof at a constant cycle or a constant interval with respect to the parallel and perpendicular directions with reference to the conveyance direction X of the conveyor 1.

[0066] Therefore, for example, when the size of the small piece 2A is large for the detection resolution of the distinguishing device 3, plural distinguishing results are obtained for the single small piece 2A.

[0067] As for this point, more concrete explanation will be described as follows, referring to Fig. 3(a) and Fig. 3(b).

[0068] Here, Fig. 3(a) and Fig. 3(b) are schematic perspective views of the separation apparatus 200.

[0069] Fig. 3(c) and Fig. 3(d) are explanation views of the groups of distinguishing results by the distinguishing device 3 of the separation apparatus 200.

[0070] As shown in Fig. 3(a), for example, as for the small piece 2A conveyed by the conveyor 1, the constituent substances corresponding to the distinguishing positions 8C to 8E are analyzed, respectively.

[0071] Since the small piece 2A does not exist at the distinguishing positions 8A, 8B, 8F and 8G, data indicating that small piece 2A does not exist is obtained. Here, the distinguishing positions 8A, 8B, 8C, 8D, 8E, 8F and 8G denote the positions where the distinguishing device 3 distinguishes whether the small pieces exist or not and analyzes the constituent substances thereof by using the plural light emitting/light receiving elements which the distinguishing device 3 is provided with.

[0072] Next, as shown in Fig. 3(b), when a certain period of time passes and the small piece 2A is further conveyed

in the conveyance direction X by the conveyor 1, the constituent substances at the distinguishing positions 8B to 8F are analyzed, respectively.

[0073] Since the small piece 2A does not exist at the distinguishing positions 8A and 8G, data indicating that small piece 2A does not exist is obtained.

[0074] Thus, as shown in Fig. 3(c), distinguishing operation at the distinguishing positions 8A to 8G is repeated at a constant interval, and plural distinguishing results 9 are obtained with respect to the single small piece 2A.

[0075] That is, the distinguishing device 3 has the plural light emitting/light receiving elements as an optical device disposed one-dimensionally, which correspond to the distinguishing positions 8A to 8G, and repeats the distinguishing operation with respect to the conveyance direction X of the conveyor 1. Thus, the lattice-like plural distinguishing results 9 which are arranged two-dimensionally for the conveyor 1 are obtained.

[0076] By the way, the distinguishing device 3 may have an optical device which, for example, has plural light emitting/light receiving elements arranged two-dimensionally, and may collectively obtain many distinguishing results arranged two-dimensionally.

[0077] When the constituent substance is distinguished continuously with respect to the parallel or perpendicular direction with reference to the conveyance direction X, the calculation part 6 judges that the small piece 2A exists as a single lump on a figure which is formed by the distinguishing positions 8A to 8G.

[0078] That is, the calculation part 6 analyzes an adjacency state of the plural distinguishing results 9, and judges that the plural distinguishing results 9, which correspond to the distinguishing positions on the same figure, are the distinguishing results that should be dealt with as distinguishing results with respect to the single small piece 2A.

[0079] Here, when the adjacency state of the plural distinguishing results 9 is analyzed by the calculation part 6, the adjacency state is analyzed by distinguishing whether the small piece exists or notat the distinguishing positions 8A to 8G without taking the constituent substance of the small piece into consideration.

[0080] Further, when the calculation part 6 judges that the small piece 2A which should be blown off and be separated exists on the figure described above, the calculation part 6 performs quadrature and calculates the position of the center of gravity of the figure.

[0081] For example, as shown in Fig. 3(d), a solid line 10 which encloses plural distinguishing results 9 is created, the quadrature is performed for the figure which is formed by the solid line 10 and considered the shape of the small piece 2A, and the position of the center of gravity 11 of the figure is calculated.

[0082] Then, when the center of gravity 11 passes under the group of nozzles 5, air is jetted from the corresponding nozzle which corresponds to the position of the center of gravity 11, so that the small piece 2A' is blown off and separated.

[0083] The length of an air injection period may be adjusted according to the size of the small piece 2A.

[0084] More concretely, when the weight of the small piece 2A and/or the conveyance speed of the conveyor 1 are large, the air may be jetted not only at the timing when the center of gravity 11 passes under the group of nozzles 5 but also continually or intermittently at least until the center of gravity 11 passes under the group of nozzles 5 from the upper stream side of the position of the group of nozzles 5.

[0085] Accordingly, even when the weight of the small piece 2A and/or the conveyance speed of the conveyor 1 are large, the small piece 2A can be separated correctly from the small pieces 2B to 2D, because the air also hits a front side portion of the small piece 2A, which is away from the center of gravity 11 by a desired distance with respect to the conveyance direction X of the conveyor 1.

[0086] By the way, also in this embodiment, erroneous decision resulting from an electric noise, a shape of material, and the like may occur.

[0087] That is, as described above, since the optical device is used in the distinguishing device 3, the erroneous decision due to the shape of the material, the surface condition of the material, and the like may occur.

[0088] For example, when the small piece 2A of PS should be separated, there is a case where the distinguishing results 9 which show that PS exists in the small piece 2B of PP are obtained. If the air is jetted according to such distinguishing results 9, the small piece 2B of PP may be separated.

[0089] Next, more concrete explanation will be described, referring to Figs. 4(a) to 4(e).

[0090] Figs. 4(a), 4(b), 4(c) and 4(d) are the explanation views of the groups of distinguishing results obtained by the distinguishing device 3 of the separation apparatus, respectively, and Fig. 4(e) is the explanation view of the distinguishing application area shown in Fig. 4(d).

[0091] There is a case where the group of distinguishing results with respect to the single small piece 2A which should be separated, as shown in Fig. 4(a), has been formed only by the distinguishing result 9A which indicates the constituent substance A of the small piece 2A correctly. And also, there is a case where the group of distinguishing results with respect to the single small piece 2A which should be separated, as shown in Fig. 4(b), has been formed by the distinguishing result 9A which indicates the constituent substance A of the small piece 2A correctly and the distinguishing result 9B which indicates the constituent substance B rather than the constituent substance A of the small piece 2A incorrectly.

[0092] Further, as shown in Fig. 4(c), there is a case where it is judged that the two overlapping small pieces 2A and

2B exist as a single lump.

[0093] Therefore, it may be determined whether the jetting of air is carried out or not, by simply ignoring the distinguishing results except the distinguishing result 9A being a large majority, or it may be determined whether the jetting of air is carried out, by using an evaluation function, based on a score which is given to each of the plural kinds of constituent substances.

[0094] Here, an example, in which it is determined by using evaluation functions whether the jetting of air is carried out or not, will be described. That is, the evaluation functions are expressed by the following (Expression 1) and (Expression 2). A determination value J_{OK} which denotes a permission degree of blowing off is defined by the (Expression 1) and a determination value J_{NG} which denotes a disapproval degree of blowing off is defined by the (Expression 2). According to this example, in the case of $J_{OK}<J_{NG}$, the jetting of air is not carried out, and in the case of $J_{OK} \geq J_{NG}$, the jetting of air is carried out.

(Expression 1)

$$J_{OK}=p(A)q(A)\alpha_{OK}(A)+p(B)q(B)\alpha_{OK}(B).$$

(Expression 2)

$$J_{NG}=p(A)q(A)\alpha_{NG}(A)+p(B)q(B)\alpha_{NG}(B).$$

Here, p(A) is a constant showing the probability of a distinguishing result with respect to the constituent substance A, and

p(B) is a constant showing the probability of a distinguishing result with respect to the constituent substance B.

[0095] For example, if it is known beforehand that the erroneous decision about the constituent substance A occurs easily, p(A) is set smallish.

[0096] Next, q(A) is an area ratio (%) about the constituent substance A, and

q(B) is an area ratio (%) about the constituent substance B.

[0097] For example, q(A) is a numerical value which is obtained by dividing the number of the distinguishing result 9A, which correctly indicates the constituent substance A about a figure which is considered a shape of the small piece 2A, by the summation of the number of all the distinguishing results 9A, 9B and the like about the same figure.

[0098] As shown in Fig. 4(c), when the number of the distinguishing result 9A, which indicates the constituent substance A, is 15, and the summation of the number of all the distinguishing results 9A and 9B is 23 (=15+8), q(A) is about 65%.

[0099] Further, $a_{OK}(A)$ is a predetermined constant about the constituent substance A, which shows the degree of promoting the blowing off of the small piece,

$\alpha_{OK}(B)$ is a predetermined constant about the constituent substance B, which shows the degree of promoting the blowing off of the small piece,

$\alpha_{NG}(A)$ is a predetermined constant about the constituent substance A, which shows the degree of suppressing the blowing off of the small piece, and

$\alpha_{NG}(B)$ is a predetermined constant about the constituent substance B, which shows the degree of suppressing the blowing off of the small piece.

[0100] Regarding the constituent substance A, for example, in a case where importance thereof is high and then an increase in recovering quantity of the constituent substance A is desired, $\alpha_{OK}(A)$ is set largish, and for example, in a case where the accuracy of separation thereof is required and mixing reduction of the constituent substance B is desired, $\alpha_{NG}(A)$ is set largish.

[0101] Regarding the constituent substance B, for example, in a case where importance thereof is high and then an increase in recovering quantity of the constituent substance B is desired, $\alpha_{NG}(B)$ is set largish, and for example, in a case where the accuracy of separation thereof is required and mixing reduction of the constituent substance A is desired, $\alpha_{OK}(B)$ is set largish.

[0102] Incidentally, in this case, the constituent substance A is recovered by carrying out the jetting of air, and the constituent substance B is recovered by not carrying out the jetting of air.

[0103] Regarding the constituent substance A, for example, in a case where, although the importance thereof is high, the accuracy of separation thereof is not required so much, the constants indicated by the following (Expression 3) are set.

(Expression 3)

$$\alpha_{OK}(A)=0.7,\ \alpha_{NG}(A)=0.3.$$

[0104] Further, regarding the constituent substance A, for example, in a case where, although the importance thereof is not so high, the accuracy of separation thereof is required, the constants indicated by the following (Expression 4) are set.

(Expression 4)

$$\alpha_{OK}(A)=0.5,\ \alpha_{NG}(A)=0.5.$$

[0105] Similarly, regarding the constituent substance B, for example, in a case where, although the importance thereof is high, the accuracy of separation thereof is not required so much, the constants indicated by the following (Expression 5) are set.

(Expression 5)

$$\alpha_{OK}(B)=0.5,\ \alpha_{NG}(B)=0.5.$$

[0106] Further, regarding the constituent substance B, for example, in a case where, although the importance thereof is not so high, the accuracy of separation thereof is required, the constants indicated by the following (Expression 6) are set.

(Expression 6)

$$\alpha_{OK}(B)=0.7,\ \alpha_{NG}(B)=0.3.$$

[0107] From the above, for example, in a case where, although the importance of the constituent substance A is high, the accuracy of separation thereof is not required so much and, although the importance of the constituent substance B is not so high, the accuracy of separation thereof is required, the constants indicated by (Expression 3) and (Expression 6), respectively, are adopted.

[0108] By the way, if it is known beforehand that the erroneous decision occurs easily near the edge part of the small piece 2A, it may be determined whether the jetting of air is carried out or not, based on the distinguishing results in the center portion of the small piece 2A.

[0109] As shown in Fig. 4(d), if it is known beforehand that the erroneous decision occurs easily near the edge part 2A1 of the small piece 2A, it may be determined whether the jetting of air is carried out or not, by applying the above-mentioned evaluation function to the distinguishing results 9 which exist in a distinguishing application area 12 in the center portion of the small piece 2A except the neighborhood of the edge part 2A1.

[0110] Here, the distinguishing application area 12 is an area which is constituted only by the below-mentioned distinguishing positions Pc, as shown in Fig. 4(e). That is, when the data of four distinguishing results which indicate the existence of the small piece 2A is obtained at the four distinguishing positions Pu, Pd, Ps1 and Ps2, which exist around the distinguishing position Pc, the distinguishing application area 12 is set up. As shown in Fig. 4(e), the distinguishing position Pc is between the distinguishing positions Pu and Pd with reference to an arrow direction Y perpendicular to the conveyance direction X of the conveyor 1, and the distinguishing position Pc is between the distinguishing positions Ps1 and Ps2 with reference to an arrow direction X' parallel to the conveyance direction X of the conveyor 1.

[0111] By means of this, the bad influence resulting from the erroneous decision becomes small. As a result, the phenomenon, in which the material which should be separated cannot be separated, decreases more, and the phenomenon, in which the material which should not be separated is separated, decreases more.

[0112] By the way, the conveyor 1 is one example of a conveying unit useable with the present invention. The distinguishing device 3 is one example of a distinguishing unit useable with the present invention. The constitution which includes the group of nozzles 5 and the calculation part 6 is one example of a recovering unit useable with the present invention. Each of the small pieces 2A to 2D is one example of separation targets useable with the present invention. And the air is one example of air or gas useable with the present invention.

[0113] For example, a part of the function of the distinguishing device 3 may be carried out by the calculation part 6, and a part of the function of the calculation part 6 may be carried out by the distinguishing device 3.

[0114] The calculation part 6 may distinguish the shape, size and position of the small piece 2A by analyzing the adjacency state of the plural distinguishing results 9 in which the constituent substances of the small pieces 2A to 2D are the same rather than, as described above, by distinguishing whether the small piece exists or not at the distinguishing positions 8A to 8G without taking the constituent substance of the small piece into consideration, to analyze the adjacency state of the plural distinguishing results 9 (see Figs. 4(a) to 4(e)).

[0115] For example, the adjacency state of all the plural distinguishing results 9 may be analyzed first, while disregarding the constituent substances of the small pieces 2A to 2D, and after that, the constituent substances of the small pieces 2A to 2D may be analyzed. By contrast, the constituent substances of the small pieces 2A to 2D may be analyzed first,

and after that, the adjacency state of the plural distinguishing results 9 may be analyzed for every constituent substance.

[0116] In the latter case where the constituent substances of the small pieces 2A to 2D are analyzed first, and after that, the adjacency state of the plural distinguishing results 9 is analyzed for every constituent substance, there are few bad influences resulting from the erroneous decision because the constituent substances of the small pieces 2A to 2D are analyzed first.

[0117] Accordingly, since the extremely high separation precision and separation efficiency are realized and the separation purity and recovering yield of the small piece made from the constituent substance which should be separated can be raised, the range of the separation target products for recycling is enlarged and the small pieces of the specific constituent substances included in the general wastes can be recycled. As a result, improvement of the recycling quality and productivity can be expected, and also the resources circulation can be promoted.

INDUSTRIAL APPLICABILITY

[0118] A separation method of the present invention, with which it is possible to recover the separation target in higher separation precision, are useful for utilizing as a separation method, for example, for separating small pieces consisting of a specific constituent substance from a group of the small pieces in which plural small pieces obtained by crushing the used household electric appliances and the like are mixed.

Reference Signs List

[0119]

1	Conveyor
2A, 2B, 2C, 2D, 2A', 2B', 2C', 2D'	Small piece
3	Distinguishing device
4	Conveying end portion
5	Group of nozzles
6	Calculation part
7	Separation board
200	Separation apparatus

Claims

1. A separation method of analyzing constituent substances of separation targets on a conveying unit and recovering the separation target having a predetermined constituent substance by jetting a gas to a center of gravity of the separation target from a nozzle, the separation target being discharged from the conveying unit and thus being separated from the flying paths of the other small pieces, and
the separation method
characterized by
comprising the steps of:

obtaining plural distinguishing points of the separation targets (2A, 2B, 2C, 2D) on a conveying unit (1) by a distinguishing unit (3) which has lattice-like plural distinguishing points at a predetermined position for the conveying unit (1);
distinguishing by the distinguishing device (3), whether the separation targets (2A, 2B, 2C, 2D) exist or not at the plural distinguishing points;
analyzing the constituent substances of the separation targets (2A, 2B, 2C, 2D) at the plural distinguishing points when the separation targets (2A, 2B, 2C, 2D) exist; calculating a centre of gravity (11) of the separation target (2A) having the predetermined constituent substance (A) by the distinguishing device (3);
distinguishing that the separation target exists as a lump when the constituent substance is detected continuously at the plural distinguishing points;
distinguishing shape, size and position of the separation targets (2A, 2B, 2C, 2D) by analyzing an adjacency state of the distinguishing points where the separation targets (2A, 2B, 2C, 2D) exist, and
specifying the separation target (2A) having the predetermined constituent substance (A), to which the air or gas is to be jetted, based on a score which is given to each of the plural kinds of constituent substances (A, B);
analyzing the constituent substances of the separation target when the separation target exists as the lump, and in a case where it is judged that the lump is a single lump in which different kinds of constituent substances are

not overlapped, performing the jet of the gas to at least the centre of gravity of the separation target from the nozzle (5) so as to effect separation, and
in a case where it is judged that the lump is a single lump in which different kinds of constituent substances are overlapped,
performing the jet of the gas to at least the centre of gravity of the separation target from the nozzle (5) in a case of $J_{OK} \geq J_{NG}$, and not performing the jet of the gas to the separation target from the nozzle (5) in a case of $J_{OK} < J_{NG}$, by using evaluation functions based on scores given to the plural kinds of constituent substances beforehand, which are expressed by an expression 1 and an expression 2, the expression 1 defining the J_{OK} as a determination value which denotes a permission degree of blowing off and the expression 2 defining the J_{NG} as a determination value which denotes a disapproval degree of blowing off whereby:

Expression 1 is

$$J_{OK}=p(A)q(A)\alpha_{OK}(A)+p(B)q(B)\alpha_{OK}(B),$$

and

Expression 2 is

$$J_{NG}=p(A)q(A)\alpha_{NG}(A)+p(B)q(B)\alpha_{NG}(B),$$

wherein, p(A) is a constant showing probability of a distinguishing result with respect to a constituent substance A,
p(B) is a constant showing probability of a distinguishing result with respect to a constituent substance B,
q(A) is an area ratio (%) about the constituent substance A,
q(B) is an area ratio (%) about the constituent substance B,
$\alpha_{OK}(A)$ is a predetermined constant about the constituent substance A, which shows degree of promoting the blowing off,
$\alpha_{OK}(B)$ is a predetermined constant about the constituent substance B, which shows the degree of promoting the blowing off,
$\alpha_{NG}(A)$ is a predetermined constant about the constituent substance A, which shows degree of suppressing the blowing off, and
$\alpha_{NG}(B)$ is a predetermined constant about the constituent substance B, which shows the degree of suppressing the blowing off.

2. The separation method according to claim 1,
wherein a number of the nozzle (5) is a plural number, and
the gas is jetted to a circumference of the center of gravity (11) of the separation target (2A) from the plural nozzles, which has the predetermined constituent substance (A) as well as the center of gravity (11).

Patentansprüche

1. Trennverfahren zum Analysieren von Inhaltsstoffsubstanzen von Trennzielen auf einer Fördereinheit und zum Rückgewinnen des Trennziels mit einer vorgegebenen Inhaltsstoffsubstanz durch Ausstoßen eines Gases auf einen Schwerpunkt des Trennziels aus einer Düse, wobei das Trennziel von der Fördereinheit abgesondert und somit von den Flugwegen der anderen Kleinteile getrennt wird, und
das Trennverfahren
gekennzeichnet ist durch
das Umfassen der Schritte:

Beziehen von mehreren Unterscheidungspunkten der Trennziele (2A, 2B, 2C, 2D) auf einer Fördereinheit (1) durch eine Unterscheidungseinheit (3), die mehrere gitterförmige Unterscheidungspunkte an einer vorgegebenen Position für die Fördereinheit (1) hat;
Unterscheiden durch die Unterscheidungsvorrichtung (3), ob es die Trennziele (2A, 2B, 2C, 2D) an den mehreren Unterscheidungspunkten gibt oder nicht;
Analysieren der Inhaltsstoffsubstanzen der Trennziele (2A, 2B, 2O, 2D) an den mehreren Unterscheidungspunkten, wenn es die Trennziele (ZA, 2B, 2C, 2D) gibt; Berechnen eines Schwerpunktes (11) des Trennziels

(2A) mit der vorgegebenen Inhaltsstoffsubstanz (A) durch die Unterscheidungsvorrichtung (3);
Unterscheiden, dass es das Trennziel als einen Klumpen gibt, wenn die Inhaltsstoffsubstanz an den mehreren Unterscheidungspunkten kontinuierlich erfasst wird;
Unterscheiden von Form, Größe und Position der Trennziele (2A, 2B, 2C, 2D) durch Analysieren eines Angrenzungsstatus der Unterscheidungspunkte, an denen es die Trennziele (2A, 2B, 2C, 2D) gibt, und
Spezifizieren des Trennziels (2A) mit der vorgegebenen Inhaltsstoffsubstanz (A), auf die die Luft oder das Gas auszustoßen ist, auf der Basis einer Bewertung, die für jede der mehreren Arten von Inhaltsstoffsubstanzen (A, B) gegeben ist; Analysieren der Inhaltsstoffsubstanzen des Trennziels, wenn es das Trennziel als den Klumpen gibt, und
in einem Fall, in dem entschieden wird, dass der Klumpen ein einzelner Klumpen ist, in dem sich unterschiedliche Arten von Inhaltsstoffen nicht überlappen, Durchführen des Ausstoßens des Gases auf wenigstens den Schwerpunkt des Trennziels aus der Düse (5), um so eine Trennung zu bewirken, und
in einem Fall, in dem entschieden wird, dass der Klumpen ein einzelner Klumpen ist, in dem sich unterschiedliche Arten von Inhaltsstoffsubstanzen überlappen,
Durchführen des Ausstoßens des Gases auf wenigstens den Schwerpunkt des Trennziels aus der Düse (5) in einem Fall von $J_{OK} \geq J_{NG}$, und kein Durchführen des Ausstoßens des Gases auf das Trennziel aus der Düse (5) in einem Fall von $J_{OK} < J_{NG}$, indem Evaluierungsfunktionen auf der Basis von Bewertungen verwendet werden, die den mehreren Arten von Inhaltsstoffsubstanzen vorher gegeben wurden, die durch einen Ausdruck 1 und einen Ausdruck 2 ausgedrückt werden, wobei der Ausdruck 1 den J_{OK} als Bestimmungswert definiert, der einen Zulassungsgrad des Wegblasens bezeichnet, und der Ausdruck 2 den J_{NG} als Bestimmungswert definiert, der einen Ablehnungsgrad des Wegblasens kennzeichnet, wobei:

Ausdruck 1

$$J_{OK} = p(A)q(A)\alpha_{OK}(A) + p(B)q(B)\alpha_{OK}(B)$$

ist und

Ausdruck 2

$$J_{NG} = p(A)q(A)\alpha_{NG}(A) + p(B)q(B)\alpha_{NG}(B) \text{ ist,}$$

wobei p(A) eine Konstante ist, die die Wahrscheinlichkeit eines Unterscheidungsergebnisses mit Bezug auf eine Inhaltsstoffsubstanz A zeigt,
p(B) eine Konstante ist, die die Wahrscheinlichkeit eines Unterscheidungsergebnisses mit Bezug auf eine Inhaltsstoffsubstanz B zeigt,
q(A) ein Flächenverhältnis (%) über die Inhaltsstoffsubstanz A ist,
q(B) ein Flächenverhältnis (%) über die Inhaltsstoffsubstanz B ist,
$\alpha_{OK}(A)$ eine vorgegebene Konstante über die Inhaltsstoffsubstanz A ist, die den Förderungsgrad des Wegblasens zeigt,
$\alpha_{OK}(B)$ eine vorgegebene Konstante über die Inhaltsstoffsubstanz B ist, die den Förderungsgrad des Wegblasens zeigt,
$\alpha_{NG}(A)$ eine vorgegebene Konstante über die Inhaltsstoffsubstanz A ist, die den Unterdrückungsgrad des Wegblasens zeigt, und
$\alpha_{NG}(B)$ eine vorgegebene Konstante über die Inhaltsstoffsubstanz B ist, die den Unterdrückungsgrad des Wegblasens zeigt.

2. Trennverfahren nach Anspruch 1,
wobei eine Anzahl der Düsen (5) eine mehrfache Anzahl ist und
das Gas auf einen Umfang des Schwerpunktes (11) des Trennziels (2A) aus den mehreren Düsen ausgestoßen wird, das die vorgegebene Inhaltsstoffsubstanz (A) sowie den Schwerpunkt (11) hat.

Revendications

1. Procédé de séparation consistant à analyser des substances constitutives de cibles de séparation sur une unité de transport et à récupérer la cible de séparation comportant la substance constitutive prédéterminée en projetant un gaz sur le centre de gravité de la cible de séparation avec une buse, la cible de séparation étant éjectée de l'unité de transport et donc étant séparée des trajectoires des autres petites pièces, et
le procédé de séparation
étant caractérisé
en ce qu'il comprend les étapes suivantes :

la récupération de plusieurs points de distinction des cibles de séparation (2A, 2B, 2C, 2D) sur une unité de transport (1) par l'intermédiaire d'une unité de distinction (3) qui comporte plusieurs points de distinction en réseau à une position prédéterminée pour l'unité de transport (1),
la distinction opérée par le dispositif de distinction (3) de ce que les cibles de séparation (2A, 2B, 2C, 2D) se trouvent ou non au niveau des différents points de distinction,
l'analyse des substances constitutives des cibles de séparation (2A, 2B, 2C, 2D) au niveau des différents points de distinction lorsque les cibles de séparation (2A, 2B, 2C, 2D) s'y trouvent ; le calcul par le dispositif de distinction (3) du centre de gravité (11) de la cible de séparation (2A) comportant la substance constitutive (A) prédéterminée,
la distinction opérée de ce que la cible de séparation se trouve en tant que masse lorsque la substance constitutive est détectée de façon continue au niveau des différents points de distinction,
la distinction de la forme, de la taille et de la position des cibles de séparation (2A, 2B, 2C, 2D) en analysant un état de proximité des points de distinction où se trouvent les cibles de séparation (2A, 2B, 2C, 2D), et
la spécification de la cible de séparation (2A) comportant la substance constitutive (A) prédéterminée sur laquelle doit être projeté l'air ou du gaz, sur la base d'une note qui est donnée à chacun des différents types de substances constitutives (A, B) ; l'analyse des substances constitutives de la cible de séparation lorsque la cible de séparation se trouve en tant que masse, et
dans un cas où l'on évalue que la masse est une masse unique dans laquelle ne se chevauchent pas différents types de substances constitutives : l'exécution du jet de gaz au moins sur le centre de gravité de la cible de séparation avec la buse (5) de sorte à réaliser la séparation, et
dans un cas où l'on évalue que la masse est une masse unique dans laquelle se chevauchent différents types de substances constitutives :
l'exécution du jet de gaz au moins sur le centre de gravité de la cible de séparation avec la buse (5) dans le cas où $J_{OK} \geq J_{NG}$, et l'absence d'exécution du jet de gaz sur la cible de séparation avec la buse (5) dans le cas où $J_{OK} < J_{NG}$, en utilisant des fonctions d'évaluation fondées sur des notes données à l'avance aux différents types de substances constitutives, lesquelles sont exprimées par l'expression 1 et l'expression 2, l'expression 1 définissant le paramètre J_{OK} comme une valeur de détermination qui indique le degré d'autorisation d'éjection et l'expression 2 définissant le paramètre J_{NG} comme valeur de détermination qui indique le degré de refus d'éjection, grâce à quoi :

$$\text{l'expression 1 vaut :}$$
$$J_{OK} = p(A)\ q(A)\ \alpha_{OK}(A) + p(B)\ q(B)\ \alpha_{OK}(B),$$

et

$$\text{l'expression 2 vaut :}$$
$$J_{NG} = p(A)\ q(A)\ \alpha_{NG}(A) + p(B)\ q(B)\ \alpha_{NG}(B)$$

où p(A) est une constante indiquant la probabilité d'un résultat de distinction par rapport à une substance constitutive A,
p(B) est une constante indiquant la probabilité d'un résultat de distinction par rapport à une substance constitutive B,
q(A) est un rapport de surface (%) concernant la substance constitutive A,
q(B) est un rapport de surface (%) concernant la substance constitutive B,
$\alpha_{OK}(A)$ est une constante prédéterminée concernant la substance constitutive A qui indique le degré de valorisation de l'éjection

α_{OK}(B) est une constante prédéterminée concernant la substance constitutive B qui indique le degré de valorisation de l'éjection
α_{NG} (A) est une constante prédéterminée concernant la substance constitutive A qui indique le degré de suppression de l'éjection
α_{NG}(B) est une constante prédéterminée concernant la substance constitutive B qui indique le degré de suppression de l'éjection.

2. Procédé de séparation selon la revendication 1,
dans lequel le nombre de buses (5) est un nombre pluriel, et
le gaz est projeté à partir des différentes buses vers la circonférence du centre de gravité (11) de la cible de séparation (2A) qui comporte la substance constitutive (A) prédéterminée tout comme le centre de gravité (11).

FIG.1(a)

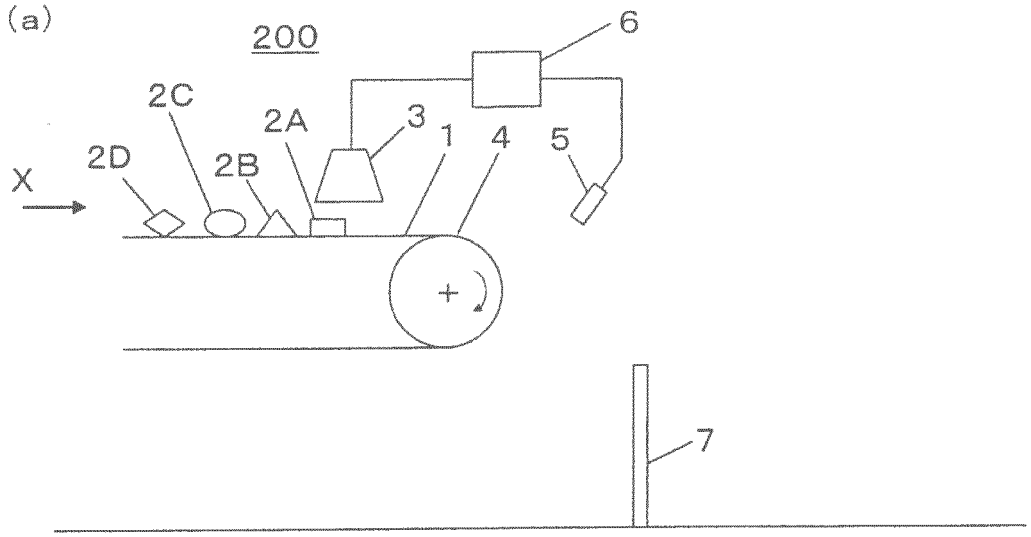


FIG.1(b)

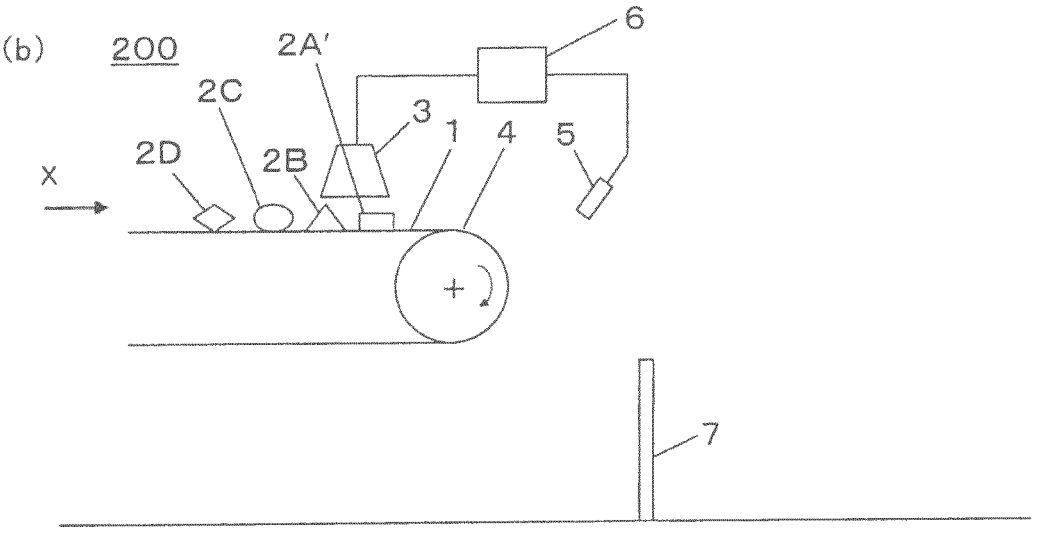


FIG.1(c)

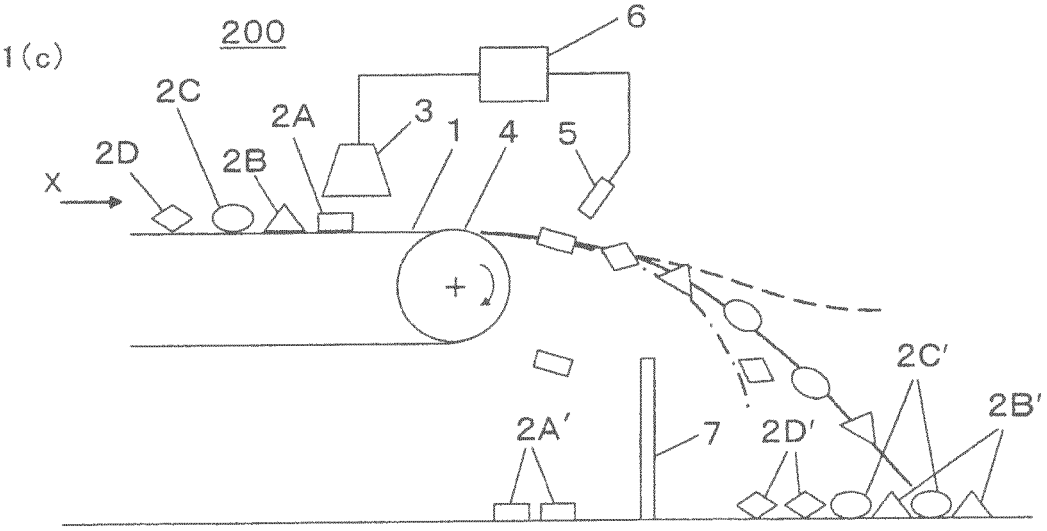


FIG.2

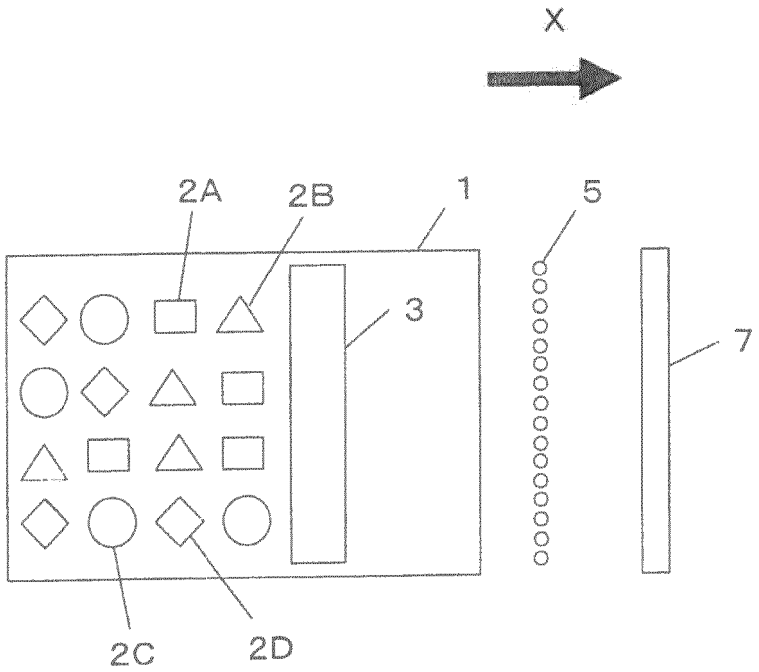


FIG.3(a)

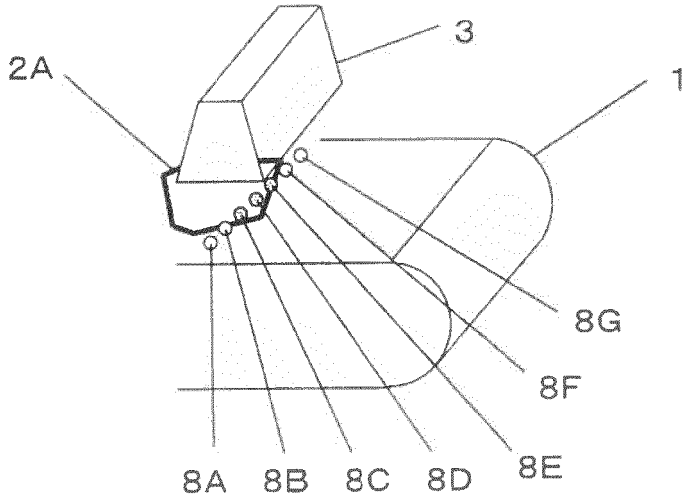


FIG.3(b)

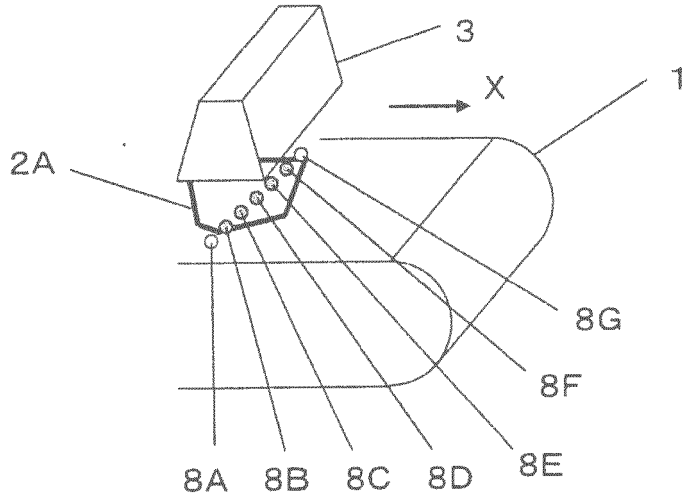


FIG.3(c)

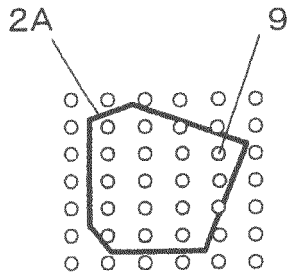


FIG.3(d)

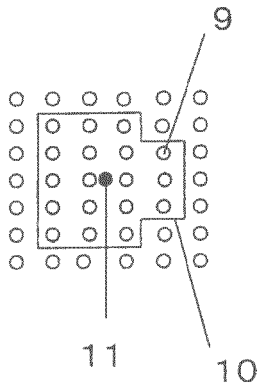


FIG.4(a)

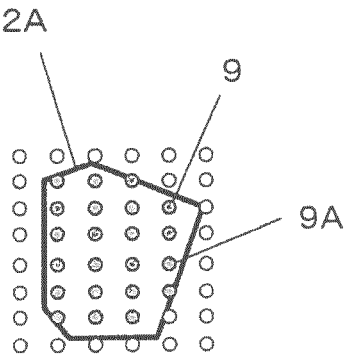


FIG.4(b)

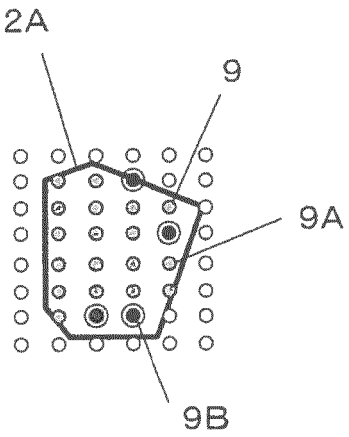


FIG.4(c)

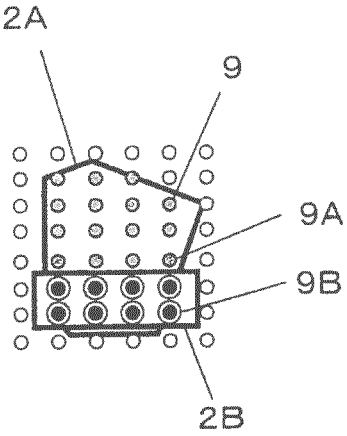


FIG.4(d)

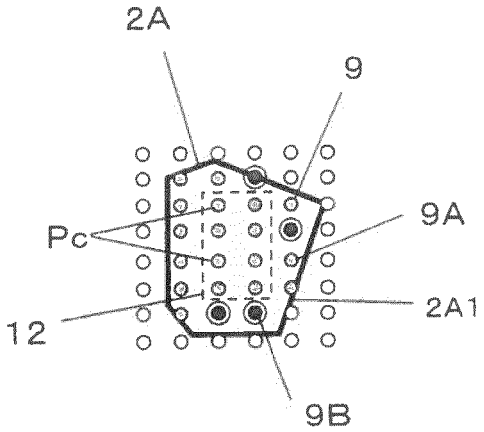


FIG.4(e)

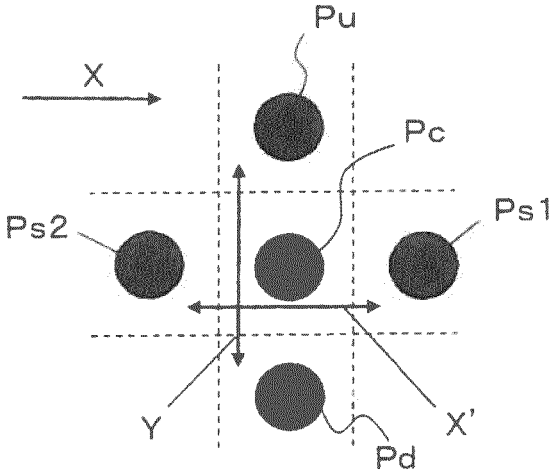


FIG.5

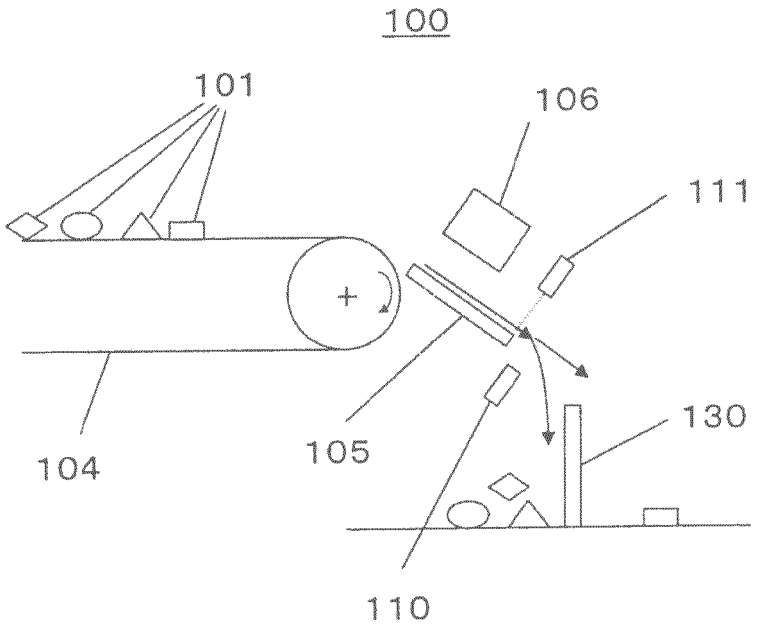


FIG.6(a)

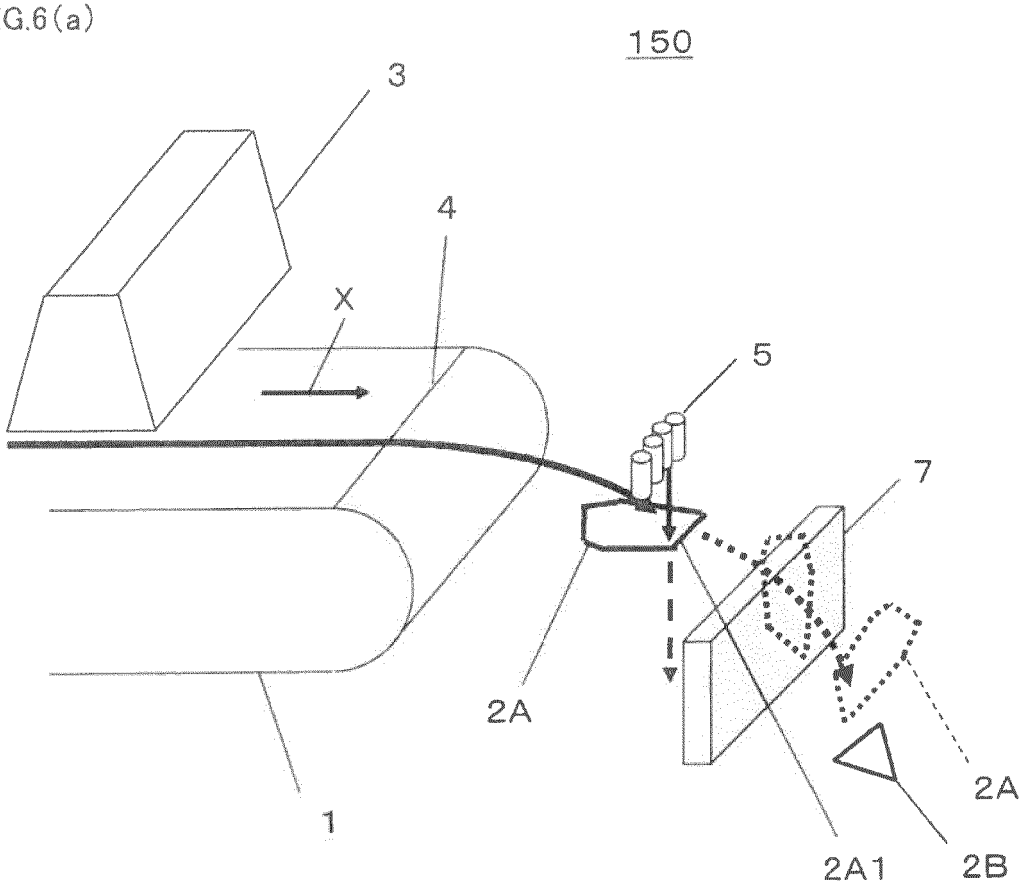


FIG.6(b)

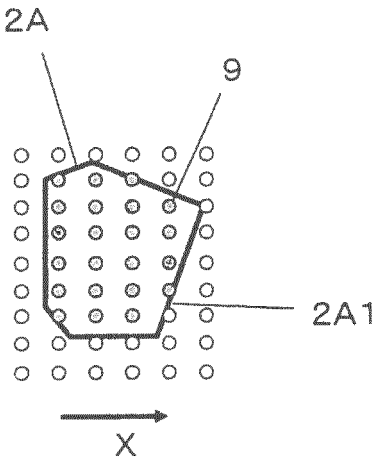
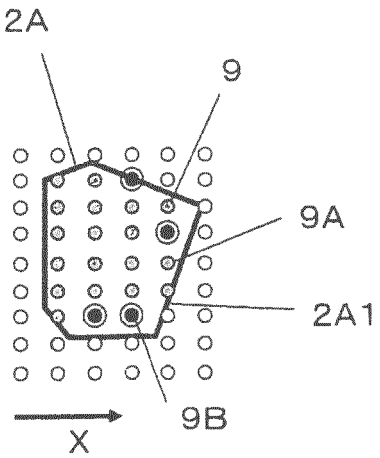


FIG.6(c)



REFERENCES CITED IN THE DESCRIPTION

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