United States Patent [19]

Dreher et al.

[11] **3,731,783**

[45] **May 8, 1973**

[54] METHODS AND APPARATUS FOR SORTING ARTICLES

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[73] Assignee: **Western Electric Company, Incorporated**, New York, N.Y.

[22] Filed: **Nov. 8, 1971**

[21] Appl. No.: **196,497**

[52] **U.S. Cl.**.....**198/31 AA**, 198/33 R

[51] **Int. Cl.**.....**B65g 47/24**

[58] **Field of Search**.....198/25, 31 AA, 41, 198/33 AA; 221/212, 157, 162

[56] **References Cited**

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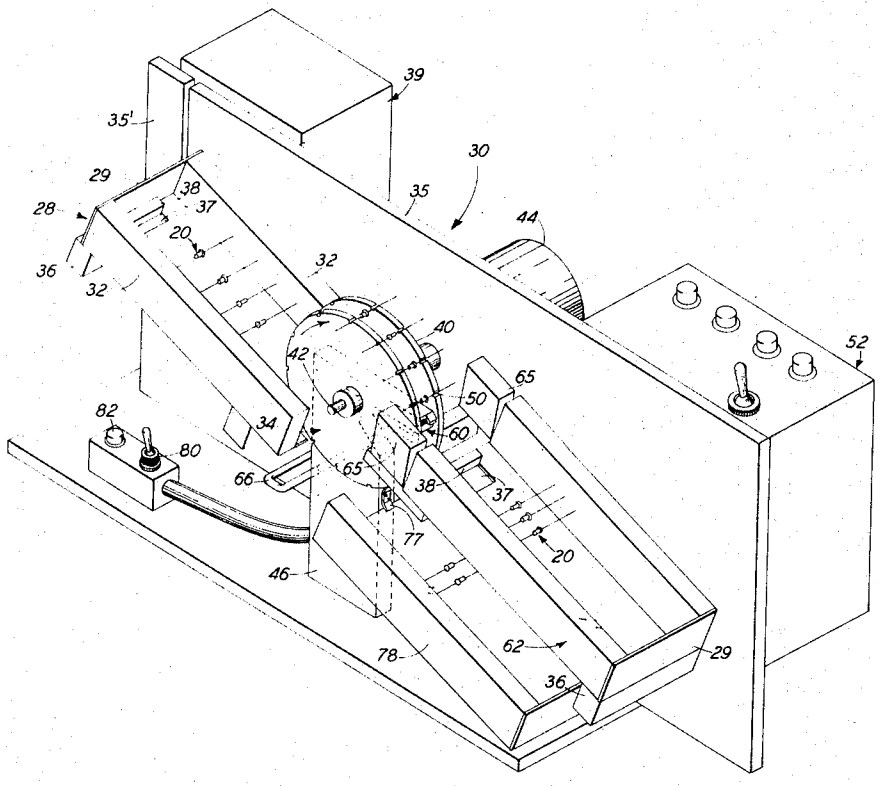
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Primary Examiner—Edward A. Sroka
Attorney—R. Y. Peters et al.

[57] **ABSTRACT**

A method and apparatus for sorting randomly oriented diodes into two groups such that all diodes in the same group conduct in the same direction; that is, are oriented alike. The randomly oriented diodes are suspended in a magnetic holding bin from which they are extracted by a sorting wheel and transported past a cam-jet-magnet sorting member. The sorting member ejects those diodes oriented in a first direction from the wheel into a first magnetic receiving bin. It assures retention, by the sorting wheel, of those diodes oriented in a second direction so that they are carried further for removal into a second magnetic receiving bin.

19 Claims, 9 Drawing Figures



Patented May 8, 1973 3,731,783

FIG-1

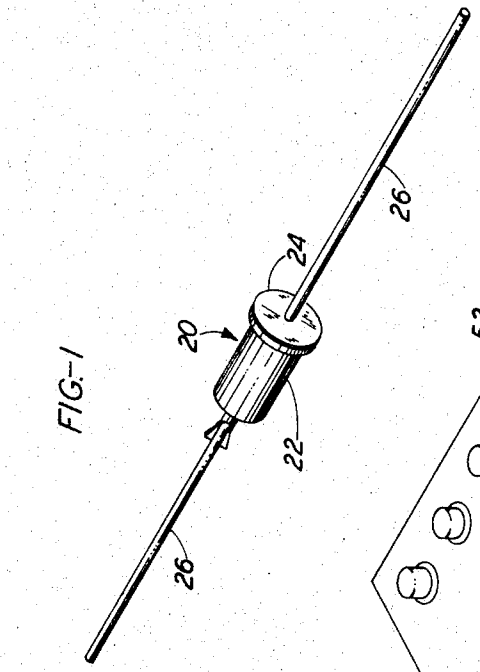


FIG-2

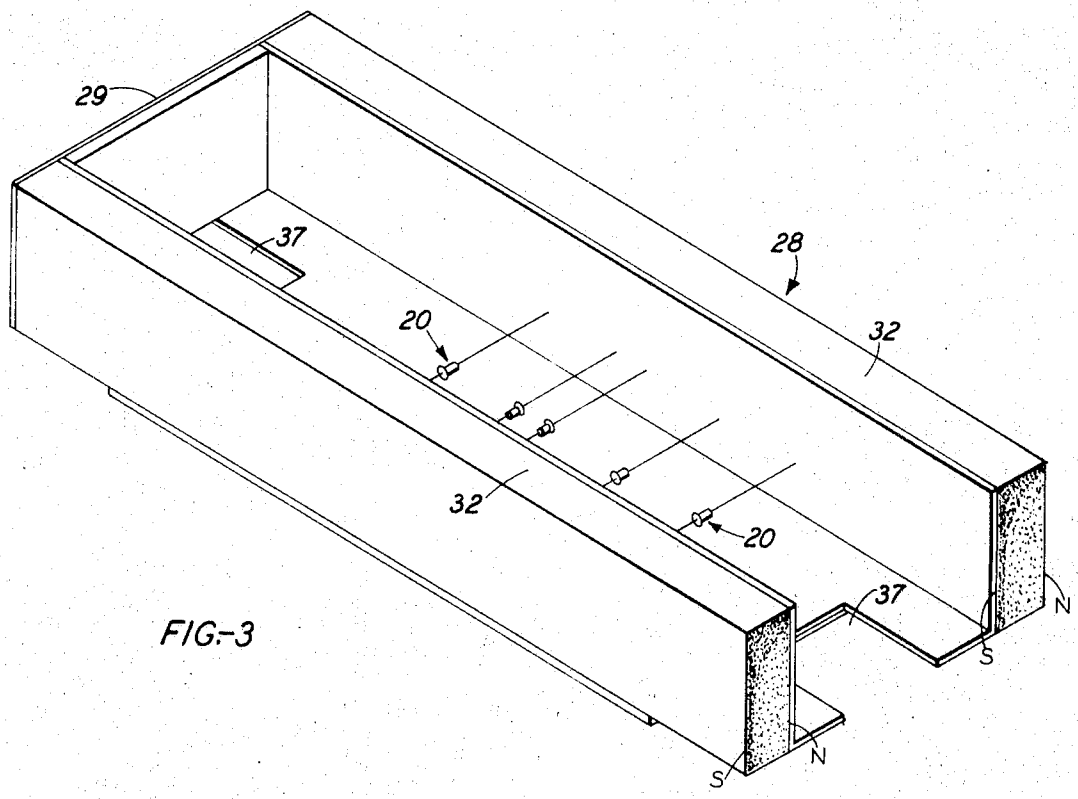


FIG.-3

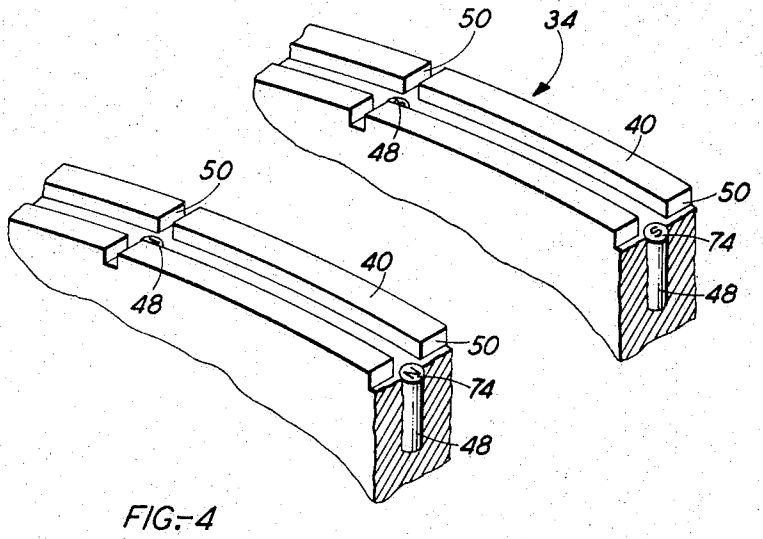


FIG.-4

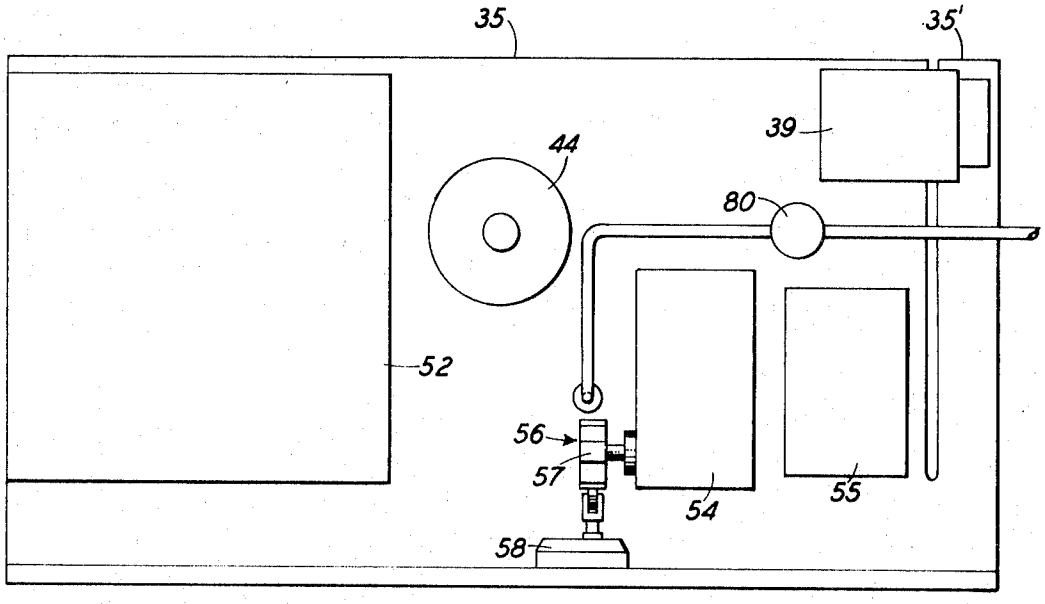


FIG.-5

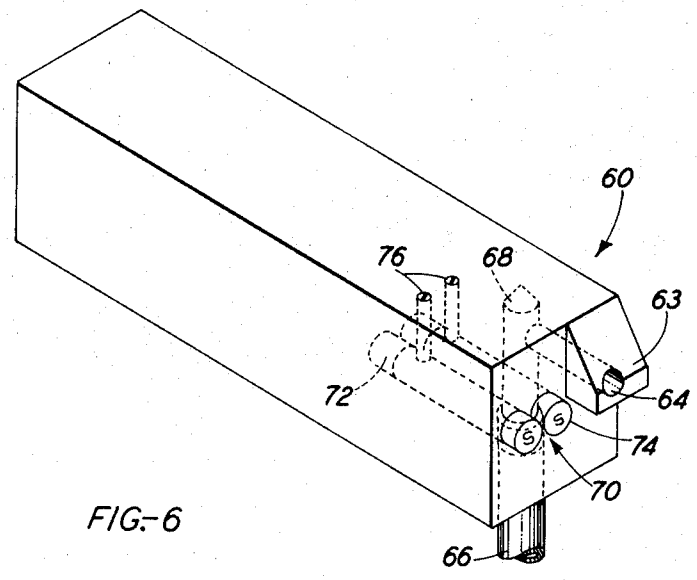


FIG.-6

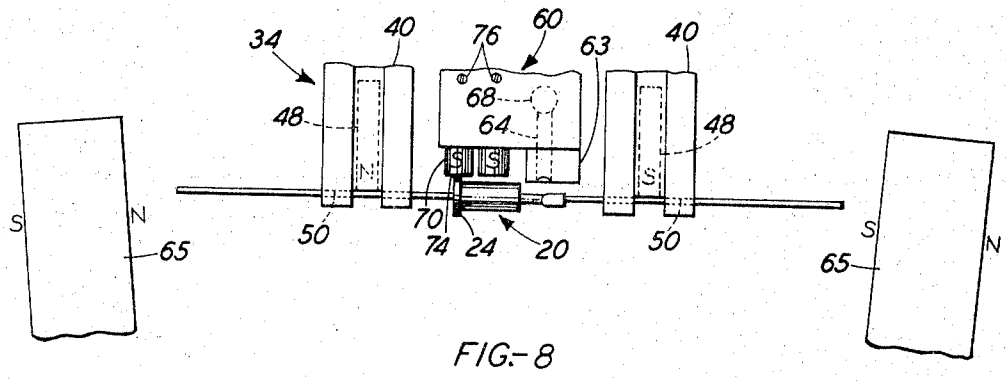


FIG.-8

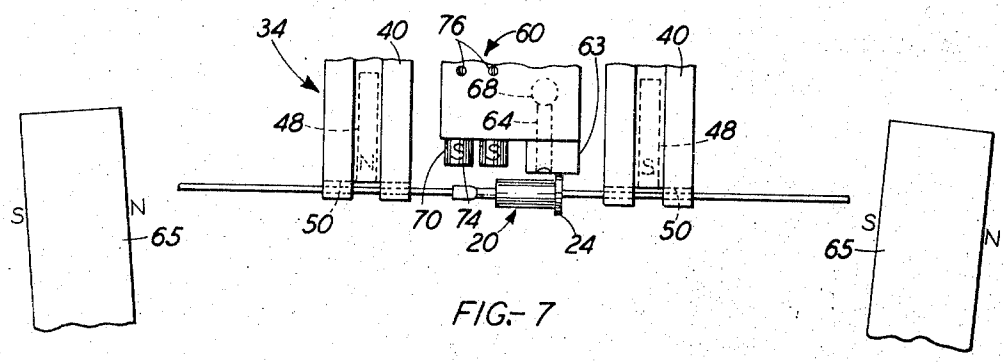
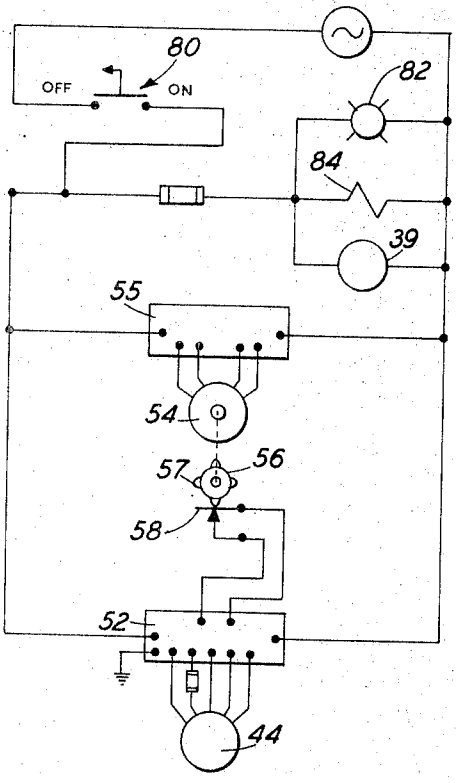


FIG.-7

FIG.-9



METHODS AND APPARATUS FOR SORTING ARTICLES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to methods and apparatus for sorting articles having one portion larger than another. More particularly, the invention relates to methods and apparatus for sorting diodes having flanged bodies so that those which conduct electrically in one direction are segregated from those which conduct in the opposite direction.

2. Description of the Prior Art

Axial leaded diodes are fed into manufacturing apparatus from magnetic bins and are dispensed from the apparatus into like bins in order to perform manufacturing operations. Such magnetic bins and apparatus are disclosed in J. E. Beroset and D. M. Large U.S. Pat. No. 3,537,380. Also, some of the theoretical and practical considerations involved in magnetic bins and apparatus of this kind are discussed in an article by J. E. Beroset, H. A. Griesemer, D. M. Large and K. C. Whitefield, "Magnetic Suspension Parts Handling," The Western Electric Engineer, July 1967, pages 36–42. If the apparatus involved is testing equipment for curve-trace testing, packaging equipment for placing the diodes in tapes, or similar equipment, the diodes must be fed into the equipment oriented so that all conduct in the same direction.

Certain types of the diodes are sealed in metal enclosures having a flange on one end and are physically and visibly asymmetrical. The prior art methods and apparatus for orienting the diodes utilize a vibratory feeder and an orienting track to exploit this asymmetry. However, vibration of the diodes tangles the leads when the diodes are placed in the bowl of the feeder. This causes both jamming of the track, which decreases the output of the apparatus, and bending of the leads. Further, since the diodes have been painted, the vibratory action of the diodes against the feeder, and against themselves, chips and scratches the paint.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention to provide new and improved methods and apparatus for sorting such articles.

With this and other objects in view, the invention encompasses a method of sorting articles, having one portion larger than another and oriented in either a first or second direction, by transporting the articles past a unique sorting member and, while transporting them, striking those articles oriented with the large portion in the first direction against the sorting member. These articles are propelled into a first receiver by blowing a fluid against them. Articles oriented with the large portion in the second direction are segregated by transporting them further and depositing them in a second receiver.

A suitable apparatus for practicing the invention involves a magnetic bin for holding the unoriented articles and first and second magnetic bins for receiving articles oriented in first and second directions, respectively. The articles are extracted from the holding bin and transported past a sorting member to the receiving bins by a sorting wheel. As the articles pass the sorting member, the large portion of those articles oriented in the first direction strikes against a cam portion of the sorting member. This frees the articles from the wheel so that air from the jet portion propels them into the first receiving bin. The magnet portion of the sorting member assures retention of those articles on the wheel whose large portion is oriented in the second direction so that they are transported further to an extractor which removes the articles from the wheel and deposits them in the second bin. The bins are symmetrical and either bin may now be rotated 180° to orient all articles in the same direction for further processing.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with its various features and advantages, can be understood best from the following more detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is an isometric view of a diode showing the large portion and axially extending leads;

FIG. 2 is an isometric view looking down on and showing the arrangement of an apparatus for sorting the diodes;

FIG. 3 is an isometric view showing a magnetic bin;

FIG. 4 is an enlarged partial sectional view of a sorting wheel showing grooves and magnets;

FIG. 5 is a rear elevational view of the apparatus showing the controls for the apparatus;

FIG. 6 is an isometric view showing a cam-jet-magnet sorting member for separating articles from the sorting wheel;

FIG. 7 is a partial plan view showing articles oriented in a first direction being separated from the sorting wheel;

FIG. 8 is a partial plan view showing how articles oriented in a second direction are retained on the sorting wheel; and

FIG. 9 is an electrical schematic of the apparatus showing control wiring.

DETAILED DESCRIPTION

Methods and apparatus embodying the invention will be described in connection with sorting semiconductor diodes of the type shown in FIG. 1; however, it is to be understood that the invention may be used for sorting other similar articles.

Referring now to FIG. 1, there is shown a semiconductor diode 20 having a body 22 and an integral flange 24 which are larger in diameter than coaxial leads 26. Also, the flange 24 and most of the body 22 lie on one side of the midpoint between the tips of the leads 26.

The body 22, flange 24 and leads 26 are made of magnetic materials; in this case, magnetic materials refers to those capable of being attracted by a magnet. The diodes 20, therefore, may be suspended in or held by a magnetic field. For example, the body 22 and the flange 24 may be of Kovar, a cobalt-iron-nickel alloy, and the leads 26 may be of nickel or copper clad iron-nickel alloy.

The diodes 20 are placed in a magnetic holding bin 28, refer to FIG. 2, of a sorting apparatus designated generally by the numeral 30. The diodes 20 in the bin 28 are randomly oriented, i.e., some have the flange 24 and most of the body 22 to the right of the midpoint of the tips of the leads 26 and some have the flange and most of the body to the left. Since all semiconductor

elements for like diodes **20** are mounted inside the body **22** so that they conduct current in the same direction, the position of the flange **24** and the body **22** to the right or the left is a physical manifestation of the direction which the diodes **20** conduct and may be used to identify this direction.

The bin **28** is detachably held by the apparatus and is of the type disclosed in the article by D. M. Large "-Portable Magnetic Bin," Issue 20, Western Electric Technical Digest, page 41, (Oct. 1970). Sides **32** of the bin **28**, refer to FIG. **3**, are magnetized through their thickness as indicated so that a permanent magnetic field is set up with flux lines crossing the bin from side to side. Elongated magnetic articles such as the diodes **20** placed in such a field will align themselves with and remain suspended in the field. In this case, then, the diodes **20** are in a state of suspension and across the bin **28** as shown in FIG. **3**.

The bin **28** is symmetrical, i.e., each end is the same, so that the bin may be mounted in apparatus and the diodes **20** extracted from either end. Further, a magnetic end plate **29** may be placed at one or both ends of the bin **28** if desired. Although the end plate **29** is not necessary to keep the diodes **20** in the bin **28**, an end plate at each end of the bin **28** is preferred because this permits the bin to be filled to a maximum and transported from one manufacturing operation to another without inadvertently dislodging some of the diodes. Since the end plate **29** is magnetic, it will be held in place by the magnetic sides **32** and may easily be removed from the bin **28**, at the time the bin is placed in the apparatus, to permit extraction of the diodes **20**.

A vertical plate **35**, to which brackets **36** are fixed, supports the bin **28** at an angle preferably between 10° and 15° with the horizontal, so that it slopes downward into a sorting wheel **34**. The downward angle aids in feeding the diodes **20** against the wheel **34**. Apertures **37**, which provide clearance for the wheel **34**, also are used to engage locating blocks **38** and prevent relative movement of the bin with respect to the brackets.

In addition to sloping, the bin **28** is vibrated to help feed the diodes **20** against the wheel **34**. A vibrator **39** vibrates a portion **35'**, of the plate **35**, (refer to FIG. **2**) to which the left bracket **36** is fixed and, therefore, vibrates the bin **28**. Since the magnetic field polarizes all the diodes **20** alike, they repel each other slightly and generally do not touch even though the bin **28** is vibrated.

The sorting wheel **34** includes two discs **40** fixed to a shaft **42** driven by a stepping motor **44**, such as Model SS-250–1027 sold by the Superior Electric Co. under the trademark "slo-syn." The discs **40** are fixed to the shaft **42**, one disc on each side of a support **46** and are nonmagnetic. Cylindrical magnets **48**, about 0.080 inch in diameter and one-fourth inch long, are inserted radially in the periphery of the discs **40** and the magnets in one disc are axially aligned with the magnets in the other. The magnets **48** are positioned so that the ends are flush with the bottom of slots or grooves **50** and have opposite polarity as shown by the partial section, refer to FIG. **4**, taken through the centerline of a groove **50**. The width of the grooves **50** is about twice the diameter of a lead **26** and the depth is about three times the width. Further, the grooves **50** and magnets **48** are evenly spaced so that there are preferably about forty such grooves and magnets around the periphery of each disc **40**.

The sorting wheel **34** is indexed in vary rapid steps by the motor **44**. The number of steps, and therefore the number of degrees of rotation for one index, is determined by a control **52**. The control **52** has a preset index and may be Model SP–1800–B3 such as is sold by the Superior Electric Co. under the trademark "slo-syn." Under the influence of the control **52**, the motor **44** indexes each time a switch in one of the control circuits is closed. The switch may be opened and closed by a motor, such as a speed reduction motor **54** controlled by a speed control **55**, refer to FIG. **5**, having a cam **56** fixed to its output shaft. For example, the motor **54** may be a 10 to 1 speed reduction motor Model M542VBO25 sold by Bodine Electric Co. and the speed control **55** may be Model SL–14 sold by Minarik Electric Co. The cam **56** may have cam lobes **57** spaced around its perimeter to actuate the follower of a switch **58**. Alternatively, the cam **56** may have magnets spaced at intervals in place of lobes around its periphery and the switch **58** may be a proximity switch, sensitive to a magnetic field, which closes each time a magnet passes it.

When the wheel **34** is indexed in the direction indicated by the arrow in FIG. **2**, i.e., clockwise looking from the front, and the periphery of the wheel wipes against the diodes **20** in the bin **28**, the magnets **48** attract one diode **20** into each of the grooves **50**. Some diodes **20** in the holding bin **28** are oriented in a first direction, i.e., have their flanges **24** to the right while some are oriented in a second direction, i.e., have their flanges to the left. The wheel **34** removes the diodes **20** from the bin **28** without changing this orientation, i.e., some of the diodes **20** attracted into the grooves **50** on the wheel **34** are oriented in the first direction and some in the second direction. The diodes **20** are carried by the wheel **34** past a sorting member **60**. The sorting member **60** is aligned with one of the positions the diode **20** will assume at the end of one of the indexes so that, when the diodes pause at that position, the sorting member will eject those diodes oriented in the first direction from the wheel into a first receiving bin **62**.

The sorting member **60**, refer to FIG. **6**, includes a cam surface **63** having a sloped portion and vertical portion and a jet **64**, about one-sixteenth inch in diameter, for projecting fluid substantially horizontally. The cam surface **63** may also be a continuous, curved surface approximating the combination of the sloped and vertical surfaces. Further, it may be advantageous in some cases to direct the jet **64** up or down at an angle to the horizontal to suit the location of the first receiving bin **62** or otherwise improve the ejection of the diodes **20** from the wheel **34**. Consequently, the sorting member **60** may be mounted on the support **46** so that the member may be adjusted in and out or at any angle with respect to the periphery of the wheel **34**.

Many fluids may be used to eject the articles, but a gas and particularly air is to be preferred for economic reasons. If air is used, it is fed to the jet **64** from a source through a tube **66** inserted in a chamber **68** to which the jet connects.

In addition to the cam surface **63** and jet **64**, the member **60** includes two magnets **70** which are inserted in bores **72**. Their protruding poles are opposite in

polarity from exposed faces 74 of the magnets 48 of the nearest disc 40, refer to FIGS. 4 and 6–8. The magnets 70 are adjustable axially so that the position of their faces 74 can be set in close proximity to the flange 24 and body 22 of those diodes 20 on the wheel 34 having their flanges to the left. The magnets 70 may be made of permanent magnet material, such as Alnico, about three thirty-seconds inch in diameter and one-half inch long and locked in position by set screws 76. Alternatively, a single rectangular magnet about three thirty-seconds inch thick, one-fourth inch wide and one-half inch long may be used.

Referring now to FIG. 7, there is shown a partial plan view of the wheel 34 transporting a diode 20 oriented in a first direction, in this case with its flange 24 to the right, past a sorting member 60 and the sorting member separating the diode from the wheel. The movement of the diode 20 is generally downward and the diode has reached a point where the body 20 is in line with the jet 64, the flange 24 has struck the cam surface 63, and the diode has been lifted to force the leads 26 from the bottom of the grooves 50. This greatly reduces the attraction of the magnets 48 and permits the air blowing through the jet 64 to propel the diode 20 into the strong magnetic field across the width of the first receiving bin 62. The diodes 20 align with this field in the same first direction they had when on the wheel 34. Since only those diodes 20 oriented in this first direction will have their leads 26 lifted from engagement with the magnets 48, only those diodes will be propelled to the first receiving bin 62 and the bin will contain nothing but diodes oriented in this first direction.

The bin 62 is of the same construction as the bin 28 shown in FIG. 3.

In order to maintain the alignment of the diodes 20, whey they are being propelled from the wheel 34, an extension 65 of the bin 62 is provided. The extension 65 includes two short permanent magnets magnetized through their thickness with the same polarity as the bin 62. The extension 65 could be made a part of the bin 62 but the bin would not be symmetrical and would not be interchangeable with the bin 28. Since it is preferable for economic reasons to make the bins interchangeable, the extension 65 is fixed to the apparatus 30 rather than the bin 62. The extension 65 produces a magnetic field which holds the diodes 20 parallel to their position on the wheel 34 as the diodes are disengaged from the wheel and are propelled into the bin 62. Thus, from the moment the diodes 20 are disengaged from the wheel 34, they are under control of a magnetic field which maintains their prior alignment and prevents them from turning end for end.

Diodes 20 oriented in the second direction, i.e., with their flanges 24 to the left, are retained on the wheel 1 with the aid of the sorting member 60. Referring now to the partial plan view, FIG. 8, when the flanges 24 of the diode 20 is to the left, it and the body 22 are in close proximity or adjacent the magnets 70. Because of the combined strength of the magnets 48 and 70, the air flowing through the jet 64 will not eject diodes 20 oriented in the second direction from the wheel 34. These diodes 20 are carried beyond the sorting member 60 to an extractor 77.

The extractor 77 may be a spring leaf, or the like, which the diodes 20 are forced against to extract them from the wheel 34.

As soon as the diodes 20 leave the wheel 34 they are under the influence of the magnetic field of a second magnetic bin 78 which is constructed in the same manner as the bins 28 and 62. The diodes 20, therefore, enter the bin 78 and are suspended in the magnetic field with the same orientation they had in the wheel 34, i.e., in the second direction.

The diodes 20 with the same orientation are now separated into their own bins. All diodes may be oriented in the same direction for subsequent manufacturing operations by turning one of the bins end for end.

The apparatus is controlled by the circuit shown in the electrical schematic diagram, FIG. 9. When a toggle switch 80, or the equivalent, is turned to the ON position, energy is applied to an indicator light 82, a solenoid valve 84 controlling the air supply to the sorting member 60, the vibrator 39, the control 52 for the stepping motor 44, and to the control 55 for the cam motor 54.

Since the vibrator 39 and the valve 84 are energized all of the time with this circuit, the bin 28 is vibrated and air is blown through the jet 64 continuously while the apparatus is operating.

The rate of closure of the switch 58 is determined by the speed of the motor 54 and the number of lobes 57 on the cam 56. Each operation of the switch 58 causes the controller 52 to step the motor 44 the number of steps equal to one index. For example, in this case, 200 steps are required to step the motor 44 around one revolution and 40 indexes are desired. The controller is set, therefore, to step the motor five times when the switch 58 has been closed once. Consequently, as long as the motor 54 continues to operate, the motor 44 will continue to index the wheel 34. Furthermore, the speed of indexing will depend on the speed of the motor 54.

While specific embodiments have been described in the foregoing specification to illustrate the invention, it will be understood that the invention is not limited to these embodiments. Various changes and modifications may be made without departing from the spirit and the scope of the invention.

What is claimed is:

1. A method for sorting articles, each having one portion thereof larger than another and each oriented in either a first or a second direction on a transporting wheel, which comprises the steps of;

striking the large portion of the articles oriented in the first direction against a sorting member to disengage the articles from the wheel;

forcing fluid against the articles simultaneously with the striking to propel the articles into a first receiver;

retaining on the wheel those articles oriented in the second direction;

removing the articles oriented in the second direction from the wheel; and

depositing the removed articles oriented in the second direction into a second receiver.

2. A method for sorting articles each having one portion thereof larger than another and each oriented either a first or second direction, which comprises the steps of:

a. suspending the articles in a holding magnetic field;

b. removing the articles from the field;

c. advancing the articles past a sorting member;

d. sorting out the articles oriented in a first direction to deposit them into a first receiving magnetic field; and

e. transporting the articles oriented in the second direction to a second receiving magnetic field so that the first direction and second direction articles are separated into groups.

3. A method as recited in claim 2, wherein the holding and the first and second receiving magnetic fields are produced by providing bins having permanent magnet sides.

4. A method as recited in claim 2, wherein the steps of advancing the articles includes the further step of striking the articles against the sorting member.

5. A method as recited in claim 4, wherein the sorting member has a cam surface with a jet therethrough and wherein the sorting step includes the further step of propelling the articles into the first magnetic field.

6. A method as recited in claim 5, wherein the propelling step is performed by blowing air through the jet.

7. A method of sorting flanged diodes oriented in either a first direction or a second direction, which comprises the steps of:

a. suspending the diodes in a magnetic holding bin;

b. extracting the suspended diodes from the holding bin

c. transporting the diodes past a sorting member;

d. striking the diodes oriented in the first direction against the sorting member to disengage them from the transporting means;

e. propelling the disengaged diodes into a magnetic bin for first direction diodes;

f. temporarily retaining the diodes oriented in the second direction in the transporting means until they are past the sorting member;

g. removing the diodes oriented in the second direction from the transporting means; and

h. depositing the second direction diodes in a magnetic bin for second direction articles.

8. Apparatus for sorting articles, each article having at least one portion thereof larger than another portion, which comprises:

a. means for holding the articles to be sorted;

b. first means for receiving the articles oriented in a first direction;

c. second means for receiving the articles oriented in a second direction;

d. means for extracting the articles from the holding means and transporting the articles to the first and second receiving means;

e. a sorting member, adjacent the extracting and transporting means, for engaging the large portion of the articles oriented in the first direction and expelling them from the extracting and transporting means and into the first receiving means, and for aiding the temporary retention of the articles oriented in the second direction in the extracting and transporting means; and

f. means for removing the articles oriented in the second direction and depositing them in the second receiving means.

9. An apparatus as recited in claim 8, wherein the means for holding the articles and the first and second means for receiving the articles comprise magnetic means.

10. An apparatus as recited in claim 9, wherein the magnetic means for holding and the first and second means for receiving are bin having permanent magnet sides.

11. An apparatus as recited in claim 10, in which the bins are reversible end for end.

12. An apparatus as recited in claim 11, wherein the extracting and transporting means comprises a sorting wheel having grooves and cooperating magnets evenly spaced around its periphery.

13. An apparatus as recited in claim 9, wherein the means for holding the articles is sloped downward toward the sorting wheel while the first and second means for receiving the articles are sloped downward away from the sorting wheel to aid in feeding the articles toward and moving them away from said wheel.

14. An apparatus as recited in claim 8, wherein the sorting member comprises a cam surface having a fluid jet therethrough for expelling the articles oriented in the first direction from the extracting and transporting means and a magnet adjacent the cam surface and fluid jet to aid in temporarily retaining the articles oriented in the second direction on the extracting and transporting means.

15. An apparatus as recited in claim 14, wherein the jet is an air jet.

16. An apparatus as recited in claim 8, wherein the articles are semiconductor diodes having coaxial leads.

17. Apparatus for sorting semiconductor diodes having axial leads and flanges, which comprises:

a. a magnetic holding bin for holding the diodes to be sorted;

b. means for vibrating the holding bin;

c. a sorting wheel, cooperating with the magnetic bin, for extracting the diodes from the bin and transporting them;

d. means for indexing the wheel in steps;

e. a sorting member, adjacent the sorting wheel and past which the wheel transports the diodes, to disengage the diodes from the wheel and propel those diodes oriented in a first direction from the wheel;

f. a first magnetic bin adjacent the wheel to receive the propelled diodes oriented in the first direction;

g. a magnet adjacent the cam surface to aid in retaining those diodes in the wheel which are oriented in a second direction;

h. an extractor adjacent the wheel to remove the diodes which have been retained in the wheel and moved past the cam surface and, therefore, are oriented in the second direction; and

i. a second magnetic bin adjacent the wheel and the extractor to receive the diodes removed by the extractor and oriented in the second direction, whereby the diodes are sorted into bins in accordance with their orientation.

18. An apparatus as recited in claim 17, wherein the sorting wheel includes a plurality of slots and adjacent magnets spaced around its periphery for engaging the diodes with the wheel.

19. An apparatus as recited in claim 18, wherein the sorting member includes a cam surface sloped upwardly toward the vertical centerline of the sorting wheel, an air jet extending through a lower portion of the cam surface and an adjacent magnet.

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