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Georges

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[54] **COMPONENT SORTING AND SEGREGATING SYSTEM**

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[52] **U.S. Cl.** ..... **209/73,** 209/81, 198/33 R

[51] **Int. Cl.** **B07c**

[58] **Field of Search** ..... 198/33 AD; 209/73, 74, 209/81

[56] **References Cited**

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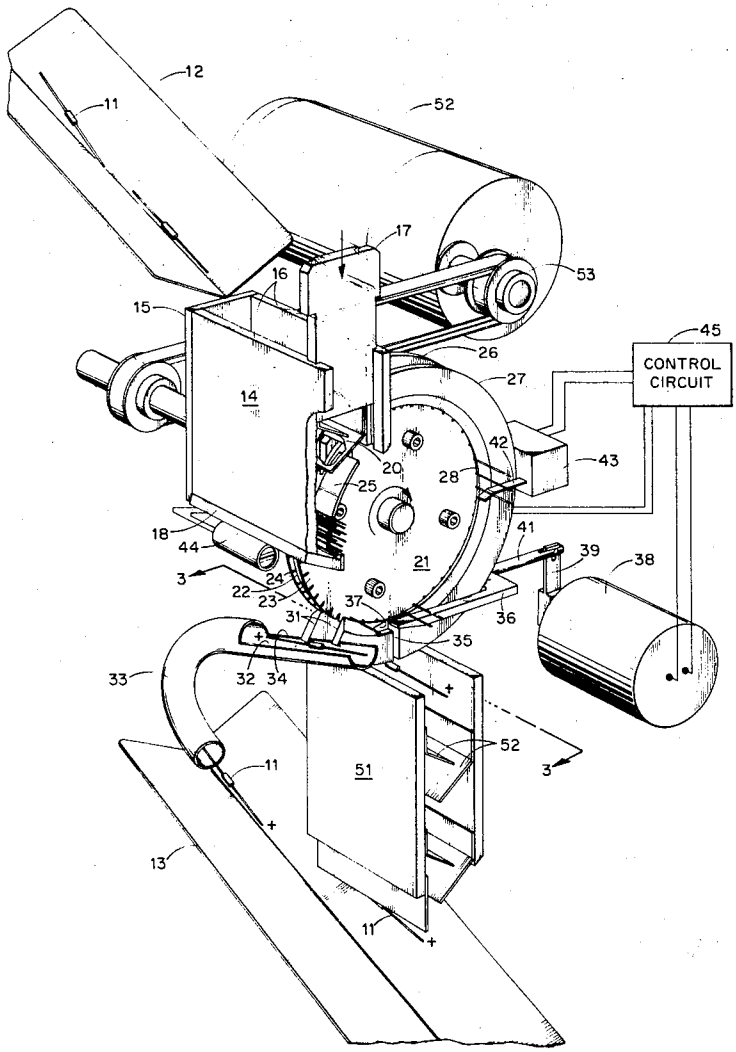
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Attorney, Agent, or Firm—Richard J. Birch, Esq.; Chittick, Thompson & Pfund

[57] **ABSTRACT**

A transport mechanism having a wheel with uniformly spaced radial peripheral slots adapted to engage the axial leads of diode components transports the diodes, one in each set of peripheral slots from a supply bin past a polarity sensing station which registers the polarity of the diode in the slot and controls a drop gravity gate mechanism subsequent to the polarity sensing station to drop diodes of a given polarity and retain in the slots those diodes of the opposite polarity until the retained diode reaches a subsequent discharge station which includes a physical reversing path between the discharge station and the ultimate delivery point for all diodes whereby diodes delivered from both the drop station and the discharge station are delivered to a common delivery point with uniform polarity orientation.

14 Claims, 6 Drawing Figures



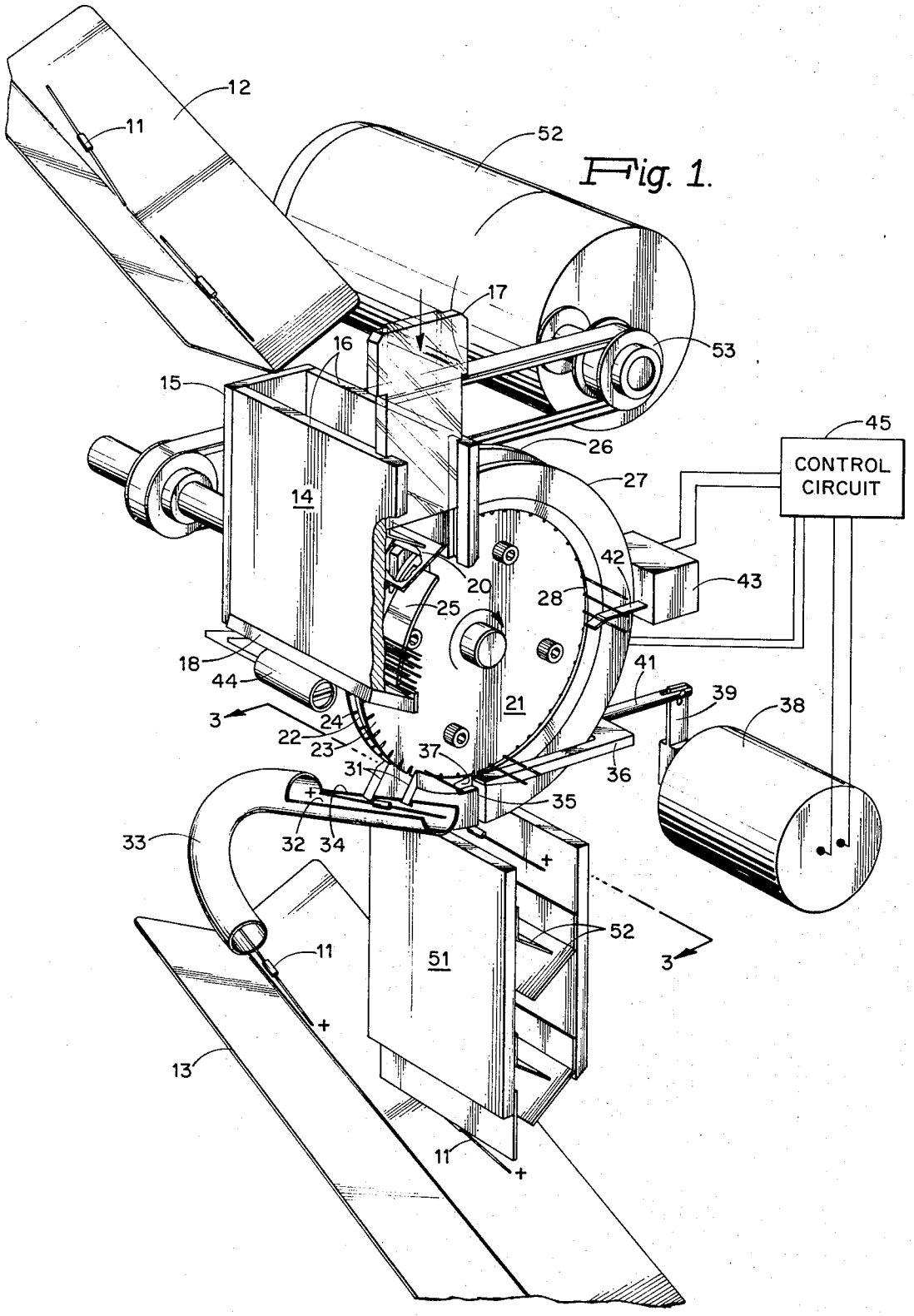

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CONTROL CIRCUIT
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Fig. 1.

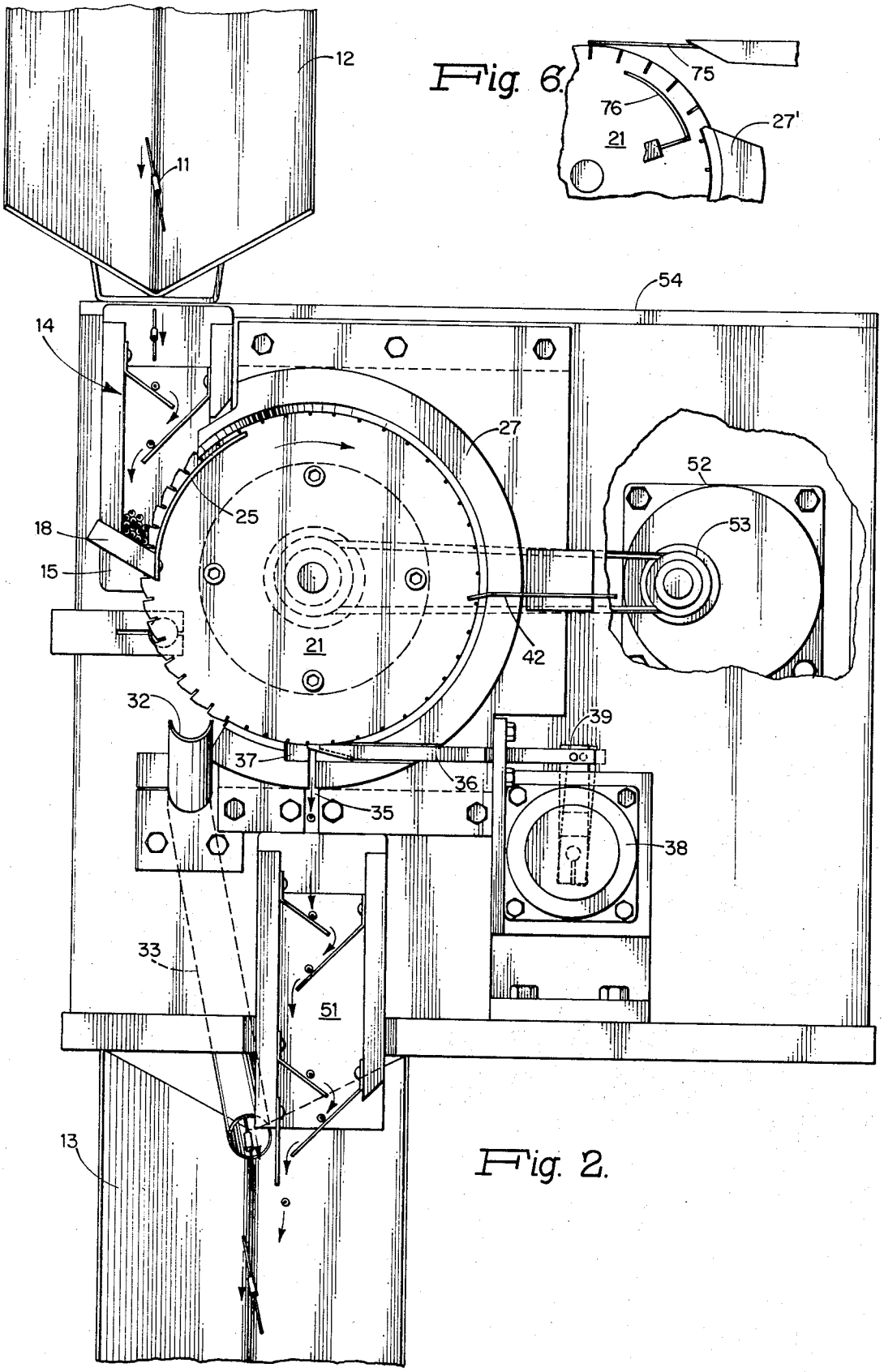

12
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Fig. 2.

75
76
27'
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Fig. 6.

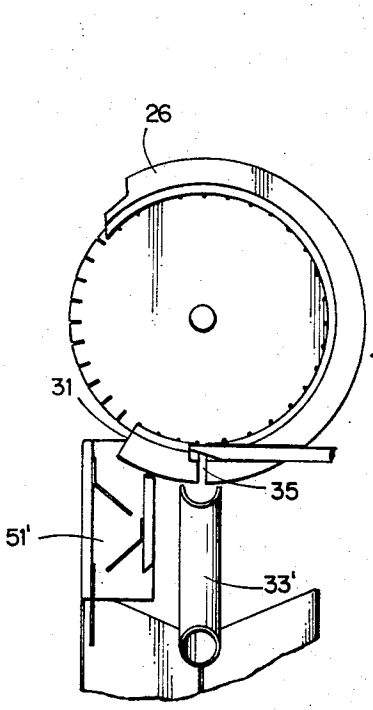


Fig. 5.

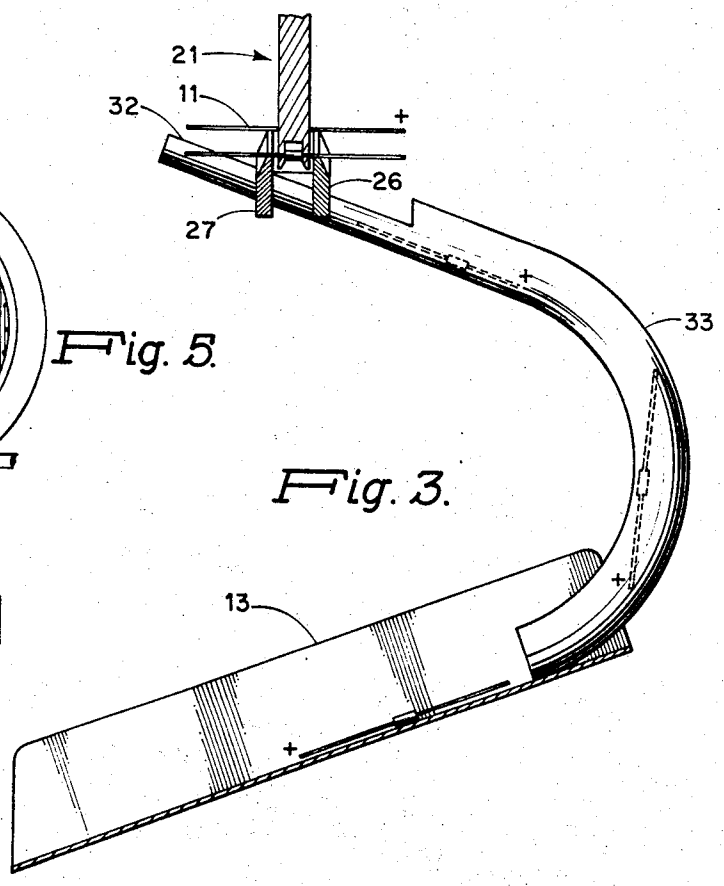


Fig. 3.

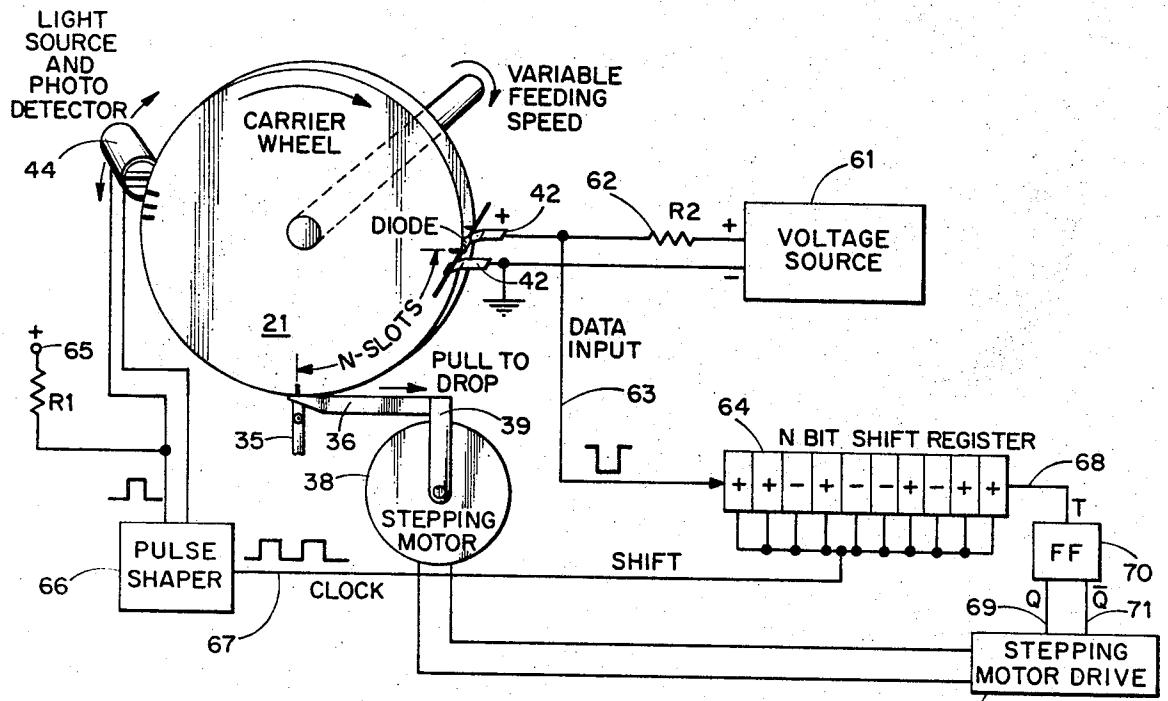


Fig. 4.

COMPONENT SORTING AND SEGREGATING SYSTEM

BACKGROUND OF THE INVENTION

The field of this invention is the inspection and handling of electronic components and more particularly the sensing of the characteristics of axial lead diode type components for electrical properties such as polarity while they are entrained in a conveyor which moves them through the inspection apparatus.

In the prior art it is known to use a radially slotted wheel transport mechanism for engaging axial lead electronic components one at a time for moving them past an operating station which is located adjacent the periphery of the rotating wheel transport. Such prior art operations include marking and banding of the cylindrical body of the electronic component and includes the selective marking in accordance with polarity based on a sensing of the diode polarity as it is engaged in the slotted wheel.

BRIEF SUMMARY OF THE INVENTION

In accordance with the present invention, axial lead diode components and other electronic elements can be engaged and transported by means of a rotating slotted wheel to be individually tested electrically as the wheel passes each transported component past a test station point adjacent the peripheral path of the wheel. While it is possible to perform any desired test at this test station and control subsequent events in accordance therewith, the present invention has as a particular embodiment which is illustrated herein the testing of the polarity of diode components and the controlling of the path of the so tested components to deliver the same at a common delivery point with the same relative physical orientation as respects electrical polarity. Thus the present invention tracks the polarity tested diode through its subsequent positions in the rotating wheel and selectively removes a diode component from the wheel at one discharge or gravity drop station for a given polarity and maintains the diode engaged in the wheel for subsequent discharge at a second discharge station for the opposite polarity of the diode. At one of the discharge stations a physical inverting mechanism is interposed in the path of the diode and both discharge paths deliver the diode components which are discharged thereto into a common delivery point or chute thereby assuring that the components are delivered to subsequent operations or packaging as desired with a uniform electrical polarity orientation. Obviously, for other tests different sorting and segregating operations could be performed by controlling the selective discharge of the elements from the slots of the wheel in accordance with the variables sensed at the sensing station. Furthermore, more than one criteria can be applied with a plurality of selective discharge controls thereby permitting the sorting of the electronic components into a plurality of groups for subsequent manipulation or processing or for grading in accordance with the quantitative measure made at the test station.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view showing the basic elements of the invention as assembled for operation.

FIG. 2 is a front elevation view of an apparatus assembled corresponding to the arrangement of FIG. 1.

FIG. 3 is a fragmentary partially sectional view generally along the line 3—3 of FIG. 1 showing the physical orientation reversing mechanism for the components.

FIG. 4 is a block diagram of th control system in accordance with the invention.

FIG. 5 is a schematic view of a modification.

FIG. 6 is a partial view showing a modification.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a general operating arrangement for the invention arranged to receive axial lead electronic components such as diodes 11, delivered with random orientation to an input chute 12 and operating to deliver the diodes 11 to an output chute 13 with all diodes 11 having the same relative electrical orientation.

The input delivery chute 12 is inclined and mounted to permit the diodes 11 to slide along the apex formed in the chute 12 and to be delivered into the open top of the feed tower generally designated 14. The feed tower 14 comprises a back plate 15, two parallel side plates 16, a transparent end gate 17 retained in sliding engagement in slots in the inner surfaces of the spaced parallel side plates 16. The feed tower 14 is closed at the bottom by an inclined bottom plate 18. Projecting from the inner surfaces of the side plates 16 is a set of alternate downwardly inclined baffles 20 adapted to receive the falling diode component 11 as it is discharged into the open top of the feed tower 14 and oriented in a generally horizontal position as the diode 11 falls through the feed tower to rest against the top surface of the inclined bottom plate 18 or against the diodes previously delivered thereto thereby stacking cord-wood fashion in the space inside the bottom of the feed tower and urged by the inclination of bottom plate 18 in the direction of the incline.

Rotatably mounted adjacent the feed tower is a pickup wheel transport generally designated 21 comprising two slotted electrically non-conducting discs 22 and 23 with aligned radial slots 24 in the periphery thereof. The discs 22 and 23 are spaced to freely receive and retain the cylindrical body portion of the diodes 11 and the slots 24 are sized to receive the axial leads on the diodes 11. The actual circumference of the discs 22 and 23 is somewhat sawtooth shaped as indicated in FIG. 2 and the disc is positioned to rotate through a slot cut into the edge of inclined bottom plate 18 thereby permitting the sawtooth edge to select from the cord-wood stacked diodes 11 a single unit which rolls by gravity to position the axial leads in the bottom of the slots 24 thereby filling the slots one diode per slot and engaging it for transport as the wheel 21 rotates. To assist in this process a curved guide plate 25 is attached to the lower edge of inclined bottom plate 18 with a curvature generally corresponding to the radius of the bottom of the slots 24 and a corresponding plate, not shown, on the opposite side of the wheel adjacent to outer face of disc 22. Located closely adjacent the outer surfaces of the discs 22 and 23 are a pair of circular sector members 26 and 27 which operate as lead guides and act to retain the diode 11 in its loaded position in a particular pair of opposed slots 24 in the wheel 21 by having an inner bevelled edge 28 which termi-

nates at a radius slightly greater than the depths of the slots 24 thereby providing clearance for the axial leads of the diodes 11 to move with the wheel 21 but preventing the axial leads from moving from a bottomed position at the bottom of the slots 24. As indicated in FIG. 1, at the portion of a baffle plate 20 broken away, the clearance between the upper surface of guide plate 25 and the bevelled inner edge 28 of lead guide 27 provides spacing for the passage of the axial leads of the diodes 11.

The lead guides 26 and 27 extend around the peripheral path of the wheel 21 and terminate at inclined end faces 31 which act as slides for the delivery of a diode contained in any of the slots 24 when the loaded slot passes beyond the position of the end faces 31. The delivery at this point is into a trough 32 formed by removing the upper portion of a curved inverting tube 33 which serves to reverse the physical orientation of the diode 11 passing therethrough. To assure smooth delivery one edge 34 of the trough portion 32 may be inserted in suitable slot cuts in the lead guides 26 and 27 to permit the inclined guide faces 31 to be able to deliver diodes 11 into the trough 32 without having the cylindrical body portion of the diode 11 bump on the edge 34.

An alternate delivery point is provided in the lead guides 26 and 27 by an aligned pair of vertical slots 35 located directly beneath the axis of rotation of the wheel 21 such that a diode contained in the slots 24 will drop by means of gravity out of the wheel slots and through the slots 35 whenever the position of loaded slots 24 appears directly over the slots 35 unless the fall of the diode in this position is otherwise impeded. For controlling the discharge of diodes through slots 35 in accordance with sensed characteristics of the diodes, a gating mechanism comprising a horizontal gating yoke member 36 is provided and supported to be slidably movable in horizontal slots 37 provided in the members 26 and 27. The gating yoke 26 is movable in limited horizontal travel under the control of a stepping motor 38 which has its shaft connected by means of a crank-arm 39 to a pin connection with actuator rod 41 extending from the cross member of the gating yoke 36. The stepping motor 38 has two positions as best seen in FIG. 2 where for the position shown the distal end of the gating yoke member 36 extends over the slots 35 and prevents diodes in the wheel slots 24 from dropping as they pass the position of slots 35. For the alternate position indicated in dotted lines in FIG. 2 the gating yoke 36 is retracted to present the slots 35 unobstructed with respect to the periphery of the wheel 21 thereby permitting diodes in the wheel slots 24 to drop vertically under the force of gravity, as indicated, whenever a loaded pair of slots 24 arrives at the position of the vertical slots 35.

For measuring the characteristics of the components which are loaded and transported by the wheel 21 a pair of leaf spring electrical contact members 42 are supported in a contact block 43 and extend on either side of the wheel 21. The contact members 42 are generally located somewhat below the horizontal center line through the axis of rotation of wheel 21 and comprise resilient leaf spring action with a downwardly inclined distal end to permit the leads of diodes 11 loaded in the slots 24 to make electrical contact with the members 42 and deflect the member slightly as it makes sliding contact passing the position of the contacts 42 and permitting the contacts 42 to return to their normal undeflected position for contacting the next diode leads as they are transported there by rotation of the wheel 21. Thus, for a brief interval of time, as the particular diode 11 is transported past the location of the leaf spring contacts 42 an electrical connection is made with the two axial leads on the diodes 11 and an appropriate electrical circuit connected to the leads 42 can be used for measurement and control purposes. A slot position sensor 44 is arranged at any suitable location to provide an electrical signal representing the passage of each slot past the point of location of the sensor 44. As shown in FIG. 1 the sensor 44 comprises a source detector photoresponsive type device directed at the surface of the slotted disc 22 and it produces an electrical pulse signal each time a slot 24 passes a selected location for the sensor 44.

The sensor 44 and the electrical contacts 42 are both connected to a control circuit 45 which will be hereinafter described for controlling the operation of the stepping motor 38.

As indicated in FIG. 1, diodes 11 delivered to the orientation reversing tube 33 are deposited in the output trough 13 with predetermined polarity whereas those which are dropped through the slot 35 have the same predetermined polarity without requiring any reversal in their path of travel to the trough 13. For delivering the diodes which drop through the slots 35 an output feed tower generally indicated at 51 is provided directly beneath the slots 35. The feed tower 51 has a series of baffles 52 which assure that the diodes dropping by gravity feed through the tower 51 arrive at the trough 13 with the same orientation they had when they dropped through the slots 35 and generally aligned with the direction of movement through the inclined trough 13 to a subsequent packing or loading station.

Referring now particulary to FIG. 2 the same general features of the invention are presented together with some of the constructional and supportive structures of a typical machine built in accordance with the invention. The feed wheel 21 is rotatively driven in the direction of the arrow by a belt drive from a drive motor 52 having a suitable speed change to an output pulley 53. The various parts may be mounted and supported on a suitable frame member 54 using any conventional forms of construction and attachment as indicated in FIG. 2. When arranged as shown the diodes 11 in input feed trough 12 follow the path indicated by the arrow through the input feed tower 14 where they stack in cord-wood fashion against the inclined top surface of bottom plate 18 and are picked up by the rotating wheel 21. After passing the electrical test station and making contacts with the spring contacts 42 the diodes are transported to the position of the vertical slots 35 where if the stepper motor 38 has been actuated to move the crank-arm 39 to its displaced position shown in FIG. 2 the gating yoke 36 is retracted to permit a diode to vertically fall through the slots 35 as indicated by the arrow. If the stepper motor 38 is in its position with crank-arm 39 in the vertical position shown in FIG. 2 the gating yoke 36 blocks the slot 35 and diodes are transported to be deposited in the open chute 32 where they slide under the influence of gravity through the smooth curved tube 33 thereby being reversed in orientation and deposited in the output feed trough 13. Those diodes which drop through the slots 35 are deliv-

ered without change of orientation through the bottom feed tower **51** to the trough **13.**

The details of the orientation reversal for diode **11** are indicated in FIG. **3.** Here the transport wheel **21** moves between the lead guides **26** and **27** transporting diodes **11** toward the inclined end faces **31** of the guides **26** and **27** where the diodes are deposited in the open top of chute **32.** Travelling around the curved tube **33** the diode **11** reverses its orientation relative to the position it had when it dropped from the guide wheel **21** and for this purpose the internal diameter of the curved tube **33** and the radius of curvature are selected to permit the full length of the leads of the diode to make the reversal without binding by contact with the inner walls of the tube **33.**

Referring now to FIG. **4** the control circuit for the system of the invention will be described. The particular function to be performed in the circuit of FIG. **4** is to sense the polarity of the diode **11** as it contacts the contacts **42** and control the stepping motor **38** in a manner to assure delivery of all the diodes to the output trough **13** with uniform polarity orientation. For this purpose the contacts **42** are supplied from a voltage source **61** through resistor **62** with a connection **63** to the input of a shift register **64.** The shift register **64** has the same number of stages as the number of slots **24** on the wheel **21** contained in the sector between the position of slots **35** and the position of the contacts **42.** The signal supplied on lead **63** will be a binary one or zero depending upon the polarity of the diode **11** in contact with the contacts **42** and since the shift register **64** has the same number of stages as the count of slots **24** in the sector between contacts **42** and slot **35** on the wheel **21** the output of the shift register **64** will correspond as a binary one or a zero with the polarity of the diode then appearing at the position of slot **35.** The photoresponsive device **44** is energized from a suitable source **65** and supplies counting pulses to a pulse-shaper **66,** the output of which on line **67** is a clock signal synchronized with the passage of slots past a predetermined position relative to the detector **44.** The exact location of the detector **44** or the contacts **42** on the periphery of the wheel **21** can be slightly adjusted to provide appropriate phase adjustment for entering the detection signal on line **63** and the first stage of shift register **64** relative to the clock shifting of these signals in the stages of the shift register to the right upon occurrence of each clock pulse on line **67.** The output of the shift register **64** on line **68** triggers a flip-flop to supply a binary assertion or negation output on lines **69, 71** to a stepping motor drive unit **72.** Upon the appearance of a binary one or plus signal output from the shift register **64** the stepping motor will be actuated for one position of crankarm **39** and for a negative or binary zero output on line **68** the stepping motor will be energized to the other position of crankarm **39.** Thus, for one polarity of the diode **11** in contact with contacts **42,** the crankarm will be actuated to let that diode drop through slot **35** after N pulses from photodetector **44** and the passage of the signal detected at contacts **42** through the N stages of shift register **64.** For the opposite polarity of the diode **11** in contact with contacts **42** the opposite actuated position of stepping motor **38** will occur N pulses later and prevent that diode from dropping through the slot **35.** Thus, the operation of the control circuit of FIG. **4** assures that all diodes are delivered by the transport wheel **21** to the ultimate output trough **13** with uniform polarity orientation.

Referring now to FIG. **5,** a modification is shown in which an orientation reversing tube **33'** is positioned beneath the vertical drop slots **35** while the output feed tower **51'** is positioned to receive the diodes discharged at the ends **31** of guides **26, 27.** Thus the location of the orientation reversing device **33** or **33'** can be at any discharge location.

FIG. **6** is a partial view showing modifications which may be used where components tend to jam and prevent smooth operation. In particular, the guide rails **26** and **27** of the embodiment of FIG. **1** have been removed from the top portion of the wheel and the resulting guide **27'** shown in FIG. **6** (and **26'** not shown) terminate at a point where the wheel travels downward. Thus components properly seated in the slots will be retained by the rails **26'** and **27'** as before but skewed components carried by the wheel but not fully seated in the slots will fall off. If desired wire pick-offs **75** on each side of the wheel can be provided which will intersect the axial lead of skewed components and assure that they do not reach the guides **26'** and **27'.** A similar pair of pick-off wires **76** on opposite sides of the wheel can be used to disengage bent lead components from the slots.

Many modifications will occur to those skilled in the art. For example, the curved inverting tube **33** and the output feed tower **51** may be interchanged to deliver uniformly orientated components to the discharge trough **13.** Furthermore, the present invention may be operated for testing other components than diodes and testing other characteristics than polarity. For example, several signal controlled discharge stations for the transport wheel could be provides with suitable ejecting or retaining means to permit sorting components into various groups based on a plurality of criteria. The criteria could, of course, be other than a mere polarity or a go or no go type measurement and could sort the components on a qualitative basis such as the value of a resistor, for example. Thus, a batch of resistors could be sorted into groups within ± 1 percent, 5 percent and 10 percent of the design or specification value of the batch which was manufactured. In sorting operations the components would be delivered to separate delivery troughs or receiving recepticles. Other applications of the invention and various modifications thereof will occur to those skilled in the art in light of the present teaching and the invention accordingly is not to be considered as limited to the disclosed embodiment but only by the scope of the appended claims.

I claim:

1. Apparatus for inspecting axial contact electronic components comprising:

means for entraining, retaining and transporting said components on a continuous inspection path with the contact axes of said components parallel to each other and transverse to said path, said path having a pick-up point for entraining said components and an exit point where said components are discharged from said path with means normally operative for retaining said components on said path between said pick-up point and said exit point;

means for making electric contact with the axial contacts of said components at a test station located on said path;

means for discharging said components at a discharge station at said exit point;

selectively operable means for discharging components entrained on the transporting means at an intermediate discharge station on said path located between said means for making electric contact and said exit point; and

means responsive to an electric characteristic of each of said components detected during said electric contact for controlling said selectively operable means in timed relation to the arrival of the respective component at said intermediate discharge station.

2. Apparatus according to claim **1** in which said characteristic detected is the polarity of said component and including:

means for conveying components discharged from each of said discharge points to a common delivery station; and

means interposed between one of said discharge points and said common delivery station for reversing the physical orientation of components discharged from said one discharge point.

3. Apparatus according to claim **2** in which the means for reversing comprises a curved tube through which the component slides.

4. Apparatus for inspecting elongated components having axial leads comprising:

an input feed tower for receiving said components and stacking a plurality of said components in a uniform pile;

a transport wheel having a plurality of opposed pairs of radial slots and mounted for rotation in relation to said input feed tower to pick one of said components from said pile in each of said opposed pairs and carrying said components around the peripheral path of said wheel;

a pair of electric contacts on opposite sides of said wheel arranged to contact said axial leads; retaining ring sectors concentric with said wheel for retaining said components in said slots said sectors having a drop slot in the bottom large enough to permit a component to drop therethrough;

a horizontally slidable bridging member for selectively opening and closing said drop slot;

a two position actuator for operating said bridging member to opening or closing position; and

a control circuit operatively connected between said electric contacts and said actuator.

5. Apparatus according to claim **4** and including a first gravity guide located directly beneath said drop slot and a second gravity guide for receiving components which pass said drop slot and are discharged at the end of said guide sectors.

6. Apparatus according to claim **5** in which said first and second gravity guides deposit components passing therethrough to a common delivery station.

7. Apparatus according to claim **6** and including an orientation reversing bend in one of said gravity guides.

8. Apparatus according to claim **7** in which said reversing guide is a curved tube.

9. In an elongated component processing machine for components having axial leads with paths of travel for some of said components to a delivery station where the physical orientation of the component is required to be reversed, the improvement which comprises a curved tube defining a portion of said path of travel with an upper inclined portion open to receive a component which will slide into the closed portion of said tube, the inner diameter and radius of curvature of said closed tube being such that said component can slide around said curve without binding, and an inclined delivery end of said tube from which said component slides with orientation reversed relative to that at the input to said tube.

10. Apparatus for inspecting elongated components having axial leads comprising:

an input feed tower for receiving said components and stacking a plurality of said components in a uniform pile;

a transport wheel having a plurality of opposed pairs of radial slots and mounted for rotation in relation to said input feed tower to pick one of said components from said pile in each of said opposed pairs and carrying said components around the peripheral path of said wheel;

a pair of electric contacts on opposite sides of said wheel arranged to contact said axial leads;

retaining ring sectors concentric with said wheel for retaining said components in said slots said sectors having a drop slot in the bottom large enough to permit a component to drop therethrough;

a gating member for selectively opening and closing said drop slot;

a two position actuator for operating said gating member to opening or closing position; and

a control circuit operatively connected between said electric contacts and said actuator.

11. Apparatus according to claim **10** in which said components are retained by gravity during initial travel over the top position on said wheel and said retaining ring sectors terminate near the position where gravity would no longer retain said components in said slots.

12. Apparatus according to claim **11** and including finger means mounted adjacent said transport wheel in the region where said ring sectors terminate and projecting toward the top of said wheel, said finger means being radially spaced relative to the bottom of said slots so as to intercept leads on said components which are bent out of axial position a predetermined amount and operative to deflect a component with such bent leads out of entrainment in said slots.

13. Apparatus according to claim **12** in which said finger means include fingers radially positioned both greater than and less than the radial distance of said slots.

14. Apparatus according to claim **11** further characterized by forming the terminated ends of said ring sectors as a downwardly inclined cam surface for deflecting unentrained components away from said wheel.

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