May 30, 1967 R. O. BAILEY 3,322,273

ROTARY BIN SORTER

Filed March 24, 1964 2 Sheets-Sheet 1

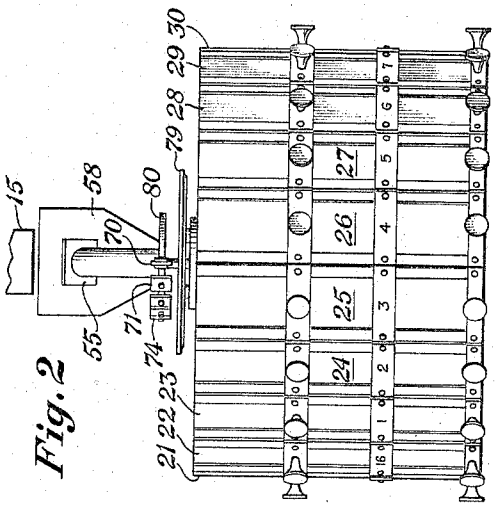


Fig. 2

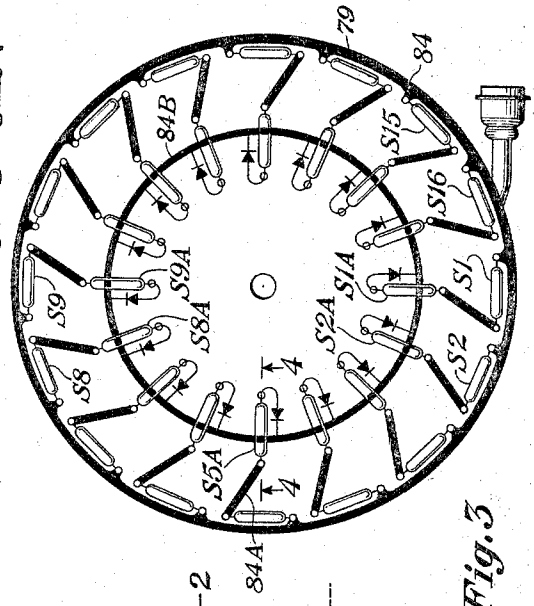


Fig. 3

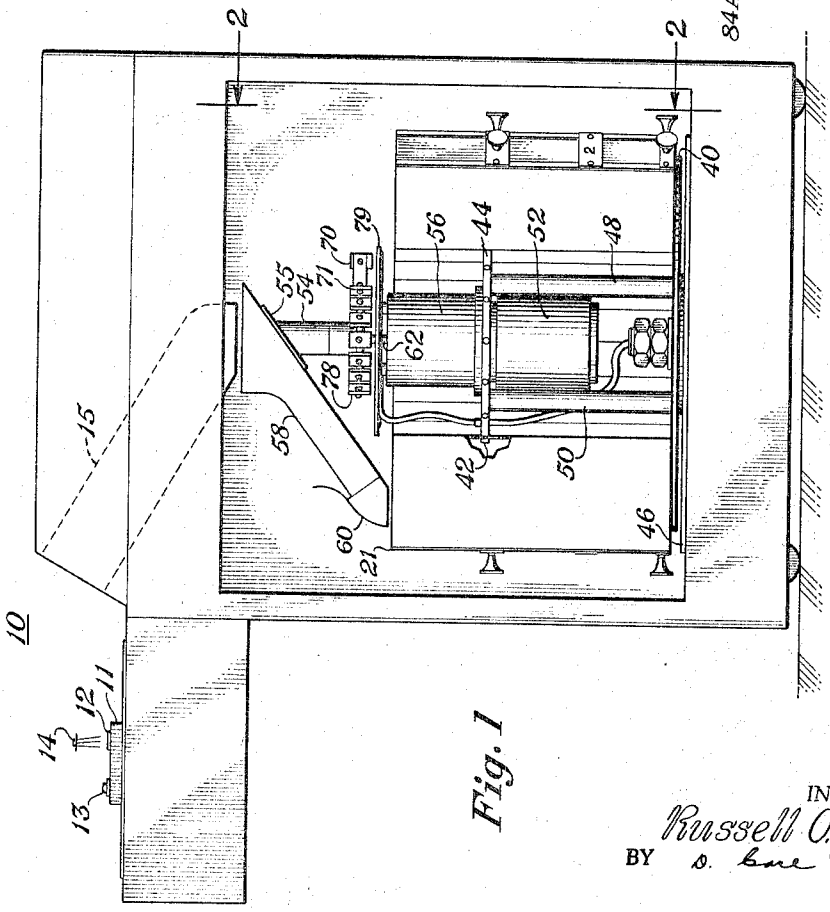


Fig. 1

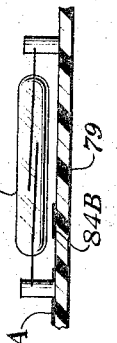


Fig. 4

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ROTARY BIN SORTER

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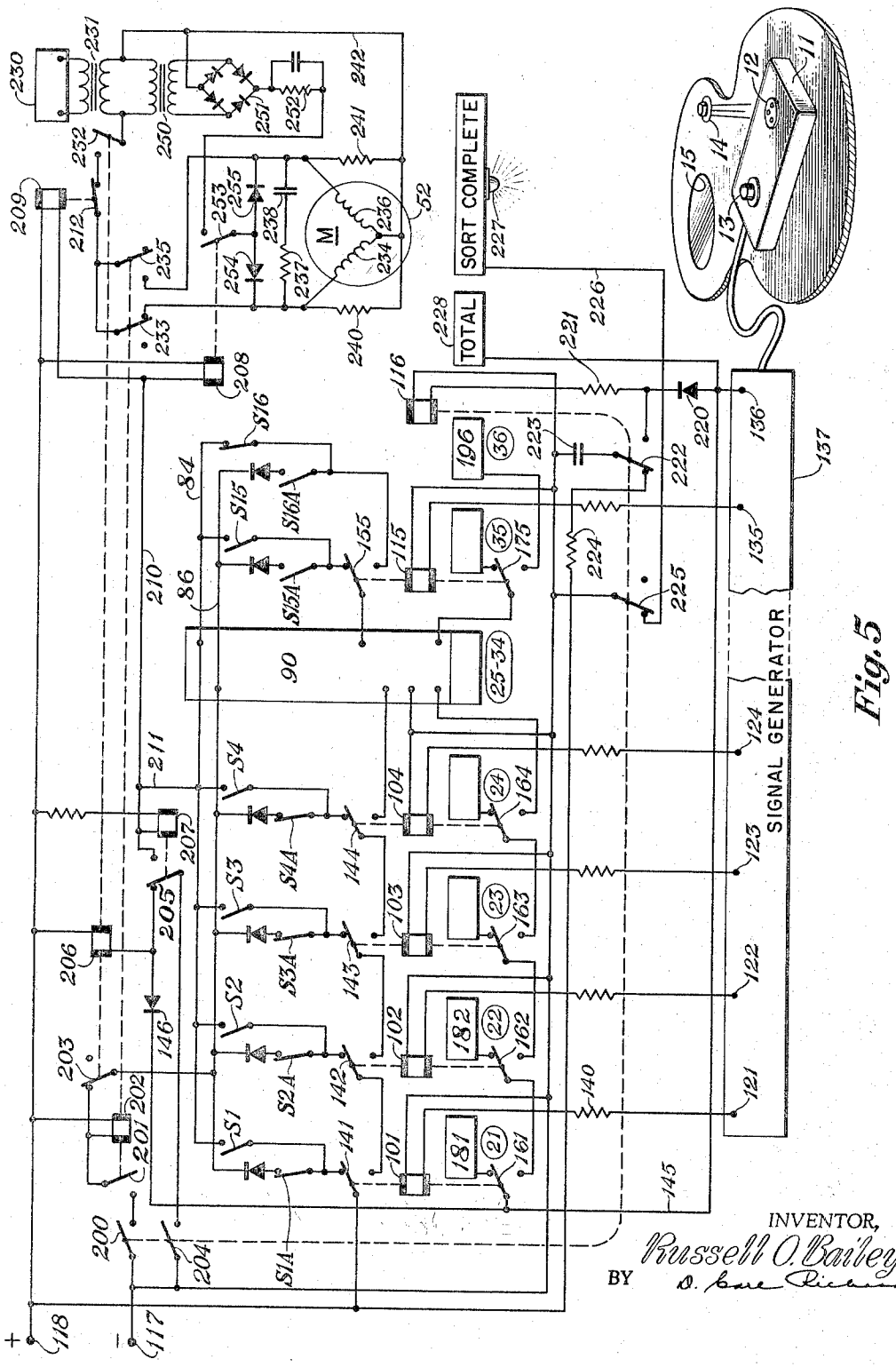


Fig. 5

United States Patent Office 3,322,273 Patented May 30, 1967

3,322,273

ROTARY BIN SORTER

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Filed Mar. 24, 1964, Ser. No. 354,210
5 Claims. (Cl. 209—74)

This invention relates to a sorting system, and more particularly, to a multiple-bin rotary sorter. In a more specific aspect, the invention relates to the control of the delivery of items, deposited serially in a sorting channel, into any one of a plurality of bins which are positioned in a circular array.

In the process of producing many products in high volume, quality and performance control often are superimposed on the output of the production line to sort the individual units produced into different categories, the nature and number of which depend upon preset or predetermined criteria. In the production of transistors, for example, there may be variations from one unit to another as they are delivered from an assembly line. The units generally must be individually tested to make certain that they meet certain standards. From such tests, they may be sorted into categories based upon the performance of each unit. The present invention relates to a multiple-bin rotary sorter which is mechanically driven in response to an external logic source which provides input signals categorizing individual units such as transistors or other articles.

More particularly, a multiple-bin rotary sorter is provided in which a plurality of article-receiving bins are disposed in a symmetrical array about a central axis. A spout supported for rotation about the axis extends radially over the position occupied by the bins. Means are provided for rotating the spout into registration with any of the bins. Control means operate upon registration of said spout with a selected bin for arresting rotation.

In a more specific aspect, the bins are elongated, truncated, pie-shaped receptacles disposed in a circular array. A drive motor is mounted at the axis of the array with a driveshaft extending above the array. The spout is supported on the driveshaft and extends radially downward adjacent to the tops of the bins and is rotatable upon energization of the motor to sweep over the bins. A fixed support is mounted adjacent to the spout and has normally open switches mounted thereon in a circular array in number corresponding with the number of bins. An energizing circuit for the motor includes de-energization means operable upon the closure of one of the switches. Switch actuator means, supported on the shaft for rotation therewith in proximity to said switches, close the switches sequentially as the spout is rotated. Means responsive to a categorizing signal energize a circuit leading to one of the switches to de-energize the motor when the spout reaches a selected bin and a selected one of the switches is closed.

For a more complete understanding of the present invention and for further objects and advantages thereof, reference may now be had to the following description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a side view partially broken away of a sorting console embodying the present invention;

FIGURE 2 is a view taken along the line 2—2 of FIGURE 1 showing a portion of the system of FIGURE 1;

FIGURE 3 is a layout of the relay turn-table;

FIGURE 4 illustrates a reed relay as viewed along line 4—4 of FIGURE 3; and

FIGURE 5 is a circuit diagram of a control system.

The present invention will be described in connection

with a manually controlled testing operation in which an operator may be seated at a test console **10** with a test block **11** on a desk portion of the console. The test block **11** has a component-receiving fixture or socket **12** and a test button **13**. The operator inserts a component **14** to be tested in the socket **12** and depresses the button **13**. Responsive thereto, one of the test systems known in the art subjects the component **14** to a plurality of different tests. When the testing sequence is completed, an actuating signal is generated by the testing unit. The operator then removes the component **14** from the fixture **12** and deposits it in a chute **15**.

This invention is directed to a system for directing the element **14** when placed in chute **15** to one of a plurality of bins, the location or identity of which is determined by a categorizing signal which results from the test procedure. There are many different tests and many different criteria that might be applied in the tests of a given component or class of components. For the purpose of the present invention, it will be presumed that a multi-component categorizing signal is generated in response to the tests of a given component, and that in response to the categorizing signal, the component is to be delivered to a particular receptacle or bin.

In accordance with the embodiment of the present invention shown in the drawings, sixteen bins **21–36** are employed. The bins are generally of truncated, pie-shaped cross section. They are mounted in a circular array on a turn-table **40**. Each bin rests on the turn-table **40** at the bottom thereof, and is hooked onto the head of a screw or bolt at a midpoint, as shown in FIGURE 1, where a keyhole in the inner wall of bin **21** engages the head of a radially extending bolt **42**. Bolt **42** is secured into the periphery of a disk **44**. The turn-table **40** is rotatably mounted on a base plate **46**. By this means, the bins can be rotated so as to face a door in console **10** for loading empty bins and removing loaded bins. A pair of vertical supports **48** and **50** are mounted on the turn-table **40** and support the disk **44**.

A synchronous stepping motor **52** is mounted on the underside of disk **44** and serves to drive a shaft **54** through a gear reduction unit **56**. The shaft **54** has a sloping upper surface with a mounting plate **55** thereon. A radial, downwardly extending delivery spout **58** is mounted on mounting plate **55** with its mouth positioned at the axis of rotation to receive components deposited in the chute **15**. The spout **58** has its discharge port or nozzle **60** positioned over the zone occupied by bins **21–36**. By rotation of spout **58**, components can be delivered to any one of the sixteen bins mounted on the turn-table **40**.

It is an object of the present invention to provide for rapid rotation of the spout **58** from any given position to a new position, and to stop the spout at the selected position, depending upon a categorizing signal in the time interval between the completion of the test of the component **14** and the time the component reaches the delivery nozzle **60** of the spout **58**. Further in accordance with the present invention, the spout **58** will not have to rotate more than 180° from any start position to reach any bin. The direction of rotation is controlled so that the spout will always travel in the direction corresponding with the shortest distance to the next selected bin.

Control of the spout **58** is accomplished in accordance with the present invention by energizing the motor **52** upon completion of the test sequence and then by stopping the motor in response to actuation of a control element by a position magnet **70** which rotates with spout **58**. More particularly, nine relatively short bar magnets **70–78** are mounted on a disk **80** which in turn is mounted on shaft **54**. Eight of the magnets, the magnets **71–78**, are mounted on a relatively short radius. Magnet **70** is

supported by a bracket from disk 80 at a considerably greater radius than magnets 71–78. The shaft 62 from the reduction gear unit 56 extends upwardly through a stationary table 79, supported above the gear reducing unit 56. The table 79 supports a plurality of reed relays. In this embodiment, a sixteen-bin unit, sixteen normally open reed relays, S1–S16 are mounted in a circle on the table 79 so that they may be actuated by the magnet 70. Sixteen additional normally open reed relays S1A–S16A are mounted on the table 79 at a shorter radius so that they will be actuated by the magnets 71–78. When motor 52 is energized, the spout 58 and magnets 70–78 rotate. When magnet 70 closes a circuit through the one of relays S1–S16 which is enabled by a categorizing signal, the motor 52 is de-energized to arrest the travel of the spout 58. The magnets 71–78 cooperate with the inner ring of reed relays S1A–S16A to provide for control of the direction in which the spout 58 rotates and to cause it to rotate in a direction for shortest traverse of the spout 58 to a new bin.

Referring to FIGURE 2, the table 79 is shown beneath the magnet-supporting disk 80. The magnet 70 is mounted in the angular position next to the magnet 71. The magnets 71–78 are mounted to span one half of the circumference of the disk 80. The back of the spout 58 is visible showing its mounting on the supporting plate 55. The magnet-supporting disk 80 rotates with the spout 58, both the disk 80 and the spout 58 being mounted on the same shaft.

FIGURE 3 is a top view of the relay table 79 of FIGURES 1 and 2. Sixteen relays S1–S16 (normally open magnetically actuated switches) are mounted adjacent to the outer rim or periphery of the table 79. In practice, the table 79 may be a printed circuit board having conductive buses thereon. One contact or terminal of each of the relays S1–S16 is connected to an outer conductive bus 84. The other terminal of each of the relays S1–S16 is connected to an individual bus, such as bus 84A, which extends toward the center of the table 79.

Sixteen additional relays S1A–S16A are mounted on table 79 which their axes directed radially. One terminal of each of the relays S1A–S16A is connected to one of the inwardly directed buses. The other terminal is connected by way of a diode to an inner or central bus 84B.

FIGURE 4 illustrates relay S5A. It is mounted at one end on a post which is in contact with the end of the bus 84A. The other end is mounted on a post from which a diode connection is made to the bus 84B. Relay S5A has two inwardly extending overlapping conductors, at least one of which is magnetic. With the magnet positioned above the conductors, the two conductors are forced together. The magnet 70 of FIGURES 1 and 2, as mounted, extends radially for cooperation with the relays S1–S16. The magnets 71–78, as mounted, extend tangentially so that they will cooperate with the radial relays S1A–S16A. For any position of the spout 58, one of the relays S1–S16 will be closed. For example, if relay S16 is closed because of the presence of magnet 70 immediately thereabove, then each of the relays S1A–S8A will be closed because magnets 71–78, respectively, are positioned above them.

The foregoing construction is utilized in connection with the circuit shown in FIGURE 5 for operation in which the spout 58 is rotated through 180° in not more than one second. Thus, the spout 58 can be moved to a position over any one of sixteen bins from any other one of the sixteen bins in a time interval of less than one second. The system is highly economical of space and yet has adequate capacity to accommodate a substantial production of items such as electrical components.

CONTROL UNIT

The manner in which the system operates will further be understood by referring to the schematic diagram of FIGURE 5.

In FIGURE 5, the relay S16 is shown closed with the relays S1–S5 and S15 being in their normally open state. The relays S1A–S4A are shown closed, as would be the case for the position of the spout 58 above discussed. Only six of the sixteen channels are shown in detail in FIGURE 5, with the remaining ten being identical in their circuit arrangement, and being represented by the block 90. The relays S1–S16 are connected to the common bus 84. Relays S1A–S16A are connected through their respective diodes to the common bus 86.

Control relays 101–116 are provided to enable one of the sixteen channels through reed relays S1–S16. More particularly, one terminal of each of the relays 101–116 is connected to a D.C. supply line 117 of negative polarity. The other terminal of each of the relays 101–116 is connected to separate input channels 121–136 which represent the output of a catagorizing signal generator 137. The logic of the system is, that if a given component passes all of the tests to which is is subjected, it will be delivered to the last of the bins. If it fails Test 1, Test 2, or Test 3, then it will be delivered to bin 21, bin 22, or bin 23, respectively, depending upon the test results. The logic is such that the appearance of a positive potential on any of the lines 121–136 will exclude the tested component from the bin on whose line the voltage appears.

Channel 121 is connected by way of a resistor 140 to relay 101. Relay 101 controls two armatures, 141 and 161. In one position of armature 141, a D.C. voltage from the positive line 118 is applied to reed relays S1 and S1A. In the second position, the position when the relay 101 is energized, power is supplied from line 118 by way of armature 141 to armature 142 to apply power to the reed relays S2 and S2A.

The armature 161 is connected to a count pulse bus 145. When relay 101 is not energized, the armature 161 applies counting pulses on bus 145 to a counter 181, which totals the number of components delivered to bin 21. When relay coil 101 is energized, the armature 161 serves to apply counting pulses from bus 145 to a succeeding counter in the bank 182–196. The counter in this bank which receives any given count pulse is dependent upon the categorizing signal. It will be noted that the armatures 161–175 are connected in a series relationship. In a similar manner, the armatures 141–155 are connected in a series relationship.

The negative power line 117 is connected by way of armatures 200 and 201 to one terminal of a relay coil 202. The second terminal of coil 202 is connected to the positive line 118. Coil 202 is connected also by way of an armature 203 to the direction bus 86.

Line 117 is also connected, by way of an armature 204 and an armature 205, to a first terminal of a relay coil 206. The first terminal of coil 206 is connected by way of a rectifier 146 to the count bus 145. The normally open terminal associated with armature 205 is connected by line 210 to one terminal of each of relay coils 207, 208, and 209. The second terminal of coils 207, 208, and 209 are connected to the positive line 118. The line 210 is also connected by way of line 211 to the stop bus 84. In the embodiment illustrated, power lines 117 and 118 supply unidirectional power at 110 volts.

Channels 121–135 of the generator 137 are connected by way of resistors only, such as resistor 140, to the respective relay coils 101–115. However, the channel 136 is connected by way of a rectifier 220 to resistor 221 and to the relay coil 116. The juncture between diode 220 and resistor 221 is connected to the normally open terminal of an armature 222, which is controlled by the relay coil 116. The armature 222 is connected to the negative line 117 by way of a condenser 223. The normally closed terminal, associated with armature 222, is connected by way of a resistor 224 to the positive line 118.

The relay coil 116 also controls a second armature 225. In the normally closed position of armature 225, power is supplied from the positive line 118 by way of conductor

226 to a lamp 227 which signals that a sorting operation is complete. A totalizing counter 228 is connected to line 136 so that a total count of all sorting sequences is registered.

MOTOR POWER

The motor 52, shown schematically in FIGURE 5, is driven from an alternating current source 230. Motor 52 is coupled to the power circuit by way of a transformer 231. One terminal of transformer 231 is connected to a series circuit including normally open armature 232 and normally closed amatures 212 and 233 and a first winding 234 of the motor 52. Armature 233 is electrically connected and mechanically linked to a second armature 235 which is normally open. Upon closure of armature 235, armature 233 opens and power may be applied from armature 212 to the second winding 236 of the motor 52. A resistor 237 and a condenser 238 are connected in series across the terminals of the windings 234 and 236 of motor 52. A resistor 240 shunts the winding 234. A resistor 241 shunts the winding 236. The common juncture of windings 234 and 236 and resistors 240 and 241 is connected by way of conductor 242 to the second terminal of transformer 231.

A braking circuit for motor 52 includes a second transformer 250 which supplies a full-wave rectifying bridge 251. One terminal of the bridge 251 is connected to line 242. The other is connected by way of an R.C. network 252 and a normally open armature 253 to the midpoint between a pair of oppositely-poled diodes 254 and 255 which are connected to the windings 234 and 236, respectively.

The armature 232 is controlled by relay coil 206 which also controls the armature 203. The armature 201 and armatures 233 and 235 are controlled by relay coil 202. Relay coil 207 controls armature 205. The relay coil 116 controls not only the armatures 222 and 225, but also the armatures 200 and 204. The relay coil 208 controls the normally open armature 253. The relay coil 209 controls the normally closed armature 212.

Energization of relay coil 206 starts the motor 52. The state of relay coil 202 controls the direction of motor 52. Energization of relay coil 209 removes power from the motor 52. Energization of relay coil 208 applies a braking force to the motor 52. Energization of relay coil 207 latches or locks the motor 52 at a given rest position.

OPERATION SEQUENCE

Motor 52 is started in response to the appearance of a a sort command voltage on line 136. This closes or energizes the relay coil 116 which serves to close circuits through armatures 200 and 204. This applies power by way of armature 204 to the relay coil 206. When relay coil 206 is energized, a circuit is completed through armature 232 to energize the motor 52.

Depending upon which bank of reed relays S1A–S16A is energized, a voltage may or may not appear on the direction bus 86 and thus on the armature 203. If a voltage *does* appear on armature 203, then relay coil 202 is energized and armatures 233 and 235 are actuated to reverse the direction of the motor 52 from normal. Energizing of the relay coil 202 closes armature 201 to apply a holding power to the relay coil 202, since armature 203 will be moved to its normally open terminal upon closure of armature 204. Thus, motor 52 is set into motion in a direction depending upon the presence or absence of voltage on bus 86. Motor 52 then rotates the spout 58 until the magnet 70 closes a selected one of the reed relays S1–S16.

To illustrate, assume that the spout 58 is initially positioned over bin 16. In this position, the stop magnet 70 closes reed relay S16. The direction magnets 71–78 close reed relays S1A–S8A. As the tester unit 137 then sequences through a series of tests, the bin relay coils 101–116 monitor the tester sort logic channels 121–136. A voltage appearing on any one of channels 121–135 excludes the tested unit from the corresponding bin. If, for example, in a given test sequence, the bin channels 121–123 each apply voltages only to relay coils 101–103, the closure of the armatures 141–143 places a voltage from line 118 on the relay S4 and on the direction relay S4A. Relay coil 202 is energized since a direction magnet is positioned over the switch S4A. When the test sequence is finished in the unit 137, a sort command voltage appears on channel 136 to energize relay coil 116. The circuit through armature 225 is thus opened, removing voltage from the sort-complete lamp 227. The circuits through armatures 200 and 204 are completed to furnish a latch-path for relay coil 202. The path through armature 204 energizes relay coil 206, thereby completing a latch-path by way of diodes 146 and 220 to relay coil 116. When the start relay coil 206 is energized, 115-volt alternating current power is applied to the motor 52 through armatures 232, 212, and 235. Motor 52 starts rotating the magnet carrier disk 80 clockwise as viewed from the top. The stop magnet 70 closes each of stop reed relays S1, S2, S3, and S4 as it passes over it. When stop reed switch S4 is closed, a voltage path is completed by way of conductor 211 to the bus 210 to energize relay coils 207, 208, and 209. Relay coils 208 and 209, thus energized, are latched to the voltage from line 118 by way of armature 205 which is held closed by energization of relay coil 207. Energization of relay coil 209 actuates the armature 212 to break the power circuit therethrough and thus remove power from the motor 52. Actuation of armature 205 de-energizes the start relay 206, thus opening the circuit through armature 232. When relay coil 207 is energized, the latch-path through diodes 146 and 220, leading to the relay coil 116, is broken to de-energize coil 116. The R.C. circuit involving condenser 223 and resistor 224 delays the release time of the armatures associated with relay coil 116 to insure that the sort operation will be complete before the sort-complete lamp 227 is energized. With the relay coil 116 de-energized, the sorter is ready for the next sort sequence. At this point in time, the drop spout 58 is positioned over bin 24. For the next sort sequence, the foregoing process is repeated but both the direction of the motor and the position in which it stops are dependent upon the condition of channels 121–135 prior to the appearance of the sort signal on channel 136.

In the embodiment of the invention above described, the motor 52 was a synchronous stepping motor of the type manufactured and sold by Superior Electric Company as a Slo-Syn SS–250 motor.

The reed relays S1–S16 and S1A–S16A were of the type well-known in the art and manufactured and sold by Hamlin Inc. of Lake Mills, Wis., and identifled as Catalog No. MRG–1.

The magnets 70–78 were of the type manufactured and sold by D. M. Steward Manufacturing Company of Chattanooga, Tenn., and identified as No. 836 Permanent Magnets.

In FIGURE 5, the signal generator has been illustrated in block form only. It is to be understood that any one of a number of different units may be provided to apply a voltage onto any one or more of the channels 121–136, in dependence upon a test condition to control the sorting logic. By way of example, the test unit may be of the type manufactured and sold by Texas Instruments Incorporated, Dallas, Tex., and identified as Model 654 Transistor and Diode Tester. Alternately, Texas Instruments' Model 659–A Integrated Circuit Tester, or Texas Instruments' Model 662 Integrated Circuit Tester may be employed as the signal generator 137 of FIGURE 5.

While the invention has been described in connection with a system in which reed relays are operated by permanent magnets in order to sense direction and position, it is to be understood that different specific means may be employed. For example, indicating lamps and photocells may be employed in place of the magnets and reed relays for establishing control conditions in the control

circuits. However, this has proven to be more expensive and somewhat less reliable than the magnet-relay system illustrated herein. In any event, direction is sensed and the motor is started in the given direction at the completion of a test sequence and upon receipt of a sort-command signal. The motor then rotates a spout to a bin position dependent upon the categorizing signal, at which the position of the spout is sensed and the motor is abruptly de-energized and braked to a stop to deliver a component to the selected bin.

Having described the invention in connection with certain specific embodiments thereof, it is to be understood that further modifications may now suggest themselves to those skilled in the art and it is intended to cover such modifications as fall within the scope of the appended claims.

What is claimed is:

1. A multiple-bin sorter system responsive to any one of a plurality of categorizing signals which comprises:
(a) a plurality of bins disposed in a circular array,
(b) a motor mounted at the axis of said array with a drive shaft extending above said array,
(c) a spout supported on said driveshaft extending radially over the zone occupied by the tops of said bins and rotatable upon energization of said motor to move sequentially into registration with said bins to direct articles thereto,
(d) a fixed support mounted adjacent to said spout having normally opein switches mounted thereon in a circular array and in number corresponding with the number of said bins,
(e) a control and energizing circuit for said motor which includes de-energization means operable upon the closure of one of said switches,
(f) means supported on said driveshaft for rotation therewith in proximity to said switches for closing said switches sequentially as said spout is rotated, and
(g) means responsive to a categorizing signal for energizing a circuit leading to said one of said switches to de-energize said motor when said one of said switches is closed.

2. A multiple-bin sorter system responsive to any one of a plurality of categorizing signals which comprises:
(a) a plurality of pie-shaped bins disposed in a circular array,
(b) a motor mounted at the axis of said array with a driveshaft extending above said array,
(c) a spout supported on said driveshaft extending radially downward adjacent to the tops of said bins and rotatable upon energization of said motor to move into registration with a selected one of said bins to direct material thereto,
(d) a fixed support mounted adjacent to said spout having field-actuated normally open switches mounted thereon in a circular array in number corresponding with the number of said bins,
(e) a control and energizing circuit for said motor which includes de-energization means operable upon the closure of one of said switches,
(f) field generating means supported on said driveshaft for rotation therewith in proximity to said switches for closing said switches sequentially as said spout is rotated, and
(g) means responsive to a categorizing signal for energizing a circuit leading to said one of said switches to de-energize said motor when said one of said switches is closed.

3. In a sorter system responsive to at least one categorizing signal in each sort cycle to deliver an article to a location selected by said signal, the combination which comprises:
(a) article delivery means movable in either of two directions,
(b) a plurality of normally open switches forming a first array,
(c) a plurality of normally open switches forming a second array,
(d) a signal switch actuator coupled to said delivery means sequentially to close switches in said first array one at a time,
(e) a bank of switch actuators in number not substantially less than one-half the number of the switches in one of said arrays coupled to said delivery means synchronously to close the fraction of the switches in said second array wrich are positioned in said second array on one side of a point in said first array corresponding with the location of said single switch actuator,
(f) an energizing circuit for said delivery means normally to move it in one direction,
(g) means to apply said categorizing signal to one switch in each of the arrays,
(h) direction control means responsive to a closed condition of any switch in said second array on which said signal appears to condition said energizing circuit move in a reverse direction,
(i) means responsive to a cycle start signal to energize said delivery means, and
(j) means responsive to positional coincidence between said delivery means and said location to de-energize said delivery means.

4. A sorter system responsive to at least one categorizing signal in each sort cycle which comprises:
(a) a plurality of bins positioned in a symmetrical first array about an axis,
(b) a spout mounted on said axis for rotation over said bins,
(c) a like plurality of normally open switches forming a second array around said axis,
(d) a like plurality of normally open switches forming a third array around said axis,
(e) a single switch actuator mounted for rotation with said spout sequentially to close switches in said second array one at a time,
(f) a bank of switch actuators numbering about one-half the number of said bins mounted for rotation with said spout to close about one-half of the switches in said second array located on one side of said single switch actuator,
(g) drive means simultaneously to move said spout and said actuators,
(h) an energizing circuit for said drive means normally to move said spout and said actuators in one direction,
(i) means to apply said categorizing signal to one switch in each of the switch arrays,
(j) direction control means responsive to a closed condition of any switch in said third array to condition said energizing circuit for reverse movement of said spout and said actuators,
(k) means responsive to a cycle start signal to energize said drive means, and
(l) means responsive to closure of said one switch in said second array to arrest travel of said spout.

5. A sorter system responsive to a categorizing signal in each sort cycle which comprises:
(a) a plurality of bins in a first array,
(b) a spout mounted for movement sequentially to register with each of said bins,
(c) a plurality of normally open switches forming a second array,
(d) a plurality of normally open switches forming a third array,
(e) one switch actuator mounted for movement in synchronism with said spout sequentially to close switches in said second array one at a time,
(f) a bank of switch actuators in number not substantially less than one-half the number of said bins

and mounted for movement in synchronism with said spout to close a fraction of the switches of said third array which are positionally related to the other switches as the bins on one side of said spout are positionally related to the other bins,

(g) drive means simultaneously to move said spout and said actuators,

(h) a direction control circuit for said drive means to move said spout and said actuators in one direction along their respective arrays,

(i) means to apply one categorizing signal to one switch in each of the second and third arrays,

(j) direction control means responsive to a closed condition of any switch in said second array having a categorizing signal thereon to alter the energizing circuit for reverse movement of said spout and said actuators,

(k) means responsive to a cycle start signal to energize said drive means, and

(l) means responsive to registration of said spout with the bin in said first array corresponding with the position of said one switch in each of said second and third arrays abruptly to arrest travel of said spout.

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ROBERT B. REEVES, *Primary Examiner.*